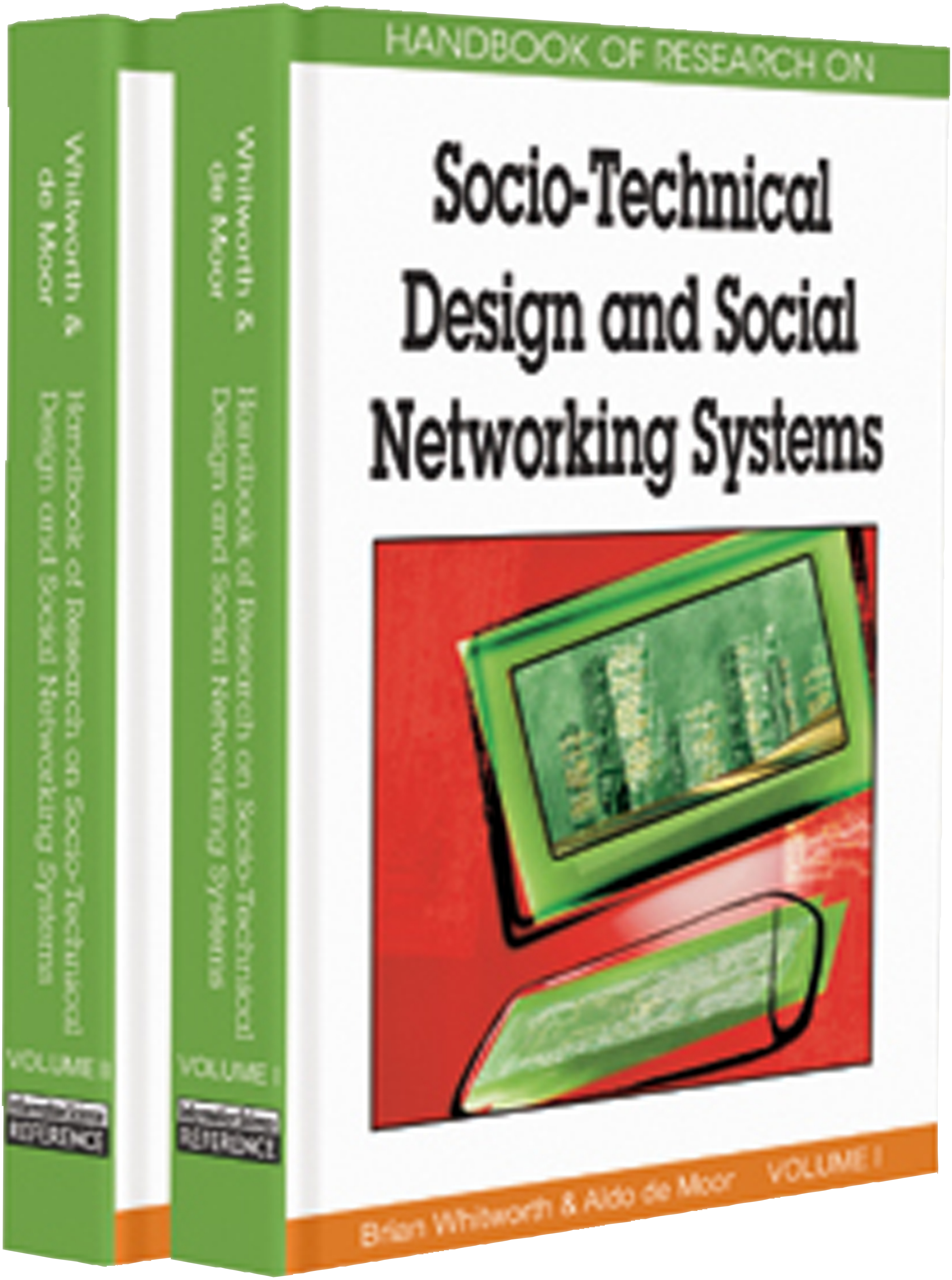
HANDBOOK OF RESEARCH ON
Socio-Technical Design and Social Networking Systems
Brian Whitworth & Aldo de Moor
VOLUME I
Whitworth & de Moor
Handbook of Research on Socio-Technical Design and Social Networking Systems
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REFERENCE
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Handbook of Research on Socio-Technical Design and Social Networking Systems
VOLUME II
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Handbook of Research on Socio-Technical Design and Social Networking Systems

Brian Whitworth
Massey University-Auckland, New Zealand

Aldo de Moor
CommunitySense, The Netherlands

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Cover Design: Lisa Tosheff
Printed at: Yurchak Printing Inc.

Published in the United States of America by
Information Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue, Suite 200
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com

and in the United Kingdom by
Information Science Reference (an imprint of IGI Global)
3 Henrietta Street
Covent Garden
London WC2E 8LU
Tel: 44 20 7240 0856
Fax: 44 20 7379 0609
Web site: http://www.eurospanbookstore.com

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Library of Congress Cataloging-in-Publication Data

Handbook of research on socio-technical design and social networking systems / Brian Whitworth and Aldo de Moor, editors.
p. cm.
Includes bibliographical references and index.
Summary: "Every day throughout the world, people use computers to socialize in ways previously thought impossible such as e-mail, chat, and social networks due to emergences in technology. This book provides a state-of-the-art summary of knowledge in this evolving, multi-disciplinary field"--Provided by publisher.
ISBN 978-1-60566-264-0 (hardcover) -- ISBN 978-1-60566-265-7 (ebook)
1. Online social networks. 2. Internet--Social aspects. 3. Information technology--Social aspects. I. Whitworth, Brian, 1949- II. Moor, Aldo de.
HM742.H37 2009
303.48'33--dc22
2008037981

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

All work contributed to this book set is original material. The views expressed in this book are those of the authors, but not necessarily of the publisher.

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Table of Contents

Detailed Table of Contents

Section VI
Socio-Technical Evaluation

Foreword

The brilliant innovators, who described socio-technical systems, wisely anticipated the complex problems that challenge modern designers. They understood that Moore's Law and other principles of technology advancement would need to be supplemented by social design breakthroughs that accommodate the realities of human relationships. While mega-bytes and giga-hertz remain adequate measures of technology advances, we still await the definition of equivalent "mega-contribs" or "giga-collabs" to represent the progress in human contributions and collaborations brought by the rapidly growing socio-technical and networking systems. Still greater challenges remain as designers, managers, and researchers struggle to measure and improve socio-technical and networking systems so as to increase trust, empathy, responsibility, and privacy.

While some narrowly focused technologists find the social aspects of systems a troubling distraction, visionary policy makers, industrial leaders, and academic researchers share a growing recognition that socio-technical and social networking systems offer compelling opportunities. They have seen beyond the playful, discretionary Web-based applications that promote personal identity exploration, fantasy game-playing and entertainment-oriented social media. These will flourish as entrepreneurial successes, but other applications are beginning to support major national priorities such as healthcare delivery, workforce competitiveness, disaster response, and political participation. Still broader applications will promote international development, sustainable energy solutions, environmental protection, and homeland security. Existing applications such as e-commerce or education will also benefit from the new possibilities brought by social media and user-generated content.

This remarkable collection of articles captures some of the excitement and possibilities for system developers and researchers. The chapters, which come from an international community representing academia and industry, provide valuable guidance for the difficult road ahead. Blending Internet technology and social goals is a challenge but the payoffs are potentially enormous. However, the turbulence of change can be unsettling, so socio-technical designers can only succeed by considering costs and benefits for all stakeholders. Since unintended consequences of these new socio-technologies may be disruptive, experience from previous systems and mechanisms for continuous improvement, such as this book provides, will help to smooth the way. For instance, for large government-directed projects, independent oversight to review designs for proposed socio-technical systems could play a positive role in ensuring successful outcomes. In addition, independent oversight panels can play a helpful role in continuously monitoring impacts and through annual retrospective reviews that update procedures and set future priorities.

The power of the Internet to lower the costs of collaboration reshapes the possibilities for socio-technical designers. Centralized, rigid, and hierarchical solutions were needed in the past when communication was difficult, dialog was a time-consuming distraction, and broad participation in discourse was a costly luxury. However these demands no longer dominate design. Shedding 19th and 20th Century top-down solutions in favor of bottom-up egalitarianism is a step in the right direction; exchanging the top-down way of thinking for a bottom-up way of thinking is somewhat harder. When every user can be an initiator and every community can quickly organize its members, technology designers and social planners need new ways of thinking. Initial attempts at alternative metaphors to capture this new concept of rapid action are not yet satisfying: viral marketing has a disease-like connotation, while explosive and forest-fire analogies are disturbingly destructive. Fresh metaphors could help designers and users appreciate the potential for thriving communities, catalytic collaboratories, and Wiki-wisdom. Visual imagery linked to defined social requirements might also more clearly give users the reassurance they demand in areas like swift trust, privacy shields, and lockbox security.

The challenges of socio-technical design and social networking systems go well beyond getting great screen designs with compelling graphics. A socio-technical infrastructure must support huge, yet reliable databases, sprawling yet easily navigable network connections, and powerful yet rapid services. The starting point for interface design is a clear presentation of choices so users can make selections with confidence, learn shortcuts for their most frequent actions, and explore safely when trying something new.

When problems arise, as they inevitably do, user support not only provides users a safety net and a supportive resource, it provides the managers with data for the continuous improvement of basic designs. However, like all social interactions customer relations go both ways. Even further, the social network allows users to help users, and this has already been an unanticipated but remarkable success story. Discussion groups have already reshaped online customer service, enabled sharing of medical experiences, and generated extensive reviews of products and services from movies to medical care.

Reliable infrastructure and excellent customer service are easy to describe but hard to deliver, due to the massive scale of modern socio-technical applications. Huge server farms with readily available backups are a good start, but keeping millions of routers and cell phone towers operating when natural disasters or peak usage periods hit is critical goal for infrastructure operators. The aspiration for customer service providers is equally complex, as it may involve millions of people across dozens of countries. Successful strategies include offering novices comprehensible navigation paths while allowing frequent users shortcuts, and enabling users of diverse languages to easily apply translation tools. The enormous variety of people means that there is a long "tail" to user needs, which includes support for older adults, for children, for users with motor, visual, or auditory disabilities, and for users with special needs such as dyslexia, aphasia, memory problems, and other cognitive limitations.

Attaining universal usability is a stronger requirement than merely achieving accessibility. It has created challenges and work for designers and programmers, but there are two pieces of good news. First, designing for diverse users has usually led to better designs for all users. For example, keeping to the clarity needed for challenged users makes for more rapid learning by novices, more speedy activity by frequent users, and better error prevention. Second, developer toolkits increasingly provide support for diversity, so that third-party tools such as screen readers, screen magnifiers, language translators, and so forth, are easy for designers to integrate. Attaining universal usability will make clear the need to also pursue "universal sociability", that is, technology that supports social principles common to all communities, like civil liberties, privacy, or fairness—in some ways that is the vision of this book.

The broad valleys joining infrastructure and customer service are filled with a rich variety of challenges, such as providing excellent service despite small displays, slow networks, and old platforms. The large displays on desktop systems are a luxury environment for designers, who must also cope with the small displays that are the norm on cell phones, digital cameras, music players, medical devices, Global Positioning Systems, and hundreds of other mobile consumer electronic products. Slow networks and even intermittent access complicates the designers' job in providing a great user experience when on-the-go users have to choose between using old data or waiting unpredictable lengths of time to get fresh data for their decision making.

The easy systems implementation problems have been addressed, so the next generation of computer managers, designers, and researchers will have to be especially creative and work intensely to come up with successful applications. Pure technical expertise is no longer enough. However, if managers require multiple evaluations, rehearsing initial designs from multiple social and technical perspectives, they have a chance of getting favorable reviews on opening night. But for all the complexity of initial roll-outs of new technologies, the real test is to ensure a successful process of continuous improvement over many years of growing usage. Socio-technical systems have to be built for easy revision, upgrade, extension, and integration with other services. Successful social systems will have long lifetimes, even as the surrounding culture evolves over decades or even hundreds of years. Similarly, socio-technical designers need to support data collection and decision making that ensures effective modifiability. Experienced designers also account for the termination of such systems, with procedures for adequate preservation or destruction of sensitive and personal data, gathered perhaps over decades of operation.

Unfortunately, the world is not always a safe place for socio-technical system designers. Hardening applications to prevent penetration and providing backup systems for recovery are known protective strategies. While building in security and repair mechanisms can double the cost of system development and service provision, they can prevent system collapse or failure. Beyond natural disasters, peak usage problems and various breakdowns, providers must also deal with incorrect data, fraudulent usage, and malicious attacks.

The socio-technical equivalent of a physical disaster is a social disaster, where anti-social behavior destroys trust and participation. Maintaining users' trust in the face of such problems is the goal, but new measures will have to be developed to assess the many flavors of trust and the fragility of users' goodwill when breakdowns occur. Examples include transparent systems where user actions are visible to all, accountable systems that make users responsible for their impacts on others, and reputation systems where users act to maintain the goodwill and trust they have worked hard to achieve.

This long list of concerns may frighten some developers, but more and more designers and their organizations are stepping forward to these challenges while advertising their skills and successes. Meanwhile researchers have stepped forward to develop new research methods and fresh theoretical foundations. The methods social and natural sciences, business, education, health, engineering, and computer science can be applied to study socio-technical systems. Marketing analysis, ethnographic observation, user surveys, focus groups, case studies, and critical incidents will join traditional experimental approaches in this emerging field.

Carefully reported case studies, long accepted in medical literature and business education, and could become central to a science of socio-technical systems when controlled experiments are difficult or impossible to do. The reductionist approach, of breaking a system down into its component parts, so valuable during four centuries of natural sciences, may have limited applicability to the study of socio-technical systems, which by definition "emerge" from their components as new system types. Indeed the integrated nature of socio-technical systems may explain the plurality of methods and disciplines involved in it. In other writing (*Science 319* (March 7, 2008), 1349-1350), I have suggested the name *Science 2.0* for the evolution of science to include new forms, such as those that deal with the human-made world of socio-technical systems. The logic is that science needs to develop new methods and measures to cope with the difficult issues of trust, empathy, responsibility, and privacy raised by Internet-based human collaboration. Eventually researchers will clarify these terms enough so that designers can know how much of an improvement in privacy is necessary to generate a desired level of trust, or whether there is sufficient responsibility to ensure fairness, or intimacy to create empathy.

The massive scale of human collaboration and contributions made possible by the Internet and related technologies has the potential for enormous benefits in demanding applications such as healthcare delivery, disaster response, international development, or sustainable energy programs. It also raises equivalent risks, like the spread of terrorist ideologies, the denial of civil liberties, and the oppression by harsh rulers. Technology can magnify both good and bad, but open discourse, participatory design, and free flow of information can raise the awareness that defeats discrimination and oppression.

This volume contributes greatly in raising awareness about socio-technical design and social networking systems. It also presents a great deal of knowledge that users, designers and managers can use to build a better world in these complex times. Brian Whitworth and Aldo de Moor have gathered valuable material from an international panel of experts who guide readers through the analysis, design and implementation of socio-technical systems. It will be widely useful in defining issues in engineering, computing, management, organization, government policy, and ethics. The practical guidance and fresh theories can inspire a new generation of designers and researchers to catalyze even more potent forms of human collaboration.

—Ben Shneiderman
University of Maryland
August 2008

Preface

When a baby is born it is tender and fragile: when it grows and dies it becomes hard and stiff… Therefore the stiff and unyielding belong to the realm of death while the tender and sympathetic belong to the realm of life.

—Laotze, Tao Te Ching, Verse 76

Introduction

This handbook addresses current issues of research into socio-technical systems (STSs)—which are computer technologies that enable social interactions of any type. Examples include conversations (e-mail), group discussions (chat), group writing (Wiki), online trade (e-bay), online learning (WebCT), social networking (Facebook), and so forth. The Internet has evolved from hosting information to hosting social interactions. Yet as technology becomes part of social life, surely social life should be part of technical design? Without this, a "social-technical gap" emerges—a deficit between what society wants and what technology does. This book aims to reduce that gap, by suggesting how social knowledge can synergize with technical knowledge.

Socio-technical systems arise when social systems emerge from technical ones, so their success requires social as well as technical performance. The new multi-disciplinary field of socio-technical development cuts across traditional disciplines like engineering, psychology, computing, health, sociology, education, and business. This is a field that no specialist academic discipline can or should encompass. It "belongs" to all disciplines, as connecting social and technical involves not one specialty but many specialties. Any research organization working in this field needs not just cross-disciplinary teams but cross-disciplinary people, to cross discipline borders to make useful connections, as many chapters of this book illustrate.

The socio-technical concept generalizes and includes human-computer interaction (HCI), standing as it were upon the shoulders of HCI. Equally at a higher level "human-centered" computing contains both STS and HCI components. This book asks not how to make technology more efficient, nor how technology harms or helps society, but how to successfully combine society and technology in socio-technical systems. The premise is that technology is not a "given", but something people create for their use, so technology should work for us, not vice-versa. Ultimately, global humanity must control, direct, and define the computer technology that is currently changing humanity, and perhaps we need to change what is changing us, to survive. If society is the context of technology, not the other way around, it is incumbent upon us to define requirements, designs and measures for technology to follow. Since it would be unwise to try to do this blindly, this book sheds light on many of the issues involved.

Vision

Throughout the world today people are using computers to socialize in ways previously thought impossible—by e-mail, chat, instant messages, online worlds, e-markets, blogs, Wikis, social networks, social bookmarks, and many other ways and forms. Each of these is a socio-technical system (STS)—a social system that emerges somehow from a technical one. This book asks how such systems work and what makes them succeed. While connecting people electronically is complex, connecting them socially is even more so, as an STS must "perform" in both social and technical terms. Spam illustrates what happens when technical but not social problems are addressed, as ISP and user inboxes fill with messages nobody reads, wasting time, money, and resources. What use is a technically efficient network if 99% of its transmissions are unwanted spam, which creates neither social value nor meaning? Similarly, online issues of security, education, health, trade, and education now depend as much on social factors as on technical ones. Yet the real issue is neither social nor technical but how they connect.

As humanity enters a new millennium, one cannot help but feel that we have, over thousands of years, and sometimes with bitter struggle, made social progress. Villages formed into towns, then cities, then city states, then nations, then "nations of nations", such as the United States, the European Union, or China. We have indeed evolved from tribal social units to social systems with hundreds of millions of people. This gives us hope that the next step, an online global society with us all "citizens of the world", is possible, by the power of global communications technology. If so, understanding social history and principles is important in creating that technology. Social "inventions" like accountability, group identity, friendship, fairness, and public good have been as important to human progress as technology inventions. While computer technology enables new and previously impossible social forms, these forms may still need to follow principles inherent in all social situations, whether virtual or physical. Given several thousand years of physical social history, often written in blood and tears, it would be arrogant for technology to discount the social as irrelevant to the technical. And as online social generations come and go it is becoming clear, in areas like e-commerce, that technology alone does not have all the answers.

As technology problems are increasingly solved, now is a good time to start to address the critical socio-technical questions. A technology-savvy society is affected by the technology it runs upon, but equally it can "socialize" the technology which it creates. Conversely, technology designs are embedded within a social context, and need to engage that context to flourish. Without a social direction technology will not grow as it should, and equally without technology society will not grow as it should. The social and the technical are partners of vastly different natures, yet together they synergize the future. Some themes of this book are that:

1. The socio-technical evolution is only just beginning.
2. Technical systems that ignore social requirements will tend to fail.
3. Social systems that ignore technical support will tend to fail.
4. The future lies in harmonizing social and technical systems in innovative ways.

The Handbook

The exploration of social-technical issues requires the "coming together" of social and technical knowledge. To produce this book we invited new perspectives from top researchers and practitioners around the world. We asked them how social ideas can enlighten technical developments, and how technical developments can inspire new forms of social interaction. The contributors to this handbook are from many countries and disciplines, and practitioners as well as academics. We hope that an understanding of social computing today and tomorrow can be found in their many points of view. This state of the art summary of research in socio-technical design and social networking provides:

1. *Social concepts and theories,* to enlighten and inspire the analysis, design, implementation, evaluation and operation of socio-technical systems.
2. *Methods of system development,* to manage the complexity of socio-technical interactions.
3. *Examples of developed systems*, with application lessons learned.
4. *Socio-technical cases,* as fields or laboratories for social or technical research.
5. *Suggestions and future trends*, based on current developments and directions.
6. *Discussion of critical ethical and social issues*, involving technology and society.

The "*Handbook of Research on Socio-Technical Design and Social Networking Systems*" is distinctive in its variety of contributors, depth and breadth of scholarship, clarity and readability, structure and layout organization, combination of practice and theory, and positive vision of the future. The quotes provided by authors throughout the book epitomize their insights. This book will be useful not only to technical designers, where understanding of social principles can decide system success or failure, but also to those working in social fields, as it shows how social concepts and goals can manifest in technical practice. It will also help those teaching the social use of technical systems in any field, as the chapters provide excellent learning cases, and the number of chapters permits selection to fit almost any focus.

Socio-technical systems are essentially "hybrids", which are an uneasy mix of high level socio-cognitive structures with equally complex hardware and software architectures. Developing systems that balance human and social aspirations with the constraints of a technology base is a difficult endeavor. We should not expect to get it right the first time. More important than success is to remember hard-won lessons, as ultimately progress is based on knowing more. This book is not the "right way" of socio-technical systems, but merely a report on initiatives, efforts and experiences from workers in the field with the aim to increase knowledge in the field. STS theory and practice is still in its infancy. It has few established paradigms, and given its inherent complexity may continue for some time as it is today—a bubbling flux of new ideas. Yet that we do not know everything does not mean that we know nothing. We do know a great deal about merging the social and the technical, as this book testifies. It provides many signposts pointing to fruitful socio-technical destinations. We invite readers to form their own STS "gestalt" based on the fascinating collection of ideas and experiences presented here, and join the journey.

Contents

The book is organized by sections, representing how a socio-technical system might evolve, from concept to implementation and evaluation. Of course such linear paths are never smooth. Just as agile methods skip or cycle phases, most chapters in this book cut across multiple sections. The grouping is by primary concern, recognizing that chapters are rarely "pure", as ideas on analysis, say, may have implications for design. The structure is simply a convenient way to structure a complex field by the problems it faces: to conceive, analyze, design, implement and evaluate useful and practical socio-technical systems as catalysts for human social progress.

Section Summaries

The section details are as follows:

Section I introduces the core socio-technical concepts underlying socio-technical systems development and traces their historical roots, as one must know the past to understand the present (Chapter I). As the term implies, socio-technical research is like two different and distant worlds colliding (Chapter II), where the impact is not just technical upon social (Chapter III), but also social upon technical (Ch 4). This collision of research worlds has implications for online work systems (Chapter V), for online communities (Chapter VI), and for software development in general (Chapter VI).

Section II presents some socio-technical perspectives for socio-technical development. Privacy is the information equivalent of physical freedom, that is freedom to control not just one's physical self but also information about that self. This social principle can apply both to the governance of physical world data (Chapter VIII), and to the governance of virtual world data (Chapter IX). Another critical social factor is leadership (Chapter X), which in turn affects the critical online choice to participate or not, that is to use the technology tools provided (Chapter XI). Social revolutionaries like Martin Luther-King and Mahatma Ghandi tapped this ultimate human choice: to act or not. Similarly, on the Internet today people also choose to participate or not, with reasons from practical needs to simple entertainment (Chapter XII). Modern social democracies produce more by letting every race, creed, and color participate, and engage productivity by fairly sharing social gains both by need (socialism) and performance (capitalism). In contrast anti-social acts like stealing deny all forms of fairness. Two complementary response strategies in cyberspace are: (1) to lessen individuals use of technology to form flow "bubbles" that isolate them from society (Chapter XIII), and (2) to strengthen social values in technology to better allow society to protect Internet citizens from anti-social others (Chapter XIV). Finally, to advance, a society must support and not repress the human innovation that bubbles up from within it, with online service provision an excellent example of how technology can help do this (Chapter XV).

Section III suggests a range of approaches to socio-technical analysis, as one must capture socio-technical requirements before developing improvements. Doing this for socio-technical systems is not as simple as just asking people what they want, as people in groups follow norms instinctively despite declared statements (Chapter XVI). With this warning, socio-instrumental pragmatism (SIP) is a useful analytic approach (Chapter XVI), and business analytics is a useful source of information, although the analysis itself is a socio-technical process (Chapter XVIII). Another useful information source is users themselves, suggesting the concept of "co-design" (Chapter XVI). Conceptual graphs can also be used to formally analyze workflows and social norms in development (Chapter XX). In any socio-technical analysis expectations are raised or lowered, as interacting with people also affects them, so socio-technical success may depend on managing those expectations (Chapter XXI). Finally, if the goal of analysis is to find out "what users want", one way to do this is to give them technology "stubs" and let them report needs and expected usage at different times (Chapter XXII).

Section IV considers socio-technical design—the actual putting together of software components to create a social effect, that is, methods for turning social requirements into technical solutions. The socio-technical walkthrough is a useful way to test a design that involves people before it is implemented (Chapter XXIII). As creating software designs parallels the creative design of furniture, the translational design approach can help STS designers (Chapter XXIV). In socio-technical systems, the human-computer divide is not absolute, so computer agents in organizational environment must model social goals, responsibilities and dependencies (Chapter XXV). Equally critical for human participation is trust, as without trust people will not risk social interactions with others (Chapter XXVI). One way to remember socio-technical success is with "patterns"; Alexander's architectural design concept carried over into software design (Chapter XXVII). Group interaction involves not only complex individuals, but also their interactions, making designing systems to support group interaction a challenge of the first order (Chapter XXVIII). Equally complex are systems that connect people in an organization to the resources they need (Chapter XXIX). If one works from social needs to technology design, rich media communication technologies need to meet those social needs not mimic face-to-face interactions (Chapter XXX). Social interaction is complex not only by quantity and quality, but also by recursion, for example me seeing you changes my behavior, but that you see that I see you also changes your behavior, which in turn changes mine, and so on. Such ripples of recursive social reflexion, where each act changes all acts, make social interactions match those of fluid mechanics for complexity, and for the same reason—the causality is circular not linear. Yet social principles can manage this complexity, for example *translucence* (that people can see clearly what others do and act accordingly) is one principle behind the success of eBay that can apply to other socio-technical systems (Chapter XXXI). Finally, for computer agents to succeed in social environments they must respect social rules, that is etiquette (Chapter XXXII).

Section V looks at socio-technical implementations, to explore some of the practical lessons learned. For example, in today's virtual worlds people can adopt a persona to live out a "second" life. While such worlds pale beside Star Trek's "Holo-deck" for realism, their capacity to support social interaction is far greater. To understand how millions of people can interact within virtual worlds a socio-technical perspective is essential (Chapter XXXIII). And while Star Trek's Captain Kirk often stressed that computers cannot comprehend human emotions, today's computer tutoring systems aim to do precisely that (Chapter XXXIV). Eye gaze is another usually human cue that is now amenable to computer analysis and used in computer interfaces (Chapter XXXV). Yet not all the conditions for human sociability seem fulfilled by current social networking systems, as while people frequently *maintain* social relations by computers they less frequently *create* them that way (Chapter XXXVI). The missing factor(s) may be not physical realism but emotional realism, that is genuineness (that you mean what you say) supported by properties like spontaneity and immediacy, effort (not copied) and non-modifiability (not faked). This trend to represent emotional and social complexity is evident in knowledge representation systems (Chapter XXXVII), online teaching systems (Chapter XXXVIII) and even academic research, as for researchers to share expensive technical resources requires collaboration (Chapter XXXIX).

Section VI looks at socio-technical evaluation, as evaluating systems gives the feedback necessary for continuous improvement. Evaluations are based on criteria, which in turn depend on one's perspective and concerns. For example, Bandura's collective efficacy concept has led to a useful measure of online communities (Chapter XL). Likewise that social capital has cognitive, relational and structural dimensions suggests dimensions for evaluating social network sites (Chapter XLI), as does the concept of situational awareness for online team collaboration systems (Chapter XLII). Online learning communities in contrast suggest a scale of affective satisfaction, as emotion is important to learning (Chapter XLIII). One can not only measure the current *state* of an online community but also its current *rate* of advancement or decline; as "social health" implies that social systems can grow or decline as individuals do (Chapter XLIV). Critical to the evolution (or devolution) of a social system is how it engenders/fosters innovation to reinvent itself for each new generation (Chapter XLV). Finally, one must measure the social context of technical systems, as a value clash at the cultural level can cause unused or unwanted systems (Chapter XLVI).

Section VII considers the future of the budding field of socio-technical development. We must learn from the past, where computing has previously over-estimated its capacity in areas like artificial intelligence, e-commerce, pattern recognition, and spatial processing. We may need to recognize that if the world is not ultimately "computable", despite computing power, the role of the computer in social computing may need to change from "solver" to "supporter" (Chapter XLVII). Equally if the role of computing as a power sharer in e-commerce is overstated, perhaps the real online commerce revolution is still to come (Chapter XLVIII). While teaching socio-technical concepts at graduate and undergraduate levels is likely to increase, it may need a change from content to process focused delivery (Chapter XLIX). While some see socio-technical progress as inevitable, one can equally argue that online communities will become more formal and rigid as they "age" (Chapter L). Yet every problem can also be seen as an opportunity, as a view on houses of the future illustrates (Chapter LI). And while technology progress may "atomize" online experiences, it also suggests systems that enhance trust in society as a whole (Chapter LII). Finally, the ultimate question facing humanity may be the old choice between good and evil, so socio-technical developers need to rise to the challenge of designing for good not ill (Chapter LIII).

Final Words

While the physical reality of technology is "hard", social realities by comparison seem "soft". That the soft should direct the hard seems counter-intuitive, but we believe this is the way computing will evolve, as it is the spirit of life. The quote beginning this preface illustrates the principle. To let technology define our future is to let something blind to human benefit lead humanity forward. Who knows where that will lead? It is better that people lead the technology forward, based on human and social concepts. While people are flawed they are not blind, as technology is, and so-called human "flaws" like variability may be virtues in an evolutionary context. Our very human reasons, emotions and social instincts have guided us well enough this far. Let us not now defect in our obligation to determine our technological future. What the human mind can conceive it can achieve, so if it can conceive technology it can conceive how to harmonize that technology not only with the social systems of humanity, but also with the natural systems of "Mother Earth" that ultimately sustain our global society.

We send our good will to all those who work to these good ends.

Brian Whitworth and Aldo de Moor
Editors of the Handbook of Research on Socio-Technical Design and Social Networking Systems

Acknowledgment

We firstly thank the many scholars and practitioners throughout the world who freely contributed their creative ideas to make this book one of a kind. They not only wrote the chapters but also did the reviews, helped with indexing, provided key words and copyedited their chapters. Thanks for help in reviewing also go to Marcus Foth, Victor M. Gonzalez, Nicholas J. Kings, Jim Nyce, and Colstan Sanger. We thank IGI for this opportunity to get these ideas out in an efficient, effective and timely manner. We thank our publisher's representative, Julia Mosemann, who patiently listened and responded to our publishing needs, complaints, suggestions and entreaties. Especial thanks go to the Editorial Board members and to the section prologue writers: Tom Stewart, Ronald Stamper Mark Aakhus, Tom Erickson, Anton Nijholt, Starr Roxanne Hiltz and Charles Steinfield, who drew upon their considerable knowledge and experience to provide advice and raise issues before each section. Last (but not least!) we thank Siew Whitworth for administrative support, particularly early on in the project. Brian also thanks his wife for her moral support, and tolerating his many hours spent on the details of this book. Indeed we both thank family, colleagues and friends who saw much less of us than usual due to this project (and may have had more to do as a result). Yet we alone are responsible for this work. As editors, we selected the contributions (with advice), advised changes, made editorial amendments and checked the details at each stage, so any errors, omissions or weaknesses in this work are ours alone. Finally, let us not forget those people known and unknown without whom this book would not have been possible—the designers, builders, managers and users of socio-technical systems!

We are, sincerely,

Brian Whitworth and Aldo de Moor, editors

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Gerrit van der Veer
Paul van der Vet
Betsy van Dijk
Shun-Yung Kevin Wang
Yves Wautelet
Hans Weigand
Heike Winschiers-Theophilus
Shumin Zhai

Also

Marcus Foth,
Victor M. Gonzalez,
Nicholas J. Kings,
Jim Nyce,
Colstan Sanger.

Section I
General Socio-Technical Theory

That social and technical systems can overlay to create "socio-technical" systems

This section introduces the idea of a socio-technical system, suggests why it is an important topic in computing today, and addresses questions like:

1. What is a socio-technical system?
2. Why is the socio-technical concept important?
3. How did the concept arise historically?
4. How do social systems relate to technical systems?
5. How can social and technical academic disciplines work together?

Prologue
General Socio-Technical Theory

Tom Stewart
System Concepts Limited, UK

Whenever two people meet, there are really six people present. There is each man as he sees himself, each man as the other person sees him, and each man as he really is.

—William James, (1842-1910)

My first encounter with the term socio-technical systems was at Loughborough University in 1970. As a founder member of the late Brian Shackel's Human Sciences and Advanced Technology research group, I was privileged to hear the industrial sociologist Lisl Klein describe the work of the Tavistock Institute. The history of the socio-technical movement is more fully described by another HUSAT pioneer, Ken Eason, in Chapter V.

At that time, so called 'new technology' was being introduced with such pace and lack of forethought that the Tavistock efforts to humanise work in the face of impersonal automation seemed all too relevant. My understanding (and it is only my understanding, so it may well be flawed), was that the Tavistock psychiatrists in the twentieth century were continuing a tradition epitomised by the writings of Karl Marx in the nineteenth century on alienation in the labour process. Marx observed that the emerging industrialisation processes deprived workers of control over their lives and selves. Growth in scientific management simply furthered this view that workers should be little more than cogs in the industrial machine.

The Tavistock socio-technical approach involved recognising that systems comprised both technical elements and social elements and that both could be developed in parallel—with benefits both for productivity and quality and for the well being of the workers. This approach has turned out to be just as important for modern computer based systems as for the industrialised production systems of the past.

In the nineteen seventies, one of the biggest concerns in the labour movement was that new technology would eliminate jobs and result in mass unemployment. As a result, unions felt threatened by computerisation plans and many organisations negotiated 'new technology agreements' to protect employment. One positive spin-off was that the unions were often able to encourage more attention to good ergonomics than might otherwise have been

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the case. However, this sometimes resulted in bizarre situations. I remember being called in as a consultant to a newspaper where the management planned to introduce Cathode Ray Tube (CRT) terminals with a refresh rate of 50Hz (the UK mains frequency). The union representative had heard that US papers were introducing terminals with 60Hz refresh rate (the US mains frequency)—and these resulted in less perceived screen flicker. He therefore negotiated a refresh rate of 56HZ which both sides believed was an acceptable compromise—despite the technical inappropriateness of the solution.

Nonetheless, such agreements were not uncommon and reflected the continuing attitude on both sides of industry that technology was an enemy of ordinary people that could be exploited (if you were a boss) or which should be opposed (if you were a worker).

But when I look round today, I see almost everyone plugged into an iPod, with a mobile phone clasped to their ear, or hunched over a laptop. Something has changed dramatically. Technology is back and this time it's personal. Few people now believe that technology itself is the problem although it can still be used to support dehumanising systems. Even anti-globalisation protesters use mobile phones and the Internet (which spun out of the military research system DARPANET—defense advanced research agency network).

However, even as a friend, technology still needs to be kept under control. As Brian Whitworth points out in Chapter I, technology connects people socially. Much of our global information society is now dependent on well designed socio-technical systems from corporate email and electronic markets to blogs and social networking sites.

One of the thorny issues which has survived from the earliest socio-technical work concerns how the socio and the technical aspects of the systems are designed. Clearly there are different skills required to design social systems from those required for the technical elements. This has sometimes resulted in a fragmentation of design teams, with some people designing technology and some dealing with 'social' issues like work design and change management. There have also been efforts to involve end users in technical design, with varying degrees of success. There is even an International Standard on Human Centred Design for Interactive Systems (ISO 13407) which I helped develop. This standard identifies a clear role for users at all stages in systems design with a view to improving system usability. But it does not address the wider social aspects of systems in any detail.

There are no easy answers to how you design socio-technical systems, and this book presents an invaluable and unique overview of a vast and confusing field. But one reason why I think it is particularly difficult nowadays is that social relationships are so much more complex than they appear on the surface. Arguably all behaviour is social, as we observe ourselves and form opinions about how others see us. Hence I included the quotation from William James at the beginning of this prologue. I also have the suspicion that social systems evolve and develop rather than allow themselves to be designed. Efforts to design socio-technical systems must allow and encourage this evolution but perhaps the more we try to actively design the social component, the less room there is for real social systems to develop.

Technologists are notoriously bad at predicting how people will use their technology over time. Technology demonstrations at conferences of how we will live in the future continue to be embarrassing after only a few years. However, the more we understand that almost all systems are socio-technical, the more likelihood there is that we will be able to design and evolve systems to support real people living real lives. The chapters in this section span a wide range of views about socio-technical theory and I believe they will contribute significantly to our understanding of this complex and changing phenomenon.

Chapter I
The Social Requirements of Technical Systems

Brian Whitworth
Massey University–Auckland, New Zealand

ABSTRACT

A socio-technical system (STS) is a social system built upon a technical base. An STS adds social requirements to human-computer interaction (HCI) requirements, which already add to technical (hardware and software) requirements. Socio-technical systems use technology to connect people socially, for example through e-mail, electronic markets, social network systems, knowledge exchange systems, blogs, chat rooms, and so forth. Yet while the technology is often new, the social principles of people interacting with people may not be. The requirements of successful social communities, whether mediated by computers or the physical world, may be similar. If so, socio-technical systems must close the gap between social needs and technical performance, between what communities want and what the technology does. If online society is essentially a social system, of people interacting with people, social principles rather than the mediating technology should drive its design. Societies create value through social synergy, which is lost for example when people steal from others, whether time (spam), money (scams), credibility (lying), reputation (libel) or anything else of value. The success of today's global information society depends upon designing the architecture of online interaction to support social goals. This chapter briefly reviews some of the emerging requirements of STS design.

Man is a social animal

—Seneca

INTRODUCTION

A *socio-technical system* (STS) is a social system sitting upon a technical base, with email a simple example of social communication by technology means. Whether a community is electronically or physically mediated a socio-technical system is people communicating with people through tech-

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nology rather than the physical world (which is a "socio-physical system"). The term *socio-technical* was introduced in the 1950's by the Tavistock Institute as the manufacturing needs of industry confronted the social needs of local communities, e.g. longwall mining in English coalmines (see http://www.strategosinc.com/socio-technical.htm). It opposed Taylorism which broke down assembly line jobs into "most efficient units", suggesting that technical systems needed to respect social needs, e.g. a nuclear plant near a village had to balance its technical needs against social needs. The socio-technical view later developed into a call for more ethical computing by supporters such as Mumford (Porra & Hirscheim, 2007).

General Systems Theory

In general systems theory (Bertalanffy, 1968) systems form when autonomous (self-directing) parts *mutually interact to create equally autonomous wholes*. Such systems do not reduce entirely to their parts as their creation involves not just those parts *but also complex feed-back and feed-forward interactions*. Just as a person is a system of autonomous cells, so a society is a "system" of autonomous citizens. Such holistic systems, whether simple cells or complex people, can *self-organize* and *self-maintain* (Maturana & Varela, 1998).

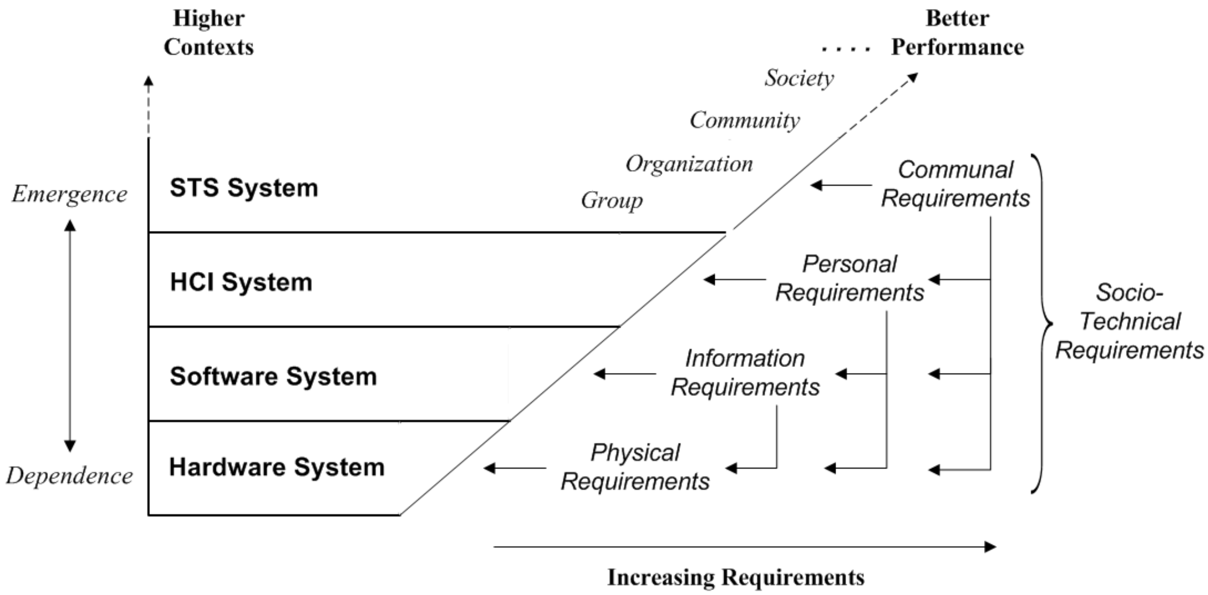
The socio-technical system (STS) is not just social and technical systems side-by-side but the whole unit. For example, a pilot flying a plane is two side by side systems with different needs, one mechanical (the plane) and one human (the pilot). In human computer interaction (HCI) these systems must work together–pilots must understand the plane's controls, which must be understandable by its crew. The STS is the plane plus crew as a *single system* with human and mechanical levels. On the mechanical level the human body is just as physical as the plane, with weight, volume etc. However the "crew + plane" system can now strategize and predict, say in an aerial dogfight. The perspective change seems minor, but has major ramifications. If a human system sits *next to* a technical one it is usually secondary, as ethics is an afterthought in engineering, but if social systems *include* technical ones, as physical societies have architectures, then the social *contextualizes* the technical even as it is created by it. Hence STS research is not just applying sociological principles to technical effects (Coiera, 2007), but how social and technical aspects integrate into a higher level system with emergent properties.

Socio-Technical Levels

Are physical systems the only possible systems? The term "information system" suggests not, and philosophers propose idea systems in logical worlds, sociologists propose social systems, psychologists propose cognitive systems, economists have economic systems, programmers have software systems, and engineers have hardware systems. Which of these approaches is "real"? Paradoxically, none are… and all are. None are, because they are all just ways of conceptualizing systems, like views in a database, not the system itself. All are, because one can without contradiction describe a system from many perspectives, namely from that of the engineer, computer scientist, psychologist and sociologist.

As system complexity increases higher system views seem to apply. For example, in the 1950s/60s computing was primarily about hardware, while in the 1970's it became about business information processing, and in the 1980s about "personal computing". With the 1990s and email computers became a social medium, and in this decade social computing has flourished with chat rooms, bulletin boards, e-markets, social networks, wikis and blogs. Computing "reinvented itself" each decade or so, from hardware to software, from software to HCI, and now from HCI to social computing. To explain this, Grudin suggested three IT "levels" (hardware, software and cognitive) (Grudin, 1990) and Kuutti later added an organizational level (Kuutti, 1996). These *physical, informational, personal* and *communal* levels suggest hardware, software, HCI and STS systems (Figure 1):

Figure 1. Socio-technical system levels



1. **Hardware systems** based on *physical level* exchanges of energy, and face problems like overheating.
2. **Software systems** emerge from hardware systems, are based on *information level* exchanges of data and code, and face problems like infinite processing loops.
3. **HCI systems** emerge from software systems, are based on *personal level* exchanges of meaning, and face problems like misunderstanding or information overload.
4. **Socio-technical systems** emerge from HCI systems, are based on *communal level* normative exchanges, and face problems like mistrust, unfairness and injustice.

Here "technology" is the hardware-software combination, so an organization's technology is both IT infrastructure (hardware) and IT services/applications (software). Equally "social" includes both people and their relations and company policies and norms. A *socio-technical system is one that involves all four socio-technical levels and their interactions.* STS research describes the connections between hardware and software technologies and people and communities.

How system levels emerge raises interesting questions:

1. **Information derives from mechanics*:*** How can physical voltage changes in a wire create bits and bytes that make computing distinct from engineering and physics?
2. **Personal cognitions derive from neural information exchanges:** How can neuronal mini-processors combine on/off Boolean states to create human awareness (Whitworth, 2008)?
3. **Social unity derives from personal cognitions:** How can a "society" emerge from autonomous yet interdependent individuals interacting?

Note that a "society" is more than buildings, information or people, being a *general form of human interaction that persists* despite changes in individuals, communications or architecture (Whitworth & deMoor, 2003).

The levels of Figure 1 are suitable for IT purposes, but biologists might want a biological level between information and human processing. Stamper's semiotic ladder splits the information level into empiric and syntactic, and distinguishes semantics (meanings) from pragmatics (intentions) (Stamper, 1996). The top of Figure 1 is open-ended, as social groups can coalesce into bigger ones, e.g. in social evolution people first formed villages, then city-states, then nations, super-nations and perhaps today a global humanity (Diamond, 1998).

System Performance

Higher levels are not just more efficient ways to *describe* a system but also more efficient ways to *operate* it. A group is just any set of individuals who see themselves as a group (DeSanctis & Gallupe, 1987), yet this perception increases performance. *Seeing* something at a higher level lets one *organize* it in a better way, just as software is a better way to operate computers than manipulating circuit voltages. Software functions are in turn giving way to user task concepts like "affordance" and task analysis methods, e.g. for users to backup a "document" currently takes three functional steps: 1. *Save As*, 2. *Select backup file name* (unlike previous backups), 3. *Load original file* (else further work changes the backup not the "master"). A "Backup Document" button that does this task in one click would be popular, reduce problems and improve productivity.

In general, as systems evolve the "performance" focus rises to higher levels. Hence *lower level performance is disregarded if higher levels fail,* e.g. computers "crash" when the software goes into an infinite loop, and users have to re-boot the machine. Yet the hardware is working perfectly. We say the system "failed" when software ignores user demands, even though the hardware is responding to software demands. In general:

System performance is defined at the highest productive level.

If a level fails, the levels above it automatically fail, as hardware failure means software failure, etc. Yet system success depends on the highest level, e.g. a web site with working hardware, software and interface "fails" if no-one visits it. Just as one can have hardware failures, software failures and usability failures, socio-technical systems can be social failures, as if one calls a party and no-one comes it doesn't matter how nice the food was. While hardware failures, software failures, usability failures and social failures seem different, they have one thing in common—in the *end the failed system does not run,* which can cause "extinction."

At each level higher performance incurs higher requirement "costs". Physical systems have physical requirements, like the stress requirements for a bridge, which designs must satisfy. Equally higher level systems have information requirements, semantic requirements and community requirements. These cumulate, each adding to the previous, just as software requirements add to hardware requirements. The requirements of a level affect not only that level but all those below it, i.e. new requirements impact the whole system. For example, the needs of database and network software led to new hard-wired CPU commands, and Web 2.0 semantic demands require code systems like UML to better transmit meaning. Socio-technical requirements like accountability, privacy and ownership can be expected to change interfaces, software and hardware. Socializing the Internet will change the whole socio-technical system, not just add social "icing" to the existing technical "cake".

Combining Reductionism and Constructivism

Software systems presume a hardware base, HCI systems presume a software base, and STSs presume an HCI base. This can be seen as higher levels emerging, or as higher levels being derived. The conflict between *constructivism* and *reductionism* seems essentially whether one sees the levels in Figure 1 as derived from the bottom-up (the parts define the whole), or as being a top-down re-definition of the system (the whole defines the parts). Psychology constructivists like Piaget, Chomsky and Maturana suggest that people "construct" the world and so see *a* world not *the* world (Maturana

& Varela, 1998), while determinists like Watson, Hull and Skinner hold that the objective world creates real sensations which define behavior (Skinner, 1948). The latter describes behavior from the bottom up, while the former takes a top-down approach. Sociology generally sees individuals as conduits of meaning for external social structures, and rejects psychological, biological and physical explanations as faulty reductionism (Bone, 2005). Yet top-down approaches cannot stand alone, as if somehow (magically) all thoughts about a culture were erased from its members, it would cease to exist, just as it would if all its members suddenly vanished physically. Indeed sociology is reconnecting to its psychology roots, e.g. Bourdieu's "habitus" concept based on the individual's perception of the social environment, and Gidden's discussion of the mental frames that underlie social life (Bone, 2005). It is being realized that the emergence of sociology from psychology does not imply that sociology reduces to psychology.

Conversely, reductionist views on any level tend to deny choice, e.g. psychological determinists would define all behaviour by physical stimulus contingencies, while social determinists hold that society writes cultural agendas like communism or capitalism upon individual *tabula rasae*[1]. Swapping behavioural engineering for social engineering seems hardly progress, as in both the world is a machine. Even in physics *one cannot take the observer out of the world equation,* so attempts to reduce systems to one level is to deny the emergent nature of the world.

The ongoing constructivist-reductionist debate assumes a single right view, but emergence allows both derivation and "new rules", e.g. chemical events must derive from quantum events, but this does not make the discipline of chemistry a sub-set of physics. If chemistry can co-exist with physics, then sociology, psychology, computing and engineering can also work together. Attempts to fit all reality to one view are doomed to fail, as any view is inherently incomplete. Rather than trying to reduce all disciplines to one "reality", let them superimpose, with the researcher or designer free to choose their viewpoint. Taking multiple perspectives *in turn* is like walking around an object to view it from all sides[2]. This approach re-introduces choice and abandons determinism, the belief we can specify an absolute order. Constructivism and reductionism remain as relative not absolute views which complement each other. Hence a "person" can be at once a physical object, an information processor, a cognitive source, and a social unit. These are not different systems but *overlapping views of the same system,* corresponding to engineering, computing, psychological, and sociological perspectives respectively (Whitworth, Fjermestad, & Mahinda, 2006). The "real" person is the interaction of all these things and perhaps more.

General System Performance Requirements

While performance seems a simple concept, the variety of animals that have evolved to "fitness" suggests it is not (David, McCarthy, & Sommer, 2003). The variety of successful information technologies today suggests the same, as an IT system is not "high performance" if it:

1. Cannot get results (ineffectual).
2. Cannot be made to work (unusable).
3. Breaks down often (unreliable).
4. Succumbs to viruses (insecure).
5. Fails when things change (inflexible).
6. Cannot work with standard plug-ins or data (incompatible).
7. Cannot download or upload (not connected).
8. Reveals private information (indiscreet).

The web of system performance (WOSP) model proposes that systems have four elements: a boundary, an internal structure, effectors and receptors. Designing each element to either reduce risk or increase opportunity gives eight basic goals, (Whitworth et al., 2006):

A. The boundary element separates "system" from "not system":
   1. **Risk focus:** Protect against unauthorized entry, misuse or takeover *(security).*
   2. **Opportunity focus:** Use outside elements as system "tools" *(extendibility).*
B. The structure element defines how the system operates internally:
   3. **Risk focus:** Continue operating despite internal failure *(reliability).*
   4. **Opportunity focus:** Adapt the system to environment changes *(flexibility).*
C. *The effectors element changes the outside world directly*:
   5. **Risk focus:** Minimize the relative resource costs of action *(usability).*
   6. **Opportunity focus:** Act directly on the environment to produce a desired change *(functionality).*
D. *The receptors element records the outside world and receives signals*:
   7. **Risk focus:** Manage the release of self information *(privacy).*
   8. **Opportunity focus:** Open and use channels to communicate meaning to other systems *(connectivity).*

These eight requirements are well known in the literature, but their combination into one framework is new. Criteria priorities vary with environment, e.g. low threat environments make security less important, while turbulent environments make flexibility more important, etc. The four "active" goals (functionality, flexibility, extendibility, connectivity) increase *opportunities*, while the four "passive" goals (security, reliability, privacy, usability) reduce *risks*. Both active and passive goals are equally important in system performance.

One might imagine that functionality (what the system does) is always top priority. Yet while "non-functional" requirements (NFRs) may be second-rate needs in IT design, many systems have more lines of error or interface code than functional code, and many fail for "unexpected" non-functional reasons (Cysneiros & Leita, 2002, p699). Indeed in nature the strongest claws, teeth or muscles are not always the "fittest", perhaps why tigers are now an endangered species. Some animals like turtles are slow but have strong defensive shells (security), while others like viruses specialize in parasitism (extendibility). Some have almost no "functionality" but are very reliable (plants), while others like bacteria are flexible enough to alter their DNA within hours. Claims that privacy is "dead" by technology's hand are premature, as the animal kingdom equivalent of privacy, camouflage, is alive and well in the animal kingdom, and the military spends billions on the physical equivalent (stealth technology). Overall, there is support for the view that IT system performance involves many goals (Chung, Nixon, Yu, & Mylopoulos, 1999).

Many criteria on many levels gives in practice what IT developers call the "requirements mess", the struggle to define "what people want" in complex socio-technical systems (Lindquist, 2005). This struggle has destroyed many a software project, and the complexity of modern IT requirements has led to agile development methods, which don't assume we know much at all.

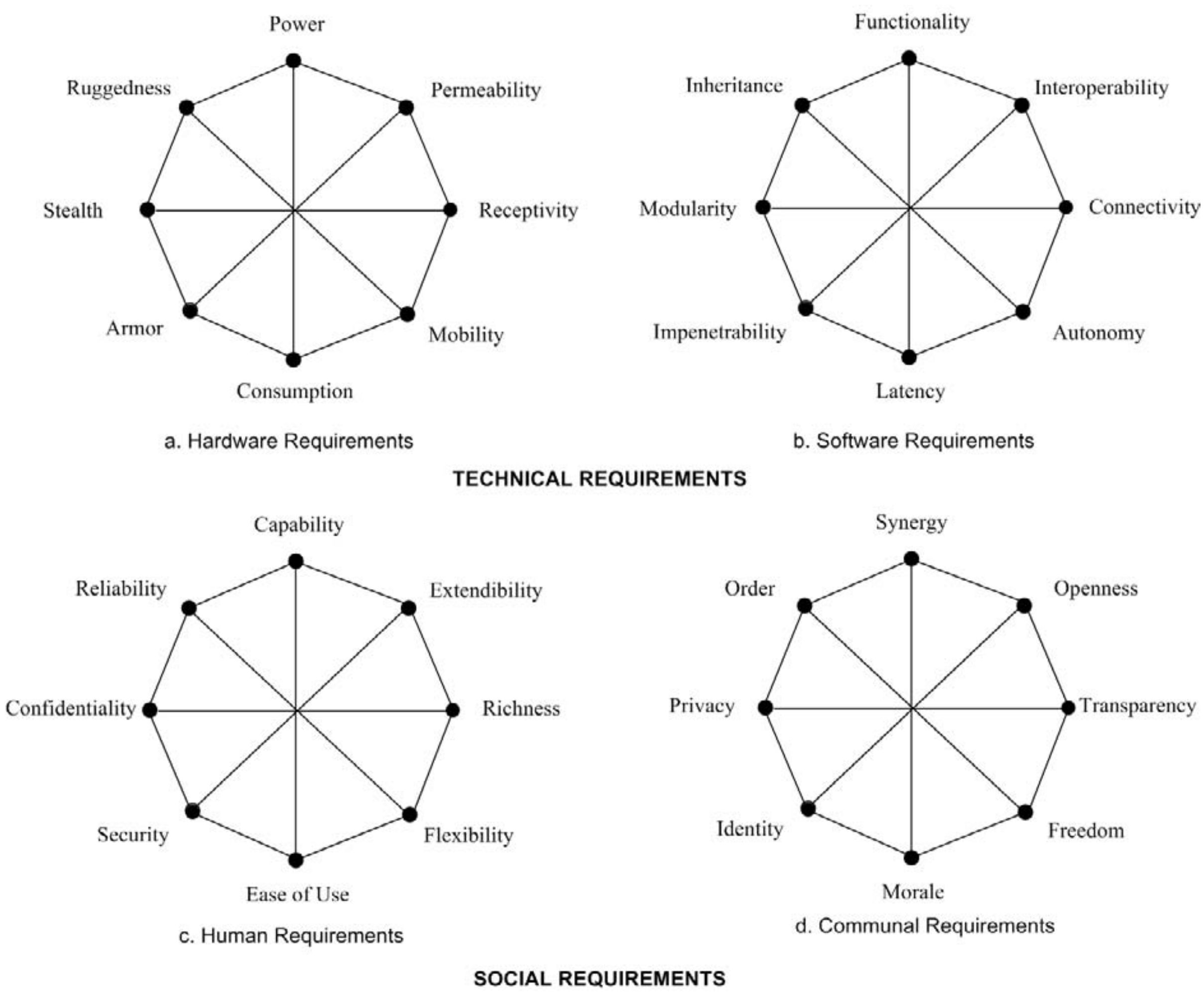
Socio-Technical Performance

Design complexity, it is proposed, arises when multiple system performance aspects vary by multiple levels, e.g. reliability varies by level, as a system can be hardware reliable but software unreliable, or both hardware and software reliable but unreliable for operator data entry (Sommerville, 2004, p. 24). Each level raises different problems. Likewise usability (the relative cost of action) means less cognitive "effort" in an HCI system, less memory/processing for a "light" software utility, or less power use for a hardware laptop. Again these are different design problems, so reconciling reliability and usability must occur on each level, not just one.

Figure 2 shows the WOSP model broken down by system levels. The details are outlined elsewhere, but in simple terms the web *area* is the overall performance, the web *shape* is the performance profile, and the web *lines* are performance tensions where improving one aspect of performance reduces another, e.g. improving flexibility can reduce reliability. As the levels change so does what the system exchanges: hardware exchanges energy, software exchanges information, people exchange meaning and communities exchange norms, ideas and beliefs. The WOSP performance criteria apply at each level, but with different names:

1. **At the hardware level** (Figure 2a) the system output is *power,* but equally important is *consumption*, as a car's miles-per-gallon is important as well as its speed. In the military a computer that worked even if soldiers dropped it was *rugged*, but it also had to be *mobile* to move it if the environment changed. A physical system that doesn't "leak" compromising emanations has *stealth*, while one that can pick up distant communications like radar is *receptive*. The boundary between system and not system must be *permeable,* as cell walls accept nutrients, yet also *protect* against attacks, like the walls and moat of a castle.
2. **At the software level** (Figure 2b) a system's *functionality* is the information processing it can provide, but equally important is *latency,*

Figure 2. WOSP Requirements by system level



or how long the processing takes. *Inheritance* ensures that each sub-routine carries forward reliable code, while *autonomy* (local freedom) lets systems respond flexibly to environment changes, as in plug-n-play. Object orientated design is an internal structure that combines inheritance and autonomy. Software must be *connected* to download or upload information, yet *modularity* lets subroutines keep private information. It must be *interoperable* by agreed standards to allow plug-ins and applets, yet remain *impenetrable* to attacks by virus or hacker hijackers.

3. **At the human level** (Figure 2c) meaning not information is exchanged, so functionality is replaced by user task *capability*, and ease of processing replaced by cognitive *ease of use*. The human terms *flexibility* and *reliability* describe the ability to change and not change given outer changes and inner changes respectively. *Richness* represents how much human meaning is communicated, and *confidentiality* lets one control one's "image" to others. Also part of human success is tool use, which in IT is *extendibility,* yet we also need *security* to defend against hijack attempts.
4. **The communal level** (Figure 2d) exchanges group, community, organization or society norms, beliefs, memes and culture. People in social groups have *synergy* if a social unit produces more than its members would alone. Equally social participation uses up *morale* or social capital*,* as does online conflict, rudeness and abuse. If the effort to participate becomes too high citizens rebel or leave. A society's ability to endure requires predictability or *order*, while its ability to innovate and reinvent itself in new times requires *freedom*. A society needs *privacy* rules to shield members from each other, and has *transparency* if services like "the media" let people see what is going on. *Openness* means the society lets other people and ideas enter to make value, while *identity* draws the conceptual boundary between "us" (the in-group) and "them" (the out-group), which written or unwritten "constitution" can prevent foreign mores from taking over the group and defines who can join.

In STS design one must first address appropriate system levels, as technical designs that ignore social factors often get "unintended" consequences. Secondly the principle that performance is not one-sided excellence applies equally to the social level. The WOSP social level (Figure 2d) suggests that STS designers and users ask if the system technology supports properties that improve community performance:

1. **Synergy:** Does the community creat extra benefits by social interaction, whether physical, informational or human outputs like enjoyment or understanding?
2. **Morale:** Does the online community have goodwill, is it socially an enjoyable place to be, without social conflict, and do members help others?
3. **Order:** Are the rules or norms of social interaction supported, giving social predictability?
4. **Freedom:** Are valid "rights" granted broadly, to allow bottom-up participation?
5. **Privacy:** Does the community respect the right not to communicate?
6. **Openness:** Does the community let new ideas in or out?
7. **Transparency:** Can people easily see what is going on?
8. **Identity:** How is the community identity maintained against ideological hijack, e.g. by online constitution, by membership rules, by community logo, slogans or symbols?

For example, in the tension between order and freedom, the order of a police state tends to stifle innovation, while anarchic freedom tends to be unstable. Democracy in its various forms is a social invention that reconciles freedom and order (somewhat).

In sum, there is no single magic "bullet" strong enough, nor any magic "pill" pure enough, to kill all the devils of system performance. One-sided "excellence" always tends to "bite back" both in design and use (Tenner, 1997), with a common example being network security "improvements" that reduce usability so much that overall performance goes down. Myopic single focus performance concerns like security (OECD, 1996), extendibility (De Simone & Kazman, 1995), privacy (Regan, 1995), usability (Gediga, Hamborg, & Duntsch, 1999) and flexibility (Knoll & Jarvenpaa, 1994, p6) tend to produce diminishing returns. The problem facing designers, researchers, managers and policy makers alike is that a blinkered focus on one system part causes problems to pop-up elsewhere. Good design inevitably requires the *innovative synthesis of conflicting goals in the total design space* (Alexander, 1964), as progress is not a simple one-track ladder "upwards".

Meaning Exchange Requirements

The HCI connectivity-privacy line (Figure 2c) introduces a social dimension to applications based on meaning exchange. Most *computer-mediated meaning exchange* theories postulate underlying psychological processes. Early theories proposed a single rational analysis process (Huber, 1984; Winograd & Flores, 1986), yet communication seemed more than just factual information exchange. Several theorized process dichotomies were suggested, including 1. *task vs. socio-emotional* (Bales, 1950), 2. *informational vs. normative* (Deutsch & Gerard, 1965), 3. *task vs. social* (Sproull & Kiesler, 1986), and 4. *social vs. interpersonal* (Spears & Lea, 1992). A three process model (Whitworth, Gallupe, & McQueen, 2000) combines these competing dichotomies into a single model of online communication with three meaning exchange processes:

1. **Resolving information:** the intellectual exchange of literal *message content* meanings about the world.
2. **Relating to others:** the emotional exchange of *sender context* meanings about sender state.
3. **Representing the group:** the intuitive exchange of *group position* meanings about group movement.

The first process intellectually gathers and analyses "facts", but information sources can give disinformation (lie), incomplete information, or information that is too late to be of use (Whitworth, Van de Walle, & Turoff, 2000). Hence in communication the source is as important as the message, as the judgement of *who* is communicating affects the meaning of *what* is said (Hovland, Janis, & Kelley 1953). If we do not trust a sender then *all* their communications are in doubt, and the better they sound the more they may be lying. It pays to build relationships because friends tend to be honest, to disclose the whole situation, and to volunteer timely messages, giving distinct relationship dimensions to communication (Devito, 1997) (p24). Finally, for a group to act it must "cohese" into an acting entity. Groups that cannot agree do not even have a decision to be right or wrong about, so groups need agreement as much as decision quality (Whitworth & Felton, 1999). This process differs from interpersonal relating as it involves individuals identifying the group "position" and adjusting their behaviour accordingly, as proposed by social identity theory (Hogg, 1990).

Each process reflects a practical human concern, namely the world, other people, and the community one is within. All are important, as sometimes what you know counts, sometimes who you know counts and sometimes, as on which side of the road to drive on, all that counts is that you do what everyone else does.

Group cohesion has in the past been seen negatively as "conformity" (Asch, 1952) or mindless "groupthink" (Janis, 1972), but the value of this process must be assessed in its combination with other processes (as that is how it normally works). When normative influence causes many minds to blindly follow a laid down group decision the problem is not that group process #3 above is working, but that the individual process #1 is not. If group members contribute by thinking, then the normative process contributes by pulling the group in behind the majority. Communal interactions serve to create unity, not to create thought, as the latter is the job of the individuals within it[3]. Normative influence works *best* when people think for themselves.

The three goals of rational understanding, emotional intimacy and group belonging can work simultaneously because one communication can have multiple semantic "threads" (McGrath 1984), e.g. one can say "I AM NOT UPSET!" in an upset voice. In this semantic conflict most people prioritize the sender state analysis, i.e. assume the person really is upset. As well as factual content and sender context, messages also contain a core of implied action, e.g. saying *"This is good, lets buy it"* gives *content* information (the item is good), *sender state* information (tone of voice), and the sender's intended action *position* (to buy the item). Figure 3 summarizes how the three meaning exchange processes tend to interact, with representing the group identity first, keeping up relationships second, and resolving world tasks by analyzing message content a distant third priority. This suggests three cumulative stages in Internet development:

- Stage 1. **A global knowledge exchange system:** This seems established, with the Internet a huge library of the world's knowledge, served by search tools like Google and knowledge harvesters like Wikipedia.
- Stage 2. **A global interpersonal network:** This stage seems underway, as people relate to people across the world by email, chat and social networks, with increasingly few degrees of separation.
- Stage 3. **A global communal identity:** This stage is still inchoate, as current online communities struggle with social features like leadership, democracy and justice, are not yet proven stable over time, and as yet have few common social structures or mores.

Communication Setting Requirements

Media Properties

An early attempt to classify communication media defined media "richness" as the "*capacity of the media to facilitate shared meaning*" (Daft et al. 1987 p358), suggesting the order: face-to-face, audio-visual, telephone, letters and posters. However studies found no performance quality differences between email, telephone, audio-visual and face-to-face (Masoodian, Apperley, & Frederickson 1995), and audio not face-to-face (FTF) gave better task times (Suh 1996). Email studies also broke the richness sequence, as subjects chose e-mail over telephone for social tasks (Lea 1991; Sproull & Kiesler 1986). Richness was clearly not the only new media factor.

Terms like "distributed" and "asynchronous" arose to contrast email with FTF conversations, but they assume that physical space-time concepts apply to online settings. Yet if two "distributed" e-mail correspondents were magically "co-located" to the same room, in email communication terms *nothing has changed at all*. Calling email "distributed applies the physical concept of space to an electronic setting where it doesn't apply. Likewise media synchronicity, defined as "… *the extent to which individuals work together on the same activity at the same time*" (Dennis & Valacich 1999) uses physical time to define an electronic media property. If email technology developed to allow virtually instant communication, would email then become synchronous? If so, at what transmission speed would asynchronous email become synchronous? Conversely, imagine two people talking "synchronously" by telephone when one boards a rocket to Mars. As the rocket leaves the earth the transmission delay increases to minutes then hours. Is the telephone still a "synchronous" medium? If not, when does it become asynchronous as the rocket speeds to Mars? That the same medium changes its type depending on use is undesirable, as true properties should change only when the thing described changes. Rather than using physical space-time properties like distributed or asynchronous, the classification below uses the interface property of *continuity*, defined as the degree of continuous communication.

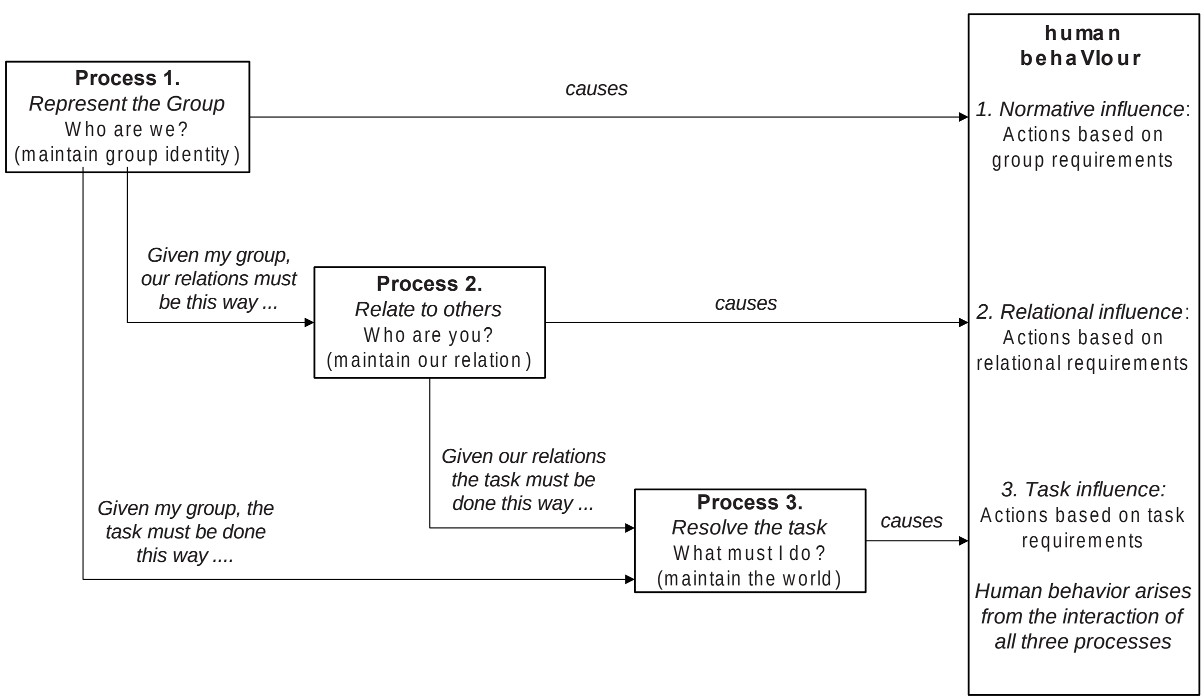
Another interface property is sender-receiver patterns like one-to-many (DeSanctis, Poole, Dickson & Jackson, 1993) which when combined with communication interactivity (Kraut, Galegher, Fish, & Chalfonte, 1992) gives communication *linkage* (B. Whitworth et al., 2000), see Figure 4. Increasing the linkage of one-to-one, one-way communication (Figure 4a) gives a two-way dyad (Figure 4b) or one-to-many broadcast (Figure 4c). A medium that supports many-to-one merging (Figure 4d) can support many-to-many, two-way signals (Figure 4e). For example, people in a choir sing (transmit voice signals) which by Fourier transforms the air "merges" in to one group sound broadcasted to all. In this communication form the group "communicates" with the group, as when a group applauds a performer. This allows a normative process whereby people match what the group is doing, so when choirs move off-key they usually do so together. The same process can occur in face-to-face discussions, where the group "valence index" (average position) on an issue effectively predicts the discussion outcome (Hoffman & Maier, 1964). Here position information can come from body language, facial expression, behaviours (like drumming fingers) and non-language sounds like groans. Computers achieve this communal communication by adding and displaying online votes, allowing electronic teams to generate online agreement using anonymous, lean messages only (Whitworth, Gallupe, & McQueen, 2001).

A Communication Setting Framework

The following communication setting properties contribute to semantic richness, defined as the total meaning exchanged:

1. **Expressiveness:** The total meaning transmitted at a moment in time based on channel number and richness:
   a. **Position** (symbolic). A discrete single symbol, say agree or disagree, that is not a language. An audience that raises their hands to vote is single-symbol communication.
   b. **Document** (structured symbols, static). *Text* language is alphabetic symbols connected by syntax into sentence forms which have meaning. *Graphics* also has "texton" elements that form by gestalt principles into meaningful "objects",

Figure 3. Human meaning exchange processes



with color and texture as attributes. Text/graphic "documents" fill most of the web today.

c. **Dynamic-audio** (dynamic, structured, single-channel). Dynamic-audio communication allows *speech* where phonemes create word and sentence sequences, *music* where notes create melody sequences, and emotive sounds. In dynamic-audio timing, tones and timbre more expressively convey feelings.

d. **Multi-media** (multi-channel, dynamic). Audio-visual communications open multiple dynamic channels to be more expressive. Face-to-face interaction maximizes richness and channels.

On a physical level expressiveness is like total network capacity (number of cables times bandwidth).

2. **Continuity:** The degree communication is a continuous flow, without pauses:

a. **Streaming.** Streaming communications flow continuously when transmitted or received, so senders cannot edit nor can receivers recall. Streaming at the sender interface is *unedited, spontaneous* and *genuine,* while received streaming is *ephemeral. Live* communication streams both when sent and received.

b. **Recorded.** In recorded communications the receiver interface stores the communication on arrival until the receiver is free to view it.

On a physical level continuity equates to the total time the network is communicating.

3. **Linkage:** The number of people sending and/or receiving meaning in a single transmission:

a. **Broadcast** (one-to-many, one-way): Communication goes from one sender to many receivers.

b. **Interpersonal** (one-to-one, two-way): Interactive communication between sender and receiver.

c. **Communal** (many-to-many, two-way). Communication goes from many to many, from the group to the group. It can occur by repeating interpersonal or broadcast communications, but pure communal communication is many-to-many in one transmission.

On a physical level linkage is like a network's communication type, e.g. line vs. wireless.

4. **Cost.** The Psychological cost to send a message is the "messaging threshold" (Reid, Malinek, Stott & Evans, 1996), e.g. e-mail has a lower threshold than letters, so sends more messages.

Figure 4. Linkage values, where S = Sender and R = Receiver

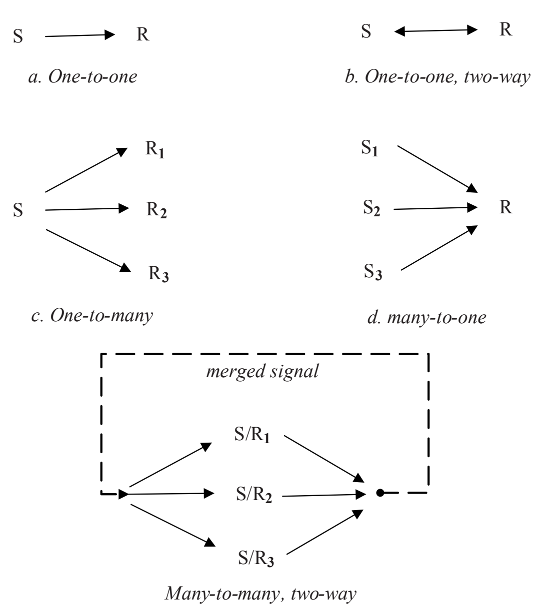


Table 1 shows this framework for physical and electronic communication settings, with the cell order informally by communication cost, e.g. email comes before letter as it takes less effort. Using this framework, telephone communication is streaming no matter how slow the transmission is, as senders cannot edit nor can receivers replay messages. Likewise email is recorded no matter how fast transmissions are, as receivers need not be present when the signal arrives.

Table 1. A simple communication settings framework

	Linkage					
	Broadcast		Interpersonal		Communal	
Expressiveness	**Streaming**	**Recorded**	**Streaming**	**Recorded**	**Streaming**	**Recorded**
Position	Flares	Footprint, Track	Body posture, Gesture	Acknowledge	Show of hands, Applause	Web counter, Karma system, Tag clouds Online voting, Reputation system, Social bookmarks,
Document	Blackboard, PowerPoint	Web site, Blog, Poster, Photo, Notice board, Book	Sign language	Texting, E-mail, Letter	Chat, Instant message	Social network Wikipedia, Emarket, Online com-munity, Bulletin board, News feeds Online reviews Media sharing ListServ
Dynamic-audio	Radio, Loudspeaker, Soapbox	Podcast, Music down-load Record/ CD	Telephone, Skype	Answer-phone	Radio talk-back, Conference call Choir,	Online talk-back? Online choirs/music groups?
Multi-media	Television, Movie, FTF speech, Show,	Online video, Videotape, DVD	FTF conversa-tion	Video-phone	FTF meeting, Cocktail party, TV interviews	MMORPG, Simulated worlds, Video-confer-ence

Examples and Implications

Some examples may clarify the issues. A telephone is a streamed, dynamic-audio, interpersonal communication, while an answer-phone is the same but recorded. A letter is also interpersonal and recorded, but in document form. A book is a one-to-one recorded document that is "broadcast" to readers by publishing duplication. Radio is a streaming dynamic-audio broadcast, ephemeral to the receiver (unless they record it on tape or CD). It is "live" if the sending interface is also streaming. TV is like radio except multi-media (has a visual channel). A movie is recorded and edited when sent, but streaming when viewed by movie patrons.

Web sites let people "publish" documents, talks (podcasts), music to download and online videos. Blogs broadcast text opinions, while email is two-way recorded text communication, as people send and receive. Chat is a few-to-few text broadcast stream for small groups, where no permanent record is kept. Instant messaging is similar, except that instant messages go to known people while chat rooms can be open. Repeating interpersonal communications like email gives a broadcast effect, as ListServs repeat point-to-point emails to "broadcast" to many people. Repeated broadcast communications in comment boards like Slashdot allow communal communication, but many "lurkers" are shy of public broadcasts. Social networks like Facebook let people limit broadcasts to friends only, which increases participation. Media sharing systems like Flickr (photos) and UTube (videos) are document systems that exchange multi-media files. True multi-media systems like video-conferencing struggle, but simulated worlds like Second Life and social games like World of Warcraft are popular.

Table 1 implies some interesting conclusions. Firstly, electronic interaction was expected to evolve to "richer" audio-visual multi-media like video-conferencing (Row 4), but instead it moved to more linkage (Column 3). The success of systems based on many-to-many position exchange is interesting, as eBay's reputation system, Amazon's book rating system, Slashdot's karma system and bulletin board "tag clouds" are not multi-media at all. They succeed by involving more people not by richer message content. *Indeed, expressivity, continuity and linkage seem all part of total communicative "power", the total meaning exchanged.*

It follows that maximizing all communication aspects is "expensive" in interface terms, as rich, continuous communal communication creates overload. For example, an electronic audio-visual meeting of twenty people would need twenty video streams to be represented on the computer screen. The physical world not only combines these streams into a common "space", it resolves real time contentions like two people speaking at once, and gives each individual view choices, including the ability to see where others are looking. This capability goes well beyond currently technology, but even the physical world interface cannot support this communication for large groups of thousands or millions.

Table 1 is interesting for the gaps it suggests. For example, the video-phone, shown as the future in shows like Star Trek is now technically possible with many mobile phones, but is still not widely used, despite marketing efforts. Perhaps video adds little to interpersonal relating above what sound already gives, or perhaps vision induces extra costs like having to look good. In some countries the movement is from mobile phone speech to texting, i.e. to less richness not more! Also interesting is the lack of dynamic-audio equivalents of text based online communal systems like Wikipedia. Are "online choirs", where people sing together via the Internet, or "online jamming" where they make music as a group, a likely future possibility? What does seem clear is that groups are critical to the Internet's future. Even the simplest online activities could be enhanced by group support, e.g. a "Group Browser" where people browse the Internet together, commenting as they go, and taking turns to choose the next site. Experts could offer online "tours" with such a tool.

Fitting Processes to Settings

The human meaning exchange processes of the last section each favour different communication settings:

1. **Literal meaning exchange** suits broadcast document communication (web site), as though message preparation cost is higher for typing text than speaking, message reception cost is equivalently less, as reading is faster than listening (Chafe, 1982) by a factor of up to four (Weeks & Chapanis, 1976).
2. **Interpersonal meaning exchange** suits two-way dyadic settings that require identification like email, or are rich enough to convey emotional feelings, like the telephone.
3. **Communal meaning exchange** in contrast needs high linkage but not richness, and can be anonymous.

For example, maximizing linkage is easiest when expressivity is lowest, as in reputation and karma systems where only position information is exchanged. This improves download and processing speeds making such systems fast. Also merging many contributions anonymizes them, which lowers the risks of participation. The "weak ties" (Granovetter, 1985) of group position exchange are a *highly condensed form of human communication* (Hiltz & Turoff, 1985) quite apart from richness.

While transmission duplication allows many-to-many interaction, in "true" many-to-many linkage groups send and receive in a single communicative act. For example, a manager could request feedback on an issue from 20 staff by email. If all replied to everyone including themselves this would create 400 emails. If each of these 400 replies also was responded to by all staff to all staff, after two rounds the discussion would create almost 1,600 emails. Hence group discussions via one-to-one communication settings like email tend to create information overload. In contrast an online vote on an issue like what software to purchase lets the question be put and responded to in a single operation that is relatively insensitive to group size. While exchanging opinions requires users to type, exchanging position information in social bookmark systems like Digg requires just a mouse click. Tag clouds go a step further, as users merely view or download as they normally do, and the system adds up their actions to create the online equivalent of "tracks" in a forest of information.

Social Requirements

Figure 2 suggests that not only must different community needs be reconciled but also the needs of society must be reconciled with the needs of individuals. One discovery of game theory was that individual needs need not support social needs, as the "equilibrium point" of the prisoner's dilemma for example is that both cheat each other (Poundstone, 1992). While mutually beneficial synergistic interactions like fair trade create enormous benefits, synergy is just one possible human interaction outcome (Table 2). Since game theory cases like social loafing and the volunteer dilemma are common in social interaction, social systems should, like the atom before quantum theory, collapse in on themselves. Based on the Darwinian principle that individuals tend to do what benefits them, social communities should be unstable (collapse) under the pressure of anti-social acts like stealing.

Yet human society, in various forms, has not only persisted for thousands of years but evolved. It defends itself against anti-social acts by locked doors, moral norms, religious edicts, revenge traditions or state justice. In the latter case the social invention of "fairness", implemented by both revenge cultures and justice systems (Rawls, 2001), seems to have pushed humanity across what Wright calls the "zero-sum barrier", from tribal competition to cooperative society (Wright, 2001). Fairness here is not simply the equal distribution of outcomes (equity), but *allocating group outcomes according to group contribution*. By this principle society punishes those who hurt it, as thieves are put in jail, and rewards those who help it, as artists and inventors are given copyright benefits. The details are argued elsewhere, but fairness plus public good is the requirement for *legitimate interactions*, which are not just fair to the parties involved but also benefit the social unit (Whitworth & deMoor, 2003). Note that to do what benefits the social is exactly the same principle as to do what benefits the individual unit (i.e. "selfishness"), just applied at a higher level. Legitimacy of interaction is a complex social success requirement for any community (Fukuyama, 1992).

If societies to perform well must support legitimate interactions and oppose anti-social acts, this challenges not just STS design but society itself. Currently the "rights" of physical society are often expressed in ownership terms (Freeden, 1991), so "freedom" is the right to own oneself, and slavery the denial of that right. Likewise analyzing who owns what information online (Rose, 2001) lets designers specify online rights (Whitworth, 2006). Such "legitimacy analysis" of online rights may suggest better ways to run physical as well as electronic communities. Meeting the social requirements of technical systems means not just mapping thousands of years of social history to information models, but also considering what this analysis implies for current physical society. Maybe some of our social traditions are just plain wrong, as if individuals can err then so can cultures.

If usability research translates psychological needs into information designs, then the job of STS research is to do the same for social needs. The new "users" of socio-technical systems are in a very real way the communities that they create (Whitworth & deMoor, 2003). For example, currently nearly 90% of all emails the Internet transmits are spam most of which is deleted by filtering technology (Metrics, 2006). Yet even so, that which gets through is enough to make spam the number one networking complaint. This waste of hardware, software and human resources, conservatively estimated in 2005 at over 50 billion dollars (FerrisResearch, 2005), illustrates what happens when socio-technical systems ignore social requirements. The error in this case is an email communication design that gives all rights to senders and none to receivers (Whitworth & Whitworth, 2004).

Summary

It is difficult to express the potential richness of the socio-technical vision in one chapter. It has considered:

1. System levels from hardware to social.
2. Performance aspects like capability and security.
3. Psychological processes that exchange literal, relational and group meaning.
4. Communication setting features like expressiveness, continuity, linkage and cost.
5. Legitimacy as a general requirement for social synergy and stability.

This research landscape is nothing if not challenging, yet the rewards are equally great, as technology plus society combines the two great driving forces of human progress. To imagine the Internet of the future, imagine a world where everything human is potentially known, where everyone is potentially connected, and where all are potentially one community. In this case, it is difficult to imagine any feasible problem that humanity together cannot solve. Business problems like "What do customers want?" could be simple outputs from socio-technical customer communities. Currently insoluble problems in government, education, health, welfare and defense could be amenable to the power of community participation. For example, in a unified and connected humanity millions of eyes watch millions of places, so someone planning a terrorist attack on humanity is likely to be seen by someone, somewhere, at some time. Tips from ordinary citizens found the U.S. Beltway Sniper, watching New Zealand citizens exposed the Rainbow Warrior attack, and likewise international terrorism is

Table 2. Social interaction types

Outcome for…		**OTHER(S)**		
		Gain	**Minor effect**	**Loss**
S E L F	Gain	Synergy	Opportunity	Anti-social
	Minor effect	Service	Null	Malice
	Loss	Sacrifice	Suicide	Conflict

vulnerable to intelligence from a connected global humanity.

Yet without a common human identity, common action is not possible. Human conflict inevitably occurs when some individuals seek power over others for their own ends. Hence to ask "*How can I use STS*?" is to misunderstand why it succeeds. Consider the apocryphal story of the programmer who stole millions using a program that transferred the fraction-of-a-cent leftovers of all financial transactions to his account. The ability to add fractions of a cent into millions of dollars illustrates the power of the computer. That this is stealing, punishable by prison, illustrates the power of society. The collapse of the dotcom bubble illustrated that people can recognize too greedy businesses, even when they are technologized. Today's socio-technical systems like Wikipedia are based on service not plunder, in this case on the principle that if we each give a little knowledge, then we can all receive a lot of knowledge. The social lesson is less that one shouldn't plunder the community and more that one should give to it. If one *uses* a society, seeing it merely as a resource, then one cannot *belong* to it. Equally, if one *belongs* to a society, then one cannot *use* it. A part that diminishes the whole diminishes itself. Cancer cells illustrate what happens when parts of the physical body enhance themselves at the expense of others—the body dies. Conversely, if the social Internet shows anything, it is that large numbers of ordinary people, when working together freely, will voluntarily help each other. This is an extra-ordinary revelation, that we are inherently good not bad, that the human majority has original goodness not original sin.

Of course life will test us. Last century atomic bomb technology asked nations if they wanted to mutually destruct or not. This century Internet technology is asking us if we want to be a single humanity or not. If we were once "*hunter gatherers of the information age*" (Meyrowitz, 1985), and then "*homesteaders on the electronic frontier*" (Rheingold, 1993), shall we now become *electronic citizens of a global cosmopolitus*? If so, the fresh spirit of socio-technical computing suggests that technology can release the goodness of humanity as well as its selfishness. The idea of freely serving one's fellow humanity, not as directed but as one chooses to do so, is illustrated by the Internet today, where every second people help others in undefined and uncontrolled ways. In this view the evolution not just of technology but of humanity itself will be by service freely rendered, not by forced servitude, however politically correct or well intentioned. While negative forces seek discord for personal gain, the social process unifying humanity has been ongoing for thousands of years. It seems very reasonable that computer technology should help bring it about.

Acknowledgment

Thanks to Rob Friedman, NJIT, for valuable comments and review.

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KEY TERMS

Channel: A single, connected stream of signals, e.g. stereo sound has two channels.

Communication: A single transmission of meaning or information between one or many sender(s) and one or many receiver(s) (Lim & Benbasat, 1991).

Communication Interface: Operates at the boundary between communicating entities and the channel (Lim and Benbasat, 1991) and may also record (store) and process communications.

Communication Environment: Any combination of communication settings available to communicators, for example, a communication environment of telephone plus email.

Communication Setting: That through which communication occurs, which may involve many channels, for example, telephone and loudspeaker are different communication settings.

Group: Any set of people who consider themselves a group (Bales, 1950; De Sanctis and Gallupe, 1987).

ENDNOTES

[1] Blank slates.

[2] One cannot combine different disciplines into one "view", just as one observer cannot *at once* view an object from many vantage points. As one first chooses a vantage point then views, so in the WOSP model one must first choose a level, then analyze from it.

[3] Hence "Groups don't think, people do"

Chapter II
The Social Study of Computer Science

Matti Tedre
Tumaini University, Tanzania

ABSTRACT

This chapter introduces the reader to some social research characteristics that are central to the social study of computer science. It introduces research studies that focus on the sociocultural aspects of computing and computer science, explains some of the central characteristics of those studies, and discusses their implications for the computer science discipline. Furthermore, this chapter is aimed at giving the reader a basic understanding of why social studies are important for the discipline of computing, as well as some broad guidelines and pointers towards carrying out such studies in computer science.

Our objective ... is to state precisely and clearly where and why sociological analysis is necessary in the understanding of scientific knowledge. Our main method is to present historical case studies. We then show how sociological analysis applies in these cases, and how it is an essential complement to even the most insightful interpretations derived from other perspectives.

—Barnes, Bloor, & Henry (1996)

INTRODUCTION

Computer science is a relatively new discipline, and it spans across traditional disciplinary boundaries, covering mathematical, engineering-oriented, and scientific traditions (Denning et al., 1989). From the birth of modern (digital, Turing-complete, electronic) automatic computing in the 1940s, those traditions have been essential to the development of the discipline. Modern computer science was born in the 1940s as a result of a number of organizations, a number of top people, many coincidences, a variety of disciplines, an uncommon political situation, a certain culture, unusually liberal funding, and

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convergence of a number of technical and scientific breakthroughs (Tedre, 2006:passim).

Since the 1940s, modern computer science has been surrounded and shaped by a vastly complex conjunction of affairs. Due to their rich and colorful history, computer science and computer technologies include plenty of phenomena, the form and functioning of which cannot be explained in terms internal to those phenomena. For instance, one cannot explain the design and the (non-)diffusion of any programming language by referring solely to its technical characteristics (Sammet, 1991). Understanding the design and diffusion of any programming language requires understanding its history and the original motivations for its development in the first place (e.g., Denning, 2003; Rosenblatt, 1984). Similar, one cannot explain the development of GNU/Linux in solely technological terms—several non-technological motives, such as economic, political, ideological, and cultural motives, can be attributed to the development of GNU/Linux (cf. Tedre et al., 2006). Technical characteristics of GNU/Linux that stem from non-technological motives are perhaps better explained in other terms, such as in psychological, sociological, or anthropological terms.

So it is implausible that one could understand the current state, a static snapshot, of knowledge in computer science without understanding the history of computer science. Moreover, one cannot understand *why* knowledge in computer science is what it is without understanding the history of computer science. In addition to history, one must also understand how society and culture today shape computer science. As computer science is a product of an array of sociocultural forces, any portrayal of computer science is a historically, culturally, and societally specific image. Especially computer science as *human activity* always happens in some philosophical, historical, and sociocultural framework. That is, of course, not to say that computer science that is situated in a historical, cultural, and societal framework could not be *objective. Objectivity* can be defined in a number of ways that permit comparisons of socially constructed knowledge (e.g., Searle, 1996:p.8). For example, objectivity can refer to how strong consensus there is concerning a specific statement.

The importance of historical, cultural, and societal self-understanding of computer science are explicitly noted in the ACM/IEEE computing curricula CC1991 and CC2001 (Tucker et al., 1991: p.73; Denning et al., 2001:p.141). Those curricula emphasize the importance of understanding cultural, social, legal and ethical issues; and stress the appreciation of philosophical questions, technical problems, and aesthetic values. It is, however, uncertain how exactly should philosophical questions, technical problems, and aesthetic values be studied. Neither is it certain how the cultural, social, legal, and ethical issues in computing should be approached. One approach that originates from science and technology studies is *social studies of computer science*—that is, research of computer science itself in its sociocultural context. The focus of social studies of computer science is different from that of social studies of computing as the former is focused on the discipline, whereas the latter is focused on the activity. Social studies of computer science aims at enriching disciplinary self-understanding of computer science by producing meta-knowledge about computer science. That knowledge helps computer scientists to delineate between brute facts (like the laws of nature) and socially constructed facts (like standards and models).

The Contribution of Social Studies of Computer Science

Researchers of social studies of computer science often adopt different conceptual and theoretical frameworks, and start from different sets of assumptions. Often those assumptions are in line with the constructionist, contingent, non-relativist, and nominalist viewpoints of science. In other words, social studies of computer science often entails the assumptions that much of people's knowledge is constructed (rather than absolute), that the history and development of current computer science is one out of an infinite number of possible routes (rather than an inevitable course), that there is a world of ontologically and epistemologically objective things (rather than only subjective statements about the world), and that many of the observed hierarchies and structures in computer science are constructed in order to give structure to the discipline (rather than being a result of an inherently structured world) (cf. Hacking, 1999).

From a narrow point of view, social studies of computer science informs computer science to the extent that social studies of computer science can contribute to knowledge about the subjects of computer science. From a broad point of view, when one considers disciplinary self-understanding to be a part of a mature discipline (e.g., Barnes et al., 1996:pp.*iix-xii*), then one should also acknowledge research that can contribute to the meta-theories, meta-knowledge, ontology, epistemology, and methodology of a particular discipline[1]. For example, De Millo et al.'s (1979) research on theory-formation in computer science is a contribution to the meta-theories of computer science, Harel's (1980) research on theorems that are untested yet widely held contributes to the meta-knowledge of computer science, Brian Cantwell Smith's (1998) *On the Origin of Objects* is a study of the ontology and the epistemology of computer science, Kidder (1981) and Suchman (1987) have contributed to the understanding of how computer scientists actually work, and there are numerous examples of research on the methodology of computer science (e.g., Tichy et al, 1995; Glass, 1995; Alavi & Carlson, 1992; Vessey et al., 2002; Palvia et al., 2003; Glass et al., 2004; Randolph, 2006). Other aspects of a broad interpretation of computer science can be considered to be, for example, sociocultural impacts of computing and computing ethics.

Generally speaking, the constructionist paradigm has established a stable status in the discipline of computing. Especially in those topics that are in close contact with the social sciences, humanities, or education field, the human-constructed nature of computing is emphasized (e.g., McGuffee, 2000; Grier, 2002; Siefkes, 1997 in Freksa et al., 1997). Computing has aptly been described as a humanly constructed and constructive endeavor: computational tools are products of human activity and those tools are agents of social change (Naur, 1992: pp.*xiii-xiv).* The term *social studies of computing* has been used in connection with research on the impact of computers on society and of society on computers (Kling, 1980); with studies of technological discourse (Agre, 1995); and on studies of virtual society (Woolgar, 2002). There are plenty of studies of sociologically, historically, anthropologically, and philosophically oriented research about different aspects of computing (such as Viller & Sommerville, 1999; Crabtree et al., 2000; Hartswood et al., 2002; Suchman, 1987; Godin, 1997; Olazaran, 1996; MacKenzie, 1993; Bowker, 1993; Forsythe, 1993; Kidder, 1981), and often those studies go under some umbrella term such as STS or SSK.

So computer science researchers, such as those above, often borrow methods and aspects of research from social sciences and humanities. This chapter summarizes the methods and concepts used by social scientists and philosophers, and explores their relevance to computing research. In this chapter, the intellectual contribution of social studies of computer science to the broader field of computer science is portrayed by referring to some aspects of research that social studies of computer science entails. This chapter discusses (1) three different sources of information—phenomena in situ, reports of phenomena, and mute evidence; (2) a linkage to the sociohistorical context; (3) ethnomethodology; (4) ethnographic methods; (5) a non-generalizing focus on cases; and (6) measures of interpretive research. Those six research aspects are here connected with examples of existing studies of computer science in order to show that our common understanding of computing has benefited when researchers have incorporated those aspects of research in their inquiry. Those six aspects of research offer some alternative windows to computing research, alternatives that differ from strictly quantitative research. Still, those six aspects do not replace quantitative methods but complement them—qualitative researchers can utilize quantitative methods, and vice versa.

Sources of Information in Social Studies of Computer Science

Disciplines such as sociology, history, and anthropology can contribute unique viewpoints to social studies of computer science. The research approaches that are either explicitly discussed in this chapter or implicit in the sources of this chapter can be categorized, according to their source of information, into

1. those that study *phenomena in situ*, or *what people do* (for instance, ethnographic observations of computer scientists in their work, or observational field studies at locations that play a part in the innofusion of computer systems—locations such as academia, hardware/software manufacturers, professional associations, government branches, or homes);
2. those that study *reports of phenomena*, or *what people say* (for instance, interviews with people in the computing field or discourse analysis of debates about computing); and
3. those that study *mute evidence* like written texts and artifacts, the creators of which are not alive or cannot be interviewed (for instance, historical records, old or new computational instruments, or statistics).

The boundaries of these three categories (research of reports, research of phenomena in situ, and research of mute evidence) are not sharp. However, that does not really matter because these categories are not presented in order to *define* social studies of computer science, but in order to present some practicable conceptual categories for types of social studies of computer science.

Studying the Sociohistorical Context of Computer Science

No matter in what terms the shaping of computer science is presented, if computer scientists wish to retrospectively understand the reasons why computer science and computing have shaped as they have, their methodological toolbox must include historical methods. This is because computer science and computing are always situated in some sociohistorical context. A historical study of computer science needs to link aspects of computing with changes of some kind (cf. Lemon, 2003:pp.294-295), be they social, cultural, theoretical, technological, or conceptual changes. A historical study is also always conducted from a specific point of view (Tuchman, 1994).

The narrative form of history-writing is especially dependent on happenings (Lemon, 2003: pp.298-301). For instance, it is not very revealing about the history of programming languages to write, "In the early 1950s machine language programming was popular and in the early 1960s fortran was a popular programming language." The historian of computer science should also link happenings. For instance, the historian may expound on why there was a shift from machine language programming to high-level programming, who began the shift, what factors contributed to the shift, and how the shift *actually* happened—the shift certainly did not happen overnight. An analytic history of computer science should not only explicate, for instance, what is "a (statistically) typical 1950s computer scientist" (e.g., a young male, in his 30s, with a background of electrical engineering or mathematics,) but also explain the reasons why typical computer scientists of the 1950s shared those characteristics and how those characteristics affected the development of computer science (cf. Lemon, 2003:pp.295-297; Tedre, 2006:393).

A narrative history of computer science is able to portray a living computer science instead of a gallery of snapshot images. That is important for our common understanding of computing, because far from being discrete steps, many "milestone" concepts and events in computing have been multifaceted issues, and they have formed as a result of controversies, debates, and power struggles. Almost everything that is considered to belong to the core knowledge of computer science today is traceable to a number of controversies or discussions.

Computer science and electronic computing are old enough that a historical study of computer science can include both (1) secondary sources, such as works of communications specialists, literary critics, or historians; reference guides; references of good monographs; or citation indexes; as well as (2) primary sources, found in, for instance, archives, statistics, censuses, letters, diaries, newspapers, or popular literature (see Tuchman, 1994). The authors of primary sources have been eyewitnesses to the reported phenomenon, whereas the authors of secondary sources have not been first-hand witnesses to the reported phenomenon.

The importance of the historical research about computers has been acknowledged broadly (e.g., Zhang & Howland, 2005; Lee, 1996; Lee, 1996b), and the history of computing as a research field is well-established. A prime example of a history of computing journal is the *IEEE Annals of the History of Computing*, which has been published quarterly since 1979. Examples of monographs include, for instance, general histories of modern computers (e.g., Campbell-Kelly & Aspray, 2004; Ceruzzi, 2003), topic-specific books (e.g., Sammet, 1969), works on specific aspects of the history of modern computers (e.g., Flamm, 1988), and works on the general history of computation (e.g., Williams, 1985). Many of these historical accounts offer sociohistorical interpretations of the discipline of computing.

Historical research on computer science, such as the kind of research published in *the Annals*, includes not only the analysis of texts, but also the analysis of other mute evidence, such as devices, parts of devices, blueprints, diagrams, components, and other material traces. The problem of interpretation of mute evidence is that there may no longer be anybody alive to articulate the intentions behind the creation of the material (Hodder, 1994). This problem of interpretation and credence is, however, common to many disciplines. In all types of interactive research the analyst has to decide whether or not to take commentary at face value and how to evaluate spoken or unspoken responses (Hodder, 1994).

If there is no way to gather indigenous commentary, material artifacts pose special problems for historians of computer science (cf. Hodder, 1994). It is, in fact, impossible to understand an unknown artifact with certainty without knowing the intentions of the creators of the artifact (Tedre, 2006:p.131). Historians have argued that there is no "original" or "true" meaning of an artifact outside a specific sociohistorical context (cf. Hodder, 1994). Von Neumann's (1945) *First Draft of a report on the EDVAC* is an example of mute evidence that needs to be situated in its sociohistorical context in order to be understood. It is difficult to capture von Neumann's intentions, motivations, and meanings and to put them in today's terms. Even more, von Neumann's metaphor transfer from neuropsychology to computing technology blurs even the technological parallels between the language of his famous draft and the language of today's computer science. Artifacts are always produced under certain material conditions embedded within social and ideological systems, and the EDVAC plans were produced in an especially rare social, political, cultural, and economic situation.

Understanding Computer Scientists' Work through Ethnomethodology

There are some attempts to prescribe how computer scientists should properly work, yet those prescriptions may not correspond to how computer scientists *actually* investigate computing, to how they give structure and meaning to computing, or to how they sustain and manage that knowledge. That is, although there are attempts to describe rigorous, official set(s) of methods of computer science, the practices of computer scientists still do not always match the official set(s) of methods. How people give structure and meaning to knowledge and how they sustain and manage that knowledge are the focus of *ethnomethodology* (Holstein & Gubrium, 1994; Denzin & Lincoln, 1994:p.204).

Similar to *methodology*, *ethnomethodology* does not refer to a specific set of methods in any straightforward sense; it is more of a study of specific actions, "people's methods," which constitute the social activities of a group of people (Lynch, 2004; Lynch, 1996). Ethnomethodology has been successfully used in studies of how scientists of different disciplines, including mathematics and natural sciences, create and maintain knowledge (Clayman, 2001). Although scientific methods in computer science can be highly technical, they are specialized instances of the much broader social phenomenon: Scientific methods are instructions that enable computer scientists to reproduce the computing community's practices (cf. Lynch, 2004). When ethnomethodologists study computer science, the aim is to dig deep into the unexplicated, obscure foundations and features of practices that are not mentioned in the formal methodological prescriptions or reports (cf. Clayman, 2001; Lynch, 2004). Hence, ethnomethodology delivers an especially attractive promise: That of explicating the *actual* ways of constructing and managing knowledge in computer science. This could be called, for instance, the in situ methodology of computer science or the tacit methodology of computer science.

In other words, ethnomethodological approaches in social studies of computer science benefit computer science (both as an activity and as a body of knowledge) to the extent that they can expose how the technological, philosophical, theoretical, conceptual, and methodological frameworks of computer science are created, maintained, and managed. For instance, ethnomethodological studies are revealing about the manners in which new innovations are conceptualized by groups of computer scientists and other stakeholders. Ethnomethodological research can elucidate the processes through which conceptual consensus is achieved in computer science. It can shed light on how epistemologically subjective results in computer science are communicated, confirmed, adopted, objectified, and institutionalized into epistemologically objective facts. It can explain how knowledge is transmitted. It can reveal how common knowledge about computer science gives meaning to activities of computer scientists and to the results of computer science. It can expound on how activities of computer scientists generate knowledge in computer science. And it can track how both intra-scientific and extra-scientific contradictions are dealt with.

The practical value of ethnomethodology has been recognized in fields such as software engineering, human-computer interaction, and other kinds of research on the relationship of work, users, and computers (e.g., Viller & Sommerville, 1999; Crabtree et al., 2000; Clayman, 2001; Hartswood et al., 2002). Lucy A. Suchman (1987:pp.49-50) expressed her ethnomethodological viewpoint in her book *Plans and Situated Actions*. On the more theoretical side of computing disciplines there are reports on how epistemologically subjective proofs are created and transformed into epistemologically objective "hard" facts in computer science (e.g., Richard De Millo et al.'s (1979) theoretical review *Social Processes and Proofs of Theorems and Programs*). Such reports shed light on the very foundations of knowledge creation in the computing disciplines (albeit De Millo et al.'s research can be considered to be only borderline ethnomethodological, because their purpose was to contribute to the formal verification debate in computer science).

In addition to the aforementioned studies in which ethnomethodology has been used to study the users of computational systems, there is also research on the methods and practices used in computer science. There is research on, for instance, how rhetorics in discourse have influenced technological decisions (e.g., Godin (1997) studied the rhetorics surrounding the innofusion of a health technology). There is research on how contingent social elements affect the closure of scientific debates (e.g., Olazaran (1996) studied how Minsky's and Papert's proofs and arguments were interpreted as showing that neural nets were not a fruitful approach to artificial intelligence). There is research on how some mathematical parts of computer science are negotiated, rather than deduced (e.g., MacKenzie (1993) examined how the IEEE standard for floating-point arithmetic arose as a result of negotiation). There is research on what kinds of rhetorical strategies have been used in arguing for the universality of computing technology (e.g., Bowker (1993) showed the ways the practitioners of cybernetics argued that they were producing a new, universal science). And there is research on how knowledge engineers' epistemological stances are reflected in artificial intelligence technology (e.g., Forsythe's (1993) study in which he drew on ethnographic material about knowledge engineers' work, showed that building a knowledge-based system necessarily involves interpretation and selection, and suggested that knowledge engineers should be trained in qualitative social science).

Ethnomethodological investigations can be conducted with a variety of methods. The knowledge construction processes in computer science have been mostly examined using analytical methods or reflection (e.g., De Millo et al., 1979; Crabtree, 2004; Hartswood et al., 2002). If the organization of social interaction is the focus of an ethnomethodological investigation, ethnomethodology is often coupled with conversation analysis (Holstein & Gubrium, 1994; Lynch, 2004). Usually, however, ethnomethodological research is ethnographic and pays especially close attention to how the people in the study setting communicate and interact (Holstein & Gubrium, 1994). The ethnographic kind of ethnomethodological studies require extensive participant observation in specialized work settings (Lynch, 2004). However, whereas in traditional ethnographic research on computer science one might assume that the language of computer science is a neutral conduit for description, in ethnomethodologically oriented research on computer science, descriptions, accounts, or reports should be treated not merely as being *about* the social world of computing as much as being *constitutive* of the social world of computing (Holstein & Gubrium, 1994).

Although it cannot be said that there is an ethnomethodological tradition in the field of computer science, ethnomethodology is not unknown to computer scientists, either. In the computer science literature there are studies in which the ethnomethodological approach has been made explicit, as well as studies that can be characterized as ethnomethodology. The majority of the ethnomethodological studies in computer science literature report on the users of information technologies (they study the end users' methods) and are aimed at informing, for instance, system designers, interface experts, and software engineers. Also present are ethnomethodological investigations in which the practices and behaviors of computer scientists are studied, yet those studies are more commonly aimed at informing sociologists than they are aimed at informing computer scientists.

Ethnographic Methods

Around the mid-1900s new technical systems grew too large and complex to be designed and maintained by single individuals. The complexity of systems today necessitates broad approaches to understanding system development. Suppose, for instance, that one wants to explain the ontological, epistemological, methodological, or material assumptions, decisions, foci, or compromises that system design may incorporate. Nowadays it is not enough to study individual actors and their surroundings because systems are no longer designed or managed by individuals; studying groups is necessary. When explicating the design decisions behind a complex system collective or multiple perspectives need to be accounted for. Ethnographic methods offer researchers of computer science a unique way of understanding the processes and dynamics behind, for instance, computer architecture design. Instead of historical studies, which are conducted in retrospect, ethnographic methods are studies of the present—studies of computer science in the making.

The term *ethnography* has been used in a large variety of meanings. One characterization is that ethnography is the "*art and science of describing a group or culture*" (Fetterman, 2004). Originally the term ethnography referred to the book-length record of anthropologist's observations and analysis about his or her involvement in a community (Agar, 2001). The data of ethnography are derived from the direct observation of behavior in particular groups (cf. Conklin, 1968 in Sills, 1968). As a verb, *doing ethnography* merely means the collection of data that describe (some parts) of a culture (e.g., Bernard, 1995:p.16; Agar, 2001 in Smelser & Baltes, 2001; Conklin, 1968).

Roughly speaking, a researcher using the scientific method seeks universal laws, emphasizes control of the research process, preserves the initial assumptions throughout the study, relies on linear models, and represents data with numbers (Agar, 2001). By contrast, again roughly speaking, a researcher using ethnography seeks local particulars, emphasizes adaptability in the course of study, develops new concepts over the course of the study, relies on systemic and processual models, and represents data more often with words than with numbers (Agar, 2001). The promise of ethnography in social studies of computer science lies in the extent to which ethnography succeeds in eliciting the perspectives and realities of computer scientists, that is, the insider's or *emic* perspectives or reality (cf. Fetterman, 2004). In other words, the promise of ethnography lies in the extent to which ethnography can explain how the activities of computer scientists create the body of knowledge of computer science.

Ethnography is often misunderstood as being purely qualitative research, but in reality it can include quantitative aspects, too. Usually, however, ethnographic research shares the features of (1) *exploring phenomena* rather than testing hypotheses; (2) emphasizing *unstructured data* instead of analytic categories; (3) focusing on *cases* in detail instead of large populations, and (4) *explicitly interpreting* the meanings and functions of human actions (Atkinson & Hammersley, 1994). Ethnographers in computing fields should live with the group they study for an extended period of time (ideally about 2 years), they should actively participate in the daily life of the group members, and they should carefully observe all aspects of the group members' life as a way of obtaining material for their study (cf. Tedlock, 2005; Atkinson & Hammersley, 1994; Bernard, 1995:p.78).

Tracy Kidder's (1981) *The Soul of a New Machine* is one of the early examples of an ethnographic-type participant observation in the field of computing. Kidder observed a group of engineers at Data General from 1978 to 1980—the whole period of a design, implementation, testing, and release of a new 32-bit minicomputer (which became the Data General Eclipse MV/8000). In his book, Kidder described the company work environment and the machine, concentrating on not only technological decisions, but also on things such as the engineers' emotions, the birth of innovations, bottom-up management, the dedication and motivations of the engineers, the pressures caused by tight schedules, disappointments, engineering ethos, and engineering artistry. Kidder discussed how architectural design is actually done, the challenge of designing a new 32-bit architecture while maintaining downward compatibility to legacy architecture, decisions concerning microcode, instruction set, registers, diagnostics, input/output, types of components used, and so forth. A competent computer scientist can get acquainted with the architecture of Data General Eclipse MV/8000 computer by studying its blueprints and specifications. Kidder's study offers some viewpoints on *why* the Eclipse MV/8000 architecture is what it is.

Ethnographic methods in social studies of computer science aim at describing and interpreting social phenomena such as ways of working, group relationships, communication, metaphors, and tropes in computing community (cf. Atkinson & Hammersley, 1994). Since ethnographic methods emphasize understanding phenomena in their rich sociohistorical contexts, ethnographic methods can be utilized in order to examine, for instance, patterns of production of scientific results, innovation, and standards in computer science. They can also be utilized to study mechanisms of technological production, design, adoption, rejection, diffusion, non-diffusion, and so forth. Scientists today have a unique opportunity to examine and document the early formation of the discipline—modern computer science is no older than 60 years, and it can be argued that many parts of computer science, such as information systems and software engineering, are still at the pre-paradigm stage of scientific development (e.g., Wernick & Hall, 2004).

Focus on Cases

Often computer science research aims at generalizability; computer scientists often argue that their results from one set of data are applicable to all similar data. In research where generalizations are made, the significance of single cases is often downplayed. By contrast, in those studies in social studies of computer science that aim at contributing to knowledge about computer science by explaining how and why computer science has taken its current form, single cases are important. Single, non-generalizable studies, such as Donald MacKenzie's (1993) study of the negotiation of floating-point arithmetic, are important because they can offer information about the *how*s and *why*s of technoscience (yet single cases can also contribute to generic theories about technoscience).

The term *case study* can be understood as a method or a research strategy (Yin, 2002) but here it is understood as the focus of a specific study. When case study is understood as an indicator of the focus of the study, case studies can be quantitative or qualitative, although many studies that are labeled as case studies are qualitative (Stake, 1994). The driving question behind case studies is, "What can be learned from the single case?" (Stake, 1994). However, it is typical of case studies that the researcher is ultimately interested in a process, or in a population of cases (Denzin & Lincoln, 1994: p.203; Denzin & Lincoln, 2005:p.380). Case studies in social studies of computer science aim at a deep understanding of phenomena in computing; and they can be of an individual, a group, a site, a class, a policy, an institution, or a community (Ary et al., 2006:p.456). Case studies aim at rich, detailed descriptions of phenomena, and they often use several different research instruments or methods.

Instrumental case studies are conducted because the researcher believes that a particular case may provide insight into an issue, theory, concept, technology, or such; and collective case studies extend to several cases (cf. Stake, 1994). Also historical narratives—such as Thomas Hughes et al.'s reports on relational databases, the Internet and the World Wide Web, theoretical computer science, artificial intelligence, and virtual reality—can be considered to be a form of case study which is aimed at uncovering the actions of stakeholders (NSR Computer Science and Telecommunications Board, 1999). Such narratives allow analogies to be drawn between events that occurred decades apart; narratives can accommodate complexity more easily than can a tightly-structured analytical essay, and can "present finely nuanced accounts that convey the ambiguities and contradictions common to real-life experiences" (NSR Computer Science and Telecommunications Board, 1999:p.3).

Evaluation of Studies of Social Reality

The crux of social studies of computer science is not numbers and proofs. Unlike the subjects of mathematics and logic, the subjects of disciplines such as sociology, history, anthropology, and philosophy are often not well-structured, logical, coherent, or well-defined. If one were to agree that changes in technology follow from choices that mirror the social relations of innovation and diffusion of technology, it would be an error to assume that having exposed the choices and their motifs, one could simply deduce the rest of reality from them (Noble, 1999). Researchers should not assume that by unearthing the social, cultural, economic, institutional, personal, and other human variables they can converge on the "true" state of affairs. That is because models and tools—such as classification systems, conceptual frameworks, data structures, or computational models—are influenced by the researcher's existing knowledge about the domain, as well as by the epistemological and methodological commitments of the researcher. Even in the field of statistics, differences in classification systems and their changes over time are actually seen today as phenomena that deserve to be examined in their own right (Desrosières, 1996 in Hantrais & Mangen, 1996).

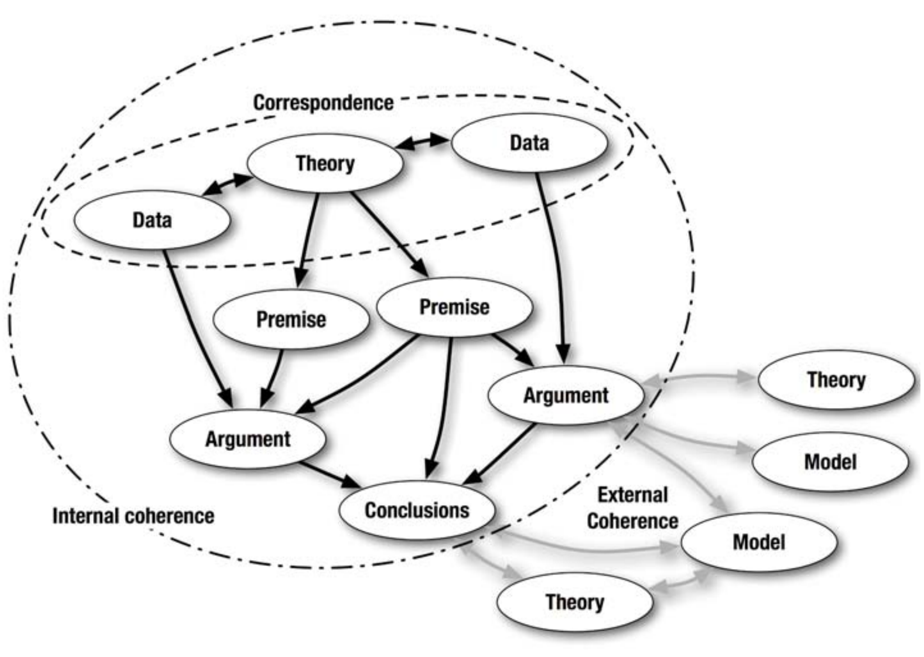
In many kinds of research validity and reliability form the stone base of confirmation. But in qualitative research there is less agreement on confirmation procedures than in quantitative research. It has been argued that the "twin struts of confirmation" are coherence and correspondence (Hodder, 1994). Internal coherence is the degree to which the parts of an argument do not contradict each other and to which the conclusions follow from the premises (Hodder, 1994). However, it must be noted that what is considered to be a credible argument may differ between disciplines and between individuals. For example, what is considered to be a credible argument in biology may differ from what is considered to be a credible argument in sociology. Ultimately, the audience interprets and judges every argument in interpretive research. External coherence refers to the degree to which the interpretation of research material fits theories, models, or interpretations accepted within and outside the discipline (Hodder, 1994) (See Figure 1).

Correspondence between theory and data is an essential part of a coherent argument. "Correspondence between theory and data" does not imply an absolute and independent link between theory and data, but it rather embeds the fit of data and theory within coherence (Hodder, 1994). The data are made to cohere by being linked within theoretical arguments (Hodder, 1994). Similarly, the coherence of the arguments is supported by their fit to data. The more robust fit there is between data and theory, the better correspondence they can be said to have.

The concepts of correspondence and coherence are portrayed in Figure 1 (cf. Tedre, 2006:p.407). Correspondence expresses how well sets of data cohere within the selected theoretical framework in the study, internal coherence expresses how well arguments and conclusions follow from the data and theory, and external coherence expresses how well the conclusions and arguments resonate with other pieces of research and theory.

In addition to the traditional measures of validity; such as instrument validity, face validity, data validity, and criterion validity (see, e.g., Bernard, 1995:pp.38-42); there are a variety of less frequent measures of validity, such as contextual validity, dialogic validity, and self-reflexive validity (Saukko, 2005). Contextual validity refers to the thoroughness and defensibility of the analyses of social, historical, political, or economic processes and structures (Saukko, 2005). Dialogic validity refers to the extent to which research is able to expose tacit, experienced, emotional, and embodied knowledge and understanding (Saukko, 2005). Self-reflexive

Figure 1. Correspondence and coherence



validity is based on the critical reflection of how social discourses shape or mediate people's self-experiences and the experiences of their environment. Self-reflexivity refers to the extent to which the researcher is aware of the discourses that guide the research analysis itself (Saukko, 2005). Although those validity measures are subjective, one must remember that *any and all* validity measures are subjective. Ultimately, the validity of a concept depends on two things: the utility of the device that measures it, and the collective judgment of the scientific community (Bernard, 1995:p.43; also Tedre, 2006:p.408).

On lines similar to Thomas Kuhn (1977:pp.321-322), three other criteria to the success of research have been proposed (Hodder, 1994): fruitfulness (how many new directions, new lines of inquiry, new perspectives are opened up), reproducibility (the extent to which other people, perhaps with different perspectives, come to the same results), and intersubjective agreement (on a science that balances between a number of disciplines, the adequacy of the results to those disciplines). Research that attacks an obstacle that hinders progress in a number of topics often turns out to be especially fruitful. That is, there are certain obstacles that, after they are overcome, allow a number of topics to be pursued.

CONCLUSION

In this chapter, a number of research aspects have been discussed; aspects that are useful in social studies of computer science, yet that do not necessarily belong to the traditional computer scientists' toolbox. These aspects of research are an example of the new viewpoints that a humanities and social sciences-based approaches have brought into understanding computer science and computing. Research that can be considered to be social studies of computer science is nowadays often conducted by trained specialists in fields such science and technology studies, interface design, management information systems, and history of computing. But also the modern computer scientist-as-a-bricoleur ought to be cognizant of different research approaches; the computer scientist working with social studies of computer science needs a full toolbox and the knowledge of how to use those tools appropriately.

The social studies of computer science can be considered to be research that situates and investigates computer science in its social, historical, cultural, linguistic, political, economic, institutional, personal/individual, and other socially constructed frameworks—including its scientific and technological frameworks. The social study of computer science aims to provide an image of computer science as knowledge and as activity; an image in which more than merely the technological aspects are considered to be influential. It can reveal how computing as a discipline is continuously recreated and maintained, and explain how scientific statements in computing are externalized, objectified, internalized, and reified—that is, explain why many things that computing professionals produce are afterwards perceived as something other than human products. The social study of computer science can explicate unspoken assumptions, shared attitudes, and tacit knowledge.

In the social study of computer science, historical methods are utilized in order to retrospectively appreciate the reasons computer science has become shaped as it has. Sociohistorical understanding offers important "lessons learned"; it can trace changes in technology and science to challenges, controversies, and discussions; it can discover parallels and analogies between previous, current, and future technology; and it links happenings and assesses the reasons for those happenings. Ethnomethodological research is a social study of computer science that offers insight into the present of computer science. It is aimed at portraying the actual processes of constructing and managing knowledge in computer science. It attempts to uncover the ambiguous and complex practices of, for instance, creating, maintaining, using, abusing, proving, refuting, negotiating, accommodating, appropriating, and contextualizing knowledge in computing.

In social studies of computer science, ethnographic methods are used to explore and portray the realities, perspectives, and group dynamics of computer scientists. Those aspects of computer science are interesting in themselves—but they may also reveal some aspects in the practices of computer scientists that have direct consequences on the common knowledge in computer science. Often different methods are combined together to case studies; studies which aim at an in-depth investigation and analysis of phenomenona. Case studies attempt at portraying phenomena and at explaining the hows and whys concerning those phenomena. Multiple methods in case studies can give rich insight into social as well as technical aspects of computer science. But the aims of the social study of computer science are not solely descriptive. In the sense that social studies of computer science offer alternative explanations of concepts, theories, instruments, techniques, methods, or designs of computer science, they can have normative aims too—that is, those studies can also aim at changing the content, processes, hierarchies, or other aspects of computer science.

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KEY TERMS

Ethnomethodology: The study of the ways (such as conventions, practices, and codes) through which people make sense as well as create their social reality and which underlie social interactions between people.

Ethnography: The term ethnography is used in various meanings, but as a set of methods, it refers to observational and participatory methods that focus on the life of some particular group of people; their culture, behavior, social interactions, and other aspects of their everyday life.

Case Study: The term case study can refer to a method, research strategy, or focus of study. In the latter meaning case studies aim at finding out what can be learned from a single case. Case studies can have quantitative and qualitative aspects, and they aim at giving rich, detailed descriptions of a phenomenon.

Method: The term method refers to a means or a procedure for accomplishing something, like measuring the execution time of a task, interviewing a group of people about an interesting phenomenon, or comparing the execution times and output sizes for a given input with two computer algorithms.

Methodology: The term methodology refers both to a specific set of methods and to the study of usage patterns, procedures, principles, and assumptions that underlie such set of methods.

ENDNOTE

1 *Ontology* refers to the study of the nature of being and reality. It deals with questions such as what kinds and types of things exist, what does the existence of some things depend on, and what does it mean if one says that something exists. *Epistemology* refers to the study of the nature of knowledge. It deals with questions such as what is knowledge, when is knowledge justified, and how do people acquire knowledge.

Chapter III
Virtual Collaboration and Community

Ann Borda
Victorian eResearch Strategic Initiative (VeRSI), Australia

Jonathan P. Bowen
London South Bank University, UK
Museophile Limited, UK

ABSTRACT

This chapter introduces the concept of a Virtual Organization (VO), using the Internet to link geographically separated participants in an efficient and novel manner. In particular, the chapter contrasts the attributes of Project VOs and Community VOs. The former tend to be more formal and arise for a particular collaborative goal with a limited lifetime. The latter are less formal and more open-ended, with a less specific purpose, largely aimed at developing an online community as an end in itself. The features of Project and Community VOs are compared and the various technologies are discussed. Two case studies are presented as examples. This is a rapidly changing area with new technologies becoming rapidly available, but the underlying concepts and reasons for the existence of VOs in the support of virtual collaborative practice remain more stable.

…the manner in which a virtual community develops must be dictated by the organic needs of its members, not the other way around

—Howard Rheingold, *The Virtual Community*

INTRODUCTION

People have collaborated throughout their development. Without collaboration, the human race would never have survived and indeed thrived. Humans are well adapted to intelligent behavior and cooperation when needed but are less well suited to lone survival. This situation has continued through from the days

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when cooperative hunting for food was required to the modern world of electronic communication, which has developed extremely rapidly over the past decade or two. Despite the pace of change, many people have used this new environment to their advantage, whether professional, socially, educationally or commercially. Increasingly, global organizations see the benefits of collaboration across distances as a means of providing focused attention to complex problems without physically relocating individuals (Malhotra and Majchrzak, 2004). All these aspects require an adaptation to a completely new medium that supports new types of virtual community that were almost unimaginable only a generation ago.

There have been some forward thinkers who can be identified with hindsight. For example, Marshall McLuhan coined the now classic expressions "*the medium is the message*" and "*global village*" in the 1960s, in the context of media in general, especially the various electronic media. These concepts have become even more apposite with the coming of the Internet, largely after McLuhan's death in 1980. Early virtual communities, such as the WELL (Whole Earth 'Lectronic Link), started in 1985 originally via dial-up lines and then via the Internet, and still continuing today, were embryonic examples of what has now become commonplace in the networked world. The phenomenon of the virtual community has been tracked by Howard Rheingold (2000) in his publication on the topic, which drew attention to this new form of community and the variety of collaborative interactions it can engender via the Internet and web technologies.

This chapter considers the current status of online collaboration and communities. In particular, it attempts to categorize different forms of virtual organization that exist for a variety of purposes. The technological features available for use are considered with respect to different types of virtual organizations and collaborative practice.

Virtual Organizations (VO)

The nature of virtual collaboration and community is manifested in the notion of the *Virtual Organization* (VO). Such organizations are built upon 'cyberinfrastructures' (Internet, web services, etc.) to link groups of people and resources distributed across organizational, institutional, and/or geographic boundaries. They are formed to leverage complementarity, core competencies and pooled resources to create productive 'organizations', be they not-for-profit, community-focused, corporate, research or educational, and they may often appear to others to be a single unified organization with a real physical location (Churchill et al., 2001; Lee et al., 2006). The VO stems from the concept of a distributed virtual networking system, the development of which has as its goal to provide a new and more effective means of using computers as tools for communication, collaboration and information sharing with others (Schraefel et al., 2000). The term VO has also been associated with 'collaboratories', online communities (Preece, 2000) and virtual environments, among others. VOs as collaborative structures have further been the study of a range of practitioners, including computer scientists, organizational theorists, sociologists, and business modelers.

In the most general terms, what characterizes VOs are the fact that they are principally computer-supported and are underpinned by collaborative tools and HCI (Borda and Farnhill, 2006; Churchill et al., 2001; Fitzgerald et al., 2008; Kimble and Hildreth, 2005). There are a number of ways in which VOs are currently supported, not least through web-based services and applications that demonstrate the Web 2.0 concept (O'Reilly, 2005). These are not technologies as such, but services (or user processes) created using the building blocks of the Internet and the web. These include blogs, wikis, multimedia sharing services, content syndication, podcasting, and content tagging services. Many of these applications of web technology are relatively mature, having been developed and in use for a number of years, although new features and capabilities are entering the public domain on a continuing basis.

Types of Collaborative VO

Two types of VO are the focus of this chapter and refer to the broadest categories of virtual collaborative practice: *Community VOs* and *Project VOs*. Both types of VOs are varied in that they can be represented by fledgling or well-defined groups. They are also characterized by distributed members or teams who are not generally co-located and can vary in size (Ballesteros, 2006; Lee et al., 2006). Shao et al. (1998) explain VOs through four key factors, the degree of variability of which decides its structure; namely, connectivity, purpose, technology and boundary. Taken together, these four key characteristics give guidance in the assessment of categories of VO.

The main distinctions between the two can be summarized as follows:

Community VOs:
- Self-forming based around interests, information and/or knowledge
- Often loose informal structure
- Often open-ended
- Externalized—public facing

Project VOs:
- Predominantly task and/or goal oriented
- Often formalized structure
- Normally finite duration
- Internalized—project teams

Project VOs

Project VOs are based around the notion of a Collaborative Work Environment (CWE) that provides "*the ability to collaborate over time and space, within and between organizations or communities* […] *to achieve flexibility by making best use of the knowledge and competences available*" (Ballesteros, 2006).

Project VOs build on the notion of changing work contexts, moving from individual to team-based and finally community-based workplaces, with an associated vision. The accompanying significant social, organizational and economical changes, as well as a driven technology evolution, dramatically impact the way communities work and collaborate. People are increasingly not working according to linear models, but rather more as dynamically and spontaneously assembled groups of people working together in a collaborative mode.

A *virtual team* is the concept commonly used to describe this way of working within a Project VO. It is also the main constituent of the Project VO itself. Some of the literature suggests that the concept of virtual teams is comprised of members who never meet face-to-face; whereas the concept of a *hybrid team* refers to members who occasionally meet face-to-face (Bell and Kozlowski, 2002). Others (Majchrzak et al., 2000) refer to virtual teams as groups of people who rarely meet face-to-face, thus most of their collaboration is mediated by technology. Virtual *project* teams refer to teams tasked with producing a specific output, collaborating in a time-limited, non-repetitive group of geographical distributed participants (Massey et al., 2003).

In further defining a Project VO, one must understand the nature of 'collaborative working'. Collaborative working can be characterized by the need for a specialized '*working space*'. Basic requirements for a working space can include areas for:

- Communicating (e.g., chat or video conferencing)
- Scheduling/calendaring (e.g., project team calendars, meeting management)
- Sharing (e.g., images, documents)
- Publishing (e.g., wikis)

Most Project VOs have two or more of these four 'areas' in common and VO members can be supported in their work in each area with the appropriate applications and tools (Bjørn, 2006; Thomas et al., 2007). One of the complex issues for virtual project teams is the coordination of work (Herbsleb et al., 2000): understanding which team member is doing what, how much effort is being expended, the status of project deliverables, etc. This is delineated by collaboration behavior (e.g. networking), tools, mutual understanding, and trust. The collaborative workplace should facilitate and ease collective work (Bjørn, 2006), but may require a strong community or organizational plan to ensure members adopt this successfully; one of the major challenges for a Project VO.

Community VOs

Related to the concept of 'virtual community' (Rheingold, 2000; Beler et al., 2004), Community VOs are a type of social aggregation with shared access to tools and/or site resources that enable the support of three key elements, namely:

- **Interests:** What interests us and how we feel about it.
- **Information:** Where to find something and how to do something (e.g., searching functions, adding content).
- **Knowledge:** Opinions, learning and relationships.

A form of Community VO that incorporates these three elements is the *Virtual Community of Practice* or VCoP. Lave and Wenger (1991) described a Community of Practice as "... *a set of relations among persons, activity and world, over time and in relation with other tangential and overlapping CoPs*". VCoPs are known to foster community activities that build relationships, create engagement, support the emergence and ongoing reinforcement of community presence, and help members of a distributed community organize around purposeful actions. However, CoPs, along with Community VOs, raise the question of whether it is more difficult to gain legitimacy in a virtual environment, but perhaps the most difficult challenge is the facilitation of participation to evolve the community (Kimble and Hildreth, 2005).

Participation is central to the evolution of an online community and integral to the creation of the relationships that help to build both the trust and identity that define a Community VO. The broad take up of Web 2.0 applications, especially social software applications such as del.icio.us (http://del.icio.us), Flickr™ (http://www.flickr.com), Facebook (http://www.facebook.com), and so forth, represent a commensurate increase in participation in virtual community environments, notably among teenagers and young adults (Owen et al., 2006; Weber and Dixon, 2007).

This also follows the notion of an 'architecture of participation' coined by Tim O-Reilly (2003) and which has its roots in open source software development communities. Such communities organize themselves so that there are lowered barriers to participation and to a market of new ideas and collaborations as in the case of entrepreneur marketplaces like Mturk (http://www.mturk.com) and Innocentive (http://www.innocentive.com).

Features of Collaborative VOs

There are common features shared across Project and Community VOs that define their capability areas, although the level of capabilities may vary with the type of VO. For instance, membership management has an equal impact in the formation and lifecycle of both types of VO, and is often enhanced with specific functionalities in terms of member roles, identity, and support for VO operational processes (Bjørn, 2006).

Scalability and dynamism may have higher levels of association among Community VOs, but less so among Project VOs, which tend to be more bounded by project structures and task orientation (Lee et al., 2006; Thomas et al, 2007). Service orientation levels will depend on the maturity and formalization of the specific VO. In general, Project VOs will require some formalized service orientation to support its processes (Bjørn, 2006); however there are categories of Community VOs that will need to support existing members and to solicit new membership with a range of services.

Research shows, for instance, that communities which transform from small, informal VOs to large community VOs require more coordination to be successful (Ballesteros, 2006; Cataldo et al., 2006). These communities rely on the flexibility necessary to respect collective and individual interests while establishing formal mechanisms to create standardized approaches and stability. It is the coexistence of these two possible tensions (i.e., flexibility and formalization) that can provide a means for growth and balancing interests.

This tension also emphasizes that the degree of technical innovativeness is not the only factor that can decide the structure of a VO. The history and culture of a VO may be relevant, as well as the way features may translate into norms during its growth and maintenance. As derived from a cross-section of the literature on collaborative VOs (DeSanctis and Monge, 1999; Lee et al., 2006; Lipnack and Stamps, 2000; Shao et al., 1998; Thomas et al., 2007; Travica, 1997), capability levels (table 1) are informed by a number of broad features which themselves may vary according to the VO.

Perhaps, the most defining features of Project and Community VOs relate to specific tasks supporting collaboration. Not surprisingly these are largely associated with forms of communication and social interaction (Churchill et al., 2001; Ballesteros, 2006; Huysman et al., 2003; Thomas 2007).

Overall, VOs can be identified by their use and/or development of applications to underpin their collaborative functions and capabilities. Following the second generation of the Internet (i.e. Web 2.0), there has been an increase in the range of such applications, for example (O'Reilly, 2005):

- Community portals
- Professional and social networking sites
- Meeting set up
- Blogs
- Wikis
- Project management tools
- Chat/videoconferencing
- Media sharing
- Other participatory tools (e.g., online discussion forums)

Table 1. VO features by capability level

Feature	Community VO	Project VO
Dynamic	High	Medium to High
Adaptive	Medium	Medium
Scalable	High	Medium
Resource provisioning and management	Medium to High	High
Service orientation	Low to Medium	High
Membership management	High	High
Participatory	High	Medium to High

VOs use these applications generally in two different ways to go about their collaboration—the first is centered on information, the second is about relationships. Certain tools will support specific information functions, such as wikis and blogs, and others will be linked to relationship functions such as social networking sites (Ballesteros, 2006; Bjørn, 2006; Williams et al., 2005). However, there is more often hybrid functionality in collaborative tools. For instance, in the area of professional networking sites, LinkedIn (http://www.linkedin.com) as one typical example can be used to disseminate questions across a VO community for users seeking particular information. Similarly, portals can be identified with a number of features providing VO members access to resources and spaces for shared interactions.

The difference in approach between knowledge and information sharing provides an additional dynamic to the shaping of VO interaction. Information can be readily disseminated and copied; this exists in static documents or text, for instance. Knowledge is more tacit and is acquired through what people know or have learned; this comes out of various modes of communication, e.g. discussion, conversation, chat, etc. (Cataldo et al., 2006; Kimble and Hildreth, 2005; Malhotra and Majchrzak, 2004). A summary of common functions associated with collaborative applications is outlined in Table 2.

The extent of use of collaborative applications may differ according to the type of VO; Project VOs may veer toward a selection of tools to support functional needs of a virtual project team. The tool must be appropriate to meet the intended goal and should be integrated into the workflow. So the choice of a blog, for instance, may not be effective if it is not seen to progress the project or a project outcome (Bjørn, 2006; Lipnack and Stamps, 2000), whereas Community VOs tend to evolve or build around self-selected tools or a corpus of tools according to the needs of membership (Cataldo et al., 2006; O'Reilly, 2005). Hence the collaboration process for a VO can be approached from different points depending on the VO: Community VOs can start with a collaborative tool and experiment with that (Williams et al., 2005); a Project VO might start from a process that they want to improve within their VO (Mader, 2008; Malhotra and Majchrzak, 2004).

By interpolation, VOs may need varying technologies at different stages because there inevitably will be different social requirements, incentives and motivations over the course of their lifetime. Whatever timeframe for use, however, collaboration tools need to be reliable, intuitive, and user-centered. If a VO membership take-up tools unaided, or with sustained use, there is a greater opportunity for members to work in *closer* collaboration within and across a VO. There are practical benefits of less undesirable duplication and more desirable cognitive activities.

Table 2. Comparison of collaboration tools and functions

Application type	Functions	Examples:
Portals	Sharing information	Ami@Work (http://www.ami-communities.eu)
	Establishing communities	
	Connecting people and organizations	
Professional networking	Sharing information	Academici (http://www.academici.com)
	Connecting people interested in same topics	
	Creating links and networks	
Social networking	Connecting people	Facebook® (http://www.facebook.com)
	Creating links and networks	
	Supporting informal knowledge sharing	
Meeting set up	Scheduling	Meet-O-Matic (http://www.meetomatic.com)
	Managing people	
Blogs	Sharing knowledge	Globe of Blogs (http://www.globeofblogs.com)
	Making information accessible	
Wikis	Sharing information	Wikia® (http://www.wikia.com)
	Sharing knowledge	
	Establishing communities	
Project management tools	Managing tasks and people	Project Place (http://www.projectplace.com)
Chat & messaging	Supporting informal knowledge sharing	Jabber® (http://www.jabber.org)
	Connecting people	
Videoconferencing	Sharing knowledge	Skype™ (http://www.skype.com)
	Sharing information	
	Connecting people4	
	Managing people	
Media sharing	Sharing information	Flickr™ (http://www.flickr.com)
	Making information accessible	

Community VOs and Project VOs further rely on forms of trust to support their interactions (Handy, 1995)—for instance, in the need to access or share information, and to establish or maintain relations. This trust is particularly heightened in virtual spaces in which relationships need to be built across physical and organizational boundaries and ‘knowledge’ is to be exchanged across these. Virtual collaboration in a VO is one means to effectively support the process.

Two case studies that provide a basis for comparing the dynamics and characteristics of a Project VO and a Community VO are provided below.

Case Study: Project VO

Funded by the European Union (6th Framework Programme-IST) from March 2006 to March 2009, the main objective of the ViroLab project (http://www.virolab.org) is to develop a Virtual Laboratory for Infectious Diseases that facilitates medical knowledge discovery and decision support for, e.g., HIV drug resistance. The infrastructure underpinning ViroLab is technologically complex involving high-performance computing, applications for data analysis, simulation and modeling and other functions. The project uses a uniform interface to available resources in the virtual laboratory, with functionality defined by well-defined tasks in clinical environments.

The Virtual Organization (VO) model, within which ViroLab operates, spans several geographically distributed physical institutions across Europe, comprising a total of thirteen partners. This VO model encompasses a combination of features as outlined in Table 1. For example, it is formed around trusted resource provisioning and management, service orientation, participation and membership. As a European-wide project, a high degree of communication is essential not only between ViroLab and the distributed research and clinical communities, but also among the core team members in order to produce deliverables within strict deadlines. Teams of varying management level are based across the partner sites so project management tool software and the use of document sharing systems have arisen out of necessity as a result. According to one of the project leaders supporting the ViroLab VO, two other factors are critical to the deployment of its collaborative technologies, namely:

a. Geographical distance; and
b. Cost effectiveness due to finite timescale and funding.

The most significant tool for collaboration thus far in the lifecycle of ViroLab is the web portal (http://www.virolab.org). The web portal is the main interface to the virtual organization and to those engaging from ‘outside’. A large project VO, like ViroLab, may easily lack the cohesion of a physical institution or location so technology, like portals, can also play a more crucial role in providing some coordination and structure. Authorised (non-public) areas of the portal have additionally become an effective tool for keeping remote staff updated on workpackage activities and as a means for them to receive input, to share files, and to generate reports. The ViroLab web portal has been designed and operated with these multiple objectives in mind and in keeping with the distributed problem-solving framework within which it sits.

ViroLab has further implemented several tools to facilitate virtual meetings, such as interactive chat and whiteboard applications that are seamlessly integrated into the portal. Researchers in different countries have been able to share information and view their opinions real time, although asynchronous interaction remains prominent. There are a few reasons for the latter. Firstly, the teams work within a range of heterogeneous environments (e.g., hospital, clinical laboratory, computing centre) and, secondly, the nature of the distribution of the teams and localized working practices lend themselves more readily to face-to-face and non-virtual communication. A third factor is the varied understanding of what roles the non-virtual organizations actually play in VO activities. However, the integration of virtual team management has been led by the mandate of the VO itself, which has a particular focus on developing a collaboratory and provisioning access to shared resources as primary outputs (Foster et al, 2001). One can compare this approach to a common challenge in the general set up of project VOs—principally, whether virtual members should emulate a face-to-face organization or whether they should strive for another type of model to support project team interactions (Churchill et al., 2001; DeSanctis and Monge, 1999; Lipnack and Stamps, 2000).

Case Study: Community VO

Community VOs exist at all sorts of different scale and for many purposes. A common interest is important for success and this interest must exist naturally. Community VOs can be used to augment existing real-life communities. An example is the virtual community associated with the Dulwich Picture Gallery in south east London (Beazley, 2008). This has developed from a purely museum-based community associated with those interested in the art gallery into a wider community drawing in those with other interests too. This has benefits for the gallery since it attracts potential visitors who may not have considered involvement with the museum otherwise.

This virtual community demonstrates the fact that a large amount of funding is not necessary to create such a community. In this case, the community has been developed through the enthusiasms of a small number of 'champions' using a selection of online facilities, typically freely available. A blog-based *Dulwich OnView* website (http://dulwichonview.org.uk) acts as the centerpiece and online magazine for the VO, augmented with a Facebook group (for a film society associated with the Picture Gallery) and Flickr™ facilities (for photographs from members of the VO). The VO is able to experiment in a dynamic way with new technologies and facilities as required and in general this has been successful in attracting further community involvement.

The project came about through discussions that the Friends of Dulwich Picture Gallery could benefit from the use of a blog. This was between an expert in the community and an expert in the technology. Both types of expertise are essential for a successful Community VO. A team of volunteers was gathered over an 18-month period. Various additional options were considered such as Flickr™ and social networking facilities such as Facebook® and ning.com.

Dulwich OnView has developed as a separate volunteer-run facility that is associated with but not run by the Dulwich Picture Gallery. Many of those involved are also members of the Friends of Dulwich Picture Gallery, which raises funds for the gallery, but the VO is not exclusively associated with the Friends organization.

The overall theme of the VO is concerned with arts and culture in the Dulwich area and also surrounding areas in south London. Thus subject matter includes material on the gallery, but not exclusively so. The overall aim is to build up a community through real-life links without the local community also well as merely online involvement. The site is intended to enable a cross-fertilization of members of the Friends organization with the width community, both within Dulwich and those with an interest in Dulwich.

The team involved with producing the blog is spread across south London and face-to-face meetings are often not possible. Management and administration are an issue as a volunteer organization and these are kept to a minimum. Editorial planning documents are prepared on Google™ Documents (http://docs.google.com) so the team can access them easily online. There is an editorial schedule to help the administrative process, but in general everyone involved manages their own time. The VO aims to reach a critical mass so that it is not dependent on a few key people.

The VO uses low cost and free tools where possible. This can restrict the functionality of individual tools, but often workarounds can be used. Examples of tools used are Gabcast (http://www.gabcast.com) for podcasting via phone and Feedblitz (http://www.feedblitz.com) for free email notification to subscribers. Currently, a free Wordpress (http://wordpress.org) website is used but a dedicated website would help to improve the 'look and feel' of the site, making it less generic in style.

This is an example of VO looking to make the transition from a small enterprise depending on a few critical people to a VO that is self-sustaining without being dependent on any one person. This is a very important transition for the long-term viability of any Community VO.

CONCLUSION

Collaborative Virtual Organizations (VOs) follow a change in human interaction in which the collaborative technologies in use and their uptake are either driven by the benefits to the VO membership as in the case of the Community VO, or else driven by the benefits of outcome as in the Project VO. This overall change is also part of a process of how we define cooperation and communication among individuals or organizations in virtual environments. For instance, managing a virtual project team is not only about the traditional process of managing a project, it is also about facilitating the creation of a virtual community and the interactions needed to engender that.

Both Project and Community VOs foster a culture that is naturally collaborative and can support a wide geographic and disciplinary membership and one that shares a common vocabulary. Overcoming time and space differences are the most obvious benefits of virtual collaboration through maintaining or building relationships through VOs.

The area of Virtual Organizations is a rapidly developing field. The emergence of new roles is to be expected: new types of technologists with the expertise to join up services, enabling VO membership and communities to function and flourish, and collaboration facilitators and managers (for informal and formal consortia respectively), who can provide the 'social' support required to deal with human issues during collaborations (Lee et al., 2006).

This chapter provides a snapshot of the current situation and it will be interesting to see how VOs develop in the future. Formalizing the operation of VOs will help in gaining greater understanding of their operation. The use of VOs is likely to become an increasingly important aspect of life, both socially and with respect to work, in an increasingly networked world.

ACKNOWLEDGMENT

Thank you to Ingrid Beazley and Yang-May Ooi who provided background information about the *Dulwich OnView* Community VO. Also, acknowledgements to ViroLab members of University College London and University of Amsterdam. Finally, thank you to Alison Liu for inspiration.

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KEY TERMS

Virtual Organization (VO): An organization built upon 'cyberinfrastructures' (Internet, web services, etc.) to link groups of people and resources distributed across organizational, institutional, and/or geographic boundaries.

Community VO: A type of online social aggregation, including shared access to tools and/or website resources, enabling the support of communication, typically self-forming based around interests, information and/or knowledge, often with a loose informal structure, open-ended in nature, and externalized with a public interface.

Project VO: A Virtual Organization based around the notion of a *Collaborative Work Environment* that is predominantly task and/or goal oriented, often with a formalized structure, normally of finite duration, and internalized for a project team.

Collaborative Work Environment (CWE): Provides technology that enables collaboration over time and space, both within and between geographically distributed organizations.

Virtual Community of Practice (VCoP): A set of relationships among geographically distributed people, facilitated by electronic networked communication.

Web 2.0: Second generation web-based applications including community portals, professional and social networking websites, meeting set-up facilities, blogs, wikis, project management tools, chat/video-conferencing, media sharing, and other participatory tools (e.g., online discussion forums).

Virtual Team: A concept commonly used to describe the way of working within a *Project VO*. Members of a virtual team may never meet face-to-face, whereas in a *hybrid team* there are typically occasional face-to-face meetings.

Chapter IV
The Social Derivation of Technical Systems

David Davenport
Bilkent University, Turkey

ABSTRACT

This chapter analyses the effect that social values have on the design of technical systems. Beginning with an examination of the role technology and accountability play in maintaining social order, it introduces the term "technology creep" to describe situations where conflicting viewpoints produce a technological arms race. Technology functioning in a social-order role inevitably supports one or other of the opposing views, so each side naturally uses it in an attempt to gain the advantage. Peace can be restored only by understanding the social dimensions of the conflict and finding a way of resolving them that is fair to all. The hotly debated issues of anonymity and copyright on the Internet are explored to illustrate this analysis, which, if correct, suggests that designers should consider not only a product's functionality, safety, its effect on the environment and users, but also non-users, especially those with different values. Awareness of the interplay between the social and technical realms will help optimize future socio-technical systems.

INTRODUCTION

This chapter examines the interaction between social values and technology, especially networked information systems. The basic idea is that technical products are always designed within a social context and so naturally embody the values, beliefs or viewpoints of the community that creates them. One is usually unaware of this, simply because most people share the same values. But, in cases where there are conflicting views, technology is often used by each side to "uphold" or promote their particular values. This can lead to a technological arms race in which the opposing camps continually create and improve their technologies in order to gain the advantage and so establish their views. Such conflicts are resolved only if: groups negotiate a peace deal that is fair and acceptable to everyone, a new technology is developed that diffuses the conflict, or one side "wins" outright (even though this may not be the optimal solution for everyone). Understanding such situations is only possible through consideration of

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the broader socio-technical perspective, with the emphasis primarily on the social aspects, rather than the technological ones.

As an admittedly over-simplified example of this, consider the case of codes used to represent textual information in digital systems. The initial (commercial) development of computers was done almost exclusively in the UK & the US; a social context where the predominant language was English. It should come as no surprise, then, that the first standard code, ASCII (the American Standard Code for Information Interchange), only encoded characters in the English alphabet. Obviously, this caused difficulties in non-English speaking countries, forcing them to extend/modify the code to make it suitable for their languages, with the result that communicating documents between countries then became problematic. The difficulties were only resolved by countries/companies working together and defining a new universal code, the UNICODE, which satisfied everyone's needs. (Torsen, 2005) The situation still persists, however, in the use of English-only characters for Internet URLs.

The following sections look at why, in the case of opposing social values, technology tends to support a particular viewpoint, leading to a technical arms race, and explains why this is especially significant in the case of information systems. This qualitative analysis is then illustrated by two in-depth examples related to anonymity and copyright issues on the Internet. The paper concludes with some general recommendations for socio-technical system design and discusses the impact new Internet technologies may have on these.

On the Roles of Technology in Society

If science is about understanding the functioning of the physical and social worlds, then technology is the application of this scientific knowledge to ease and enrich our lives. While it is well known that technology can sometimes have unexpected and undesirable consequences, and that its progress is difficult to predict, here the focus is specifically on cases involving technologies developed by groups with opposing values. To make sense of such situations, it is necessary to have some understanding of how society itself functions and manages the causes of conflict.

For the purposes of this chapter, take society to be a collection of individuals with a set of "rules" that govern their interactions. The individuals that comprise a society may change over time (as people are born and die, or as people join and leave the group); the rules, however, are founded on fundamental cultural values and while these will inevitably change, the change is likely to be much slower, perhaps almost imperceptible.

Societies survive because they afford benefits to individual members: food, shelter and security in the real world, interaction with people having common interests and goals in virtual worlds. In return, the individual members are expected to contribute to the society's well-being. The role and tasks an individual performs may be assigned by the group (especially in families and dictatorships) or may be left up to personal preference (as in most democracies.) Provided everyone plays a part, such social groupings can flourish. However, if one group or an individual benefits significantly more than other members of the community, problems can arise, especially if the imbalance is thought to have been gained unfairly. Injustice, whether real or perceived, breeds discontent and so threatens the well-being of the whole. How does a society maintain order in the face of often fickle human nature? One way is by force, but this is hardly a desirable option (except perhaps for the rulers) and, besides, given the inherent imbalance, maintaining control in this way can be very difficult. Better and potentially more stable, then, is a (free, democratic) form of society in which everyone is "equal" and generally "controls" themselves.

The rules that "control," govern or constrain, individual behaviour within a social group are of three forms: (1) personal ethics/norms, (2) physical & technological restrictions, and (3) a legal framework. (c.f. Lessig, 1999) Normally, individuals internalise the ethics and norms of their society and so act in accord with them even in the absence of any outside influence or control. Technologies can make use of the constraints the physical world naturally places on individual actions to erect further artificial guides or barriers. Similar constraints can be erected using software to control interactions in the virtual worlds of the Internet. Finally, since it is generally impossible to erect barriers to handle every eventuality, it is also important to have a legal framework that acts as a catch-all. The law is an explicit statement of what is (or is not) acceptable and so, subject to due process, allows society as a whole to restrain individuals that threaten to undermine the rights of others.

Here, then, are two other roles that technology plays within society; a social-order role that serves to remind, guide, regulate or constrain individual behaviour, and a less obvious role, that of evidence provisioning in support of the legal process.

Whatever its role, technology often brings disproportionate benefits to particular individuals or groups. These may be the developers themselves or particular user groups, and may arise from the sales of the products or from the advantage the product gives to its users (for example, in terms of restrictions placed on others.) If the discrepancy grew too pronounced it might become a potential source of conflict, but things rarely go that far. Usually, other people either attempt to obtain a share of the benefits by doing the same thing (perhaps better), or try to develop alternate technologies and products which seek to redress the imbalance. Thus begins a sort of arms race in which groups compete, not just for a share of the wealth, but to establish a particular viewpoint. I term this "technology creep," a reference to the "feature creep" commonly observed in word processing and similar applications, and noting the irony between "racing" and "creeping".

A simple, everyday example may help clarify these notions. Consider the case of speeding. For safety reasons, the law requires drivers to keep within certain speed limits, especially in highly populated areas such as towns and housing estates. Most drivers understand the dangers and reduce their speed in such areas, even if not required to do so by law. However, there always seem to be instances where they "forget", and this is where technology comes to our aid. In its simplest form it may consist of speed limit signs that remind the forgetful driver; in some cases the authorities may construct speed bumps to slow vehicles down, or even redesign the road so it becomes impossible to travel too fast; or police may mount radar speed traps to catch the unwary, including unmanned ones which automatically record the evidence photographically. Of course in reaction to this, those motorists who believe they have a right to drive faster than the legal speed limit have developed various counter-measures. Some drivers signal other oncoming vehicles to warn them of the presence of a speed trap. More hi-tech methods involved detectors which picked up signals from the police radar guns and warned their users of the "danger" ahead of them (though such detectors are now generally illegal.) As more vehicles were fitted with GPS systems that helped drivers find their way around, information regarding the locations of speed cameras began to be included in them too, so drivers were again warned to slow down, not because speeding was dangerous, but so as to avoid a speeding fine. And so the technology arms race is perpetuated. It would be possible for vehicle manufacturers to fit devices to detect speed restrictions and automatically limit the vehicle to the designated speed, but such measures would be very unpopular and someone would likely find a way to deactivate them before long. Notice how each of these technologies embed the values of those for whom they are designed—on the one hand the speed traps and those who would seek to control dangerous drivers, and on the other those drivers who believe they should be free to determine their own speed and the information devices to ensure they retain that freedom—and how this leads to an escalation, each development being countered sooner or later.

Technology creep can have advantages. For one thing it can serve as a driving force for technological development (much as the ideological differences between the United States and Russia fuelled technical developments in weapons and space technology during the Cold War period.) (Evangelista, 1988) Sharing the improved technical know-how affords long-term benefits to all and through various wealth redistribution mechanisms (such as taxes), the short-term profits can be redistributed for the common good. However, technology creep also makes it extremely difficult to predict the consequences of any new technology. A relatively small, seemingly innocuous technical development, may provoke another small change, which leads to another and another, until the original idea has been changed profoundly and in ways almost no one could have anticipated. Such uncontrolled and essentially unpredictable technological change is bound to cause difficulties, at least for some sections of the community, and may thus threaten its overall stability. Moreover, even if some form of status-quo does appear to emerge, there is no guarantee that it is the most appropriate long-term solution, and having once "locked" society into it, it may be very difficult to change course (c.f. the adoption of the QWERTY keyboard, Liebowitz and Margolis, 1995). Understanding and resolving such issues necessitates looking at the bigger picture, involving social as well as purely technical concerns.

Socio-Technical Design and Networked Information Systems

Socio-technical system (STS) research explicitly reminds one of the human social dimension that ought to be taken into account when designing systems involving technology. It recognises that technology doesn't exist in a vacuum, but affects those who use it and that they, in turn, affect its design. A socio-technical system, then, has a social component and a technical component, and both of these must be integrated and function together smoothly in order for the overall system to achieve its true potential.

In its early days, STS research was about humanising work "through the redesign of jobs and democracy in the workplace." (Mumford, 2000) It looked into the organisational issues involved in settings such as factory production lines, notorious for treating workers like robots. It developed a number of guidelines (Cherns, 1976), suggesting, for example, that if groups were given greater freedom and responsibility for their work, they would be more content and so more creative and productive. Later on socio-technical system design became concerned "with advocacy of the direct participation of end-users in the information systems design process" (Scacchi, 2004), the guidelines being updated (Clegg, 2000) to account for this new direction. Involving those who would be using the technology—whether factory production-line workers or information technology users—in decisions about its design and application, allowed potential conflicts to be identified and resolved before they caused any real problems. Today, such ideas find common expression in much engineering and management education.

This book is primarily concerned with the design of socio-technical systems that exist in the new virtual worlds of the Internet (Whitworth, 2006). The people who inhabit these worlds are those who inhabit the real world. They still have the same hopes, fears and flaws they always had, only the ways in which they interact with each other have changed. Thus, as business, government and individuals increasingly use the Internet to conduct real-world interactions, conflicts that arise in the virtual world can have potentially serious repercussions in the real-world. Consideration of social issues is thus equally important in both worlds if one is to maintain peace and prosperity, underlining the need for a socio-technical systems approach.

In the world of computers and the Internet the social-order function of technology is particularly significant because almost all of the interactions that take place are mediated by technology. This gives designers unprecedented freedom and power to organise and engineer the virtual society in ways that are often unique and simply unavailable in the physical world. This may not be immediately obvious, but consider what interactions are possible with a bank's ATM machine or how the computer's operating system quite literally determines who can access what. If the system designer has decided you shouldn't be able to do something, you can't (assuming, of course, that there are no bugs in the program and that it can't be hacked!) This point was made by Lessig (1999) in "Code and other laws of Cyberspace", though, what the basis of this power is, how it should be exercised and whether or how it can be controlled are far from clear. As Hosein et al. (2003) also make explicit, system administrators and programmers are the new sovereigns, able to exercise absolute power over their domain.

To illustrate this analysis, consider two cases that clearly show the interplay between technology and social values, and the technology creep that ensues when there are conflicting viewpoints. The first case concerns the debate surrounding anonymity on the Internet and the second, the issue of copyright. To set the scene for these it is first necessary to discuss the role of accountability in cyberspace.

Why Accountability Matters

The virtual worlds of the Internet and the World-Wide-Web have transformed our lives. A great number of people in the developed world now have instant access to information about anything and everything; they can keep in touch with family and friends online, conduct business, do research, learn, be entertained, share their thoughts and contribute creative works to the milieu via blogs and social networking sites. But despite all these great benefits, it is not Utopia. Billions are still excluded from accessing this virtual treasure trove through lack of the necessary technical infrastructure. And there is an altogether darker side to today's cyberspace. The web has become infamous for gambling and pornography sites, and for allowing pedophiles, criminals and terrorists to operate relatively unhindered. Hacking, spam, viruses, phishing, identity theft, fraud and harassment are now commonplace. Recent estimates suggest that more than 50% of all email is now spam and losses from phishing were thought to be around $3.2 billion last year. (Gartner, 2007a) The cost of virus and similar malware infections was estimated by Computer Economics (2007) to be in the region of $13.3 billion dollars in 2006, down slightly from $14.2 billion in 2005, while over 15 million cases of the most rapidly growing cybercrime, identity theft, were reported in the US in 2006. (Gartner, 2007b) In less than a decade the atmosphere has changed. Such anti-social activities have gone from isolated teenage pranks to a multi-billion dollar sector controlled by organised crime.

The main reason for this explosion of criminal activity, I suggest, is the lack of accountability on the web. Of the three tiers of rules that govern an individual's behaviour (the ethical, the technical & the legal), the Internet currently lacks a properly enforceable legal tier. The reason is that the technical tier generally fails to provide the evidence necessary for a successful prosecution and this, combined with the difficulties of international legal action (Wall and Williams, 2007), make it ineffectual. First, though, it is important to understand just how crucial accountability is to the stability of a society. Consider what might happen if there were no accountability. You could rob a bank, steal a car, or kill the annoying neighbour, all without fearing any repercussions. Of course, others might try to steal your car or kill you too. Sooner or later someone would catch you off guard. Then it would be back to the law of the jungle—the survival of the fittest—everyone would live in fear and no one would stay on top for long. The only way to avoid such a scenario is for everyone to agree, for their own sakes, that they will not kill, or steal, or do to others what they would not want done to themselves. There are three alternatives: (1) rely on everyone to abide by this agreement, (2) create barriers making it impossible for anyone to break the agreement, or (3) agree, individually and collectively, to protect each other against any who would break the agreement. Sadly, human nature seems to rule out reliance on (1) and (2), so (3) is our only real hope. In other words, society (subject to appropriate safeguards) must be able to restrain individuals who would harm others.

Whatever the philosophical merits and problems of Social Contract Theory, (see Rawls, 1999; Skovira, 2003), all that is relevant here are the practicalities of ensuring social stability. As already shown, most real-world societies sensibly take a belt-and-braces approach by combining all three options in order to hold individuals accountable for their actions, but the point remains, (in the absence of moral perfection) societies must ultimately rely on (3) and, on the Internet, enforcing such an agreement is extremely difficult.

Viruses, spam, phishing, identity theft, hacking and even piracy, then, are all symptoms of this lack of accountability. Each of them has given rise to its own technology creep as the various groups battle it out. For example, applications that check incoming emails and files for viruses now have to be updated daily to combat newly emerging threats, with firewalls to restrict unwanted intruders, and virtualisation to limit the damage if all else fails. Spam filters have gone from simply rejecting email based on the source address, to scanning the text and using Bayesian reasoning to estimate the likelihood of it being spam rather than a genuine communication. Spammers have responded by automatically adding extra words to their emails to bypass the filters, and by embedding their message in image or sound files. Social filtering is now seen as the best hope of combating spam (Whitworth and Whitworth, 2004). When it comes to the social values driving this technology creep, it seems difficult to justify virus writing, phishing, or identity theft. Those who indulge in such activities do so for unjust personal gain or seem intent on disrupting society. It could be argued in some cases that “one man’s spam is another man’s advert”, but clearly some form of compromise is needed if the current deluge is to be stemmed. In the case of copyright infringement there do appear to be justifiable viewpoints on both sides of the debate. These will be examined in detail shortly, but first consider the arguments against accountability put forward by those who believe in anonymous communication.

Anonymous Concerns

Why can’t Internet users be held accountable? Why shouldn’t they be accountable? Part of the answer undoubtedly lies in the arguments of those who believe in anonymous communications and their influence over the technical infrastructure of the net. Anonymity is seen as the ideological opposite of accountability, a dichotomy of views that leads to another instance of technology creep as the two sides battle it out for supremacy. The following sections illustrate the resulting technical to and fro, and hint at the deep social debate that underlies it.

Technological Aspects

Every computer on the Internet is assigned an IP address, a number that enables the network (TCP/IP) software to efficiently route messages from one machine to any other machine on the planet. The details of how this packet-switching network functions need not concern us here, except to note that each packet (message part) that is sent, includes the IP numbers of both its source and its destination. Intermediate routing machines examine the destination address to send the packet in the right direction. When the message arrives at its final destination, the IP number of the source is available in the packet, should a reply need to be sent back. For all practical purposes, this is the only information the destination machine has about the sender of the message (and it is thus frequently logged—recorded—for security purposes).

In fact, there is no guarantee that the source IP number is actually correct. Since none of the routers ever check it, one way to remain anonymous is to fake (spoof) the source address. Another option, one that allows interaction between the source and destination, is to use a proxy server. Proxies work by exploiting the packet-switching nature of internet communication. The client (source) machine sends its request for a particular resource (on a destination machine), as data embedded in a request sent to the proxy. The proxy machine extracts the embedded request and sends it to the destination machine.

The destination machine can send any reply it may generate back to the proxy, which in turn forwards it back to the client machine. The destination machine sees only the proxy, never the client, which thus remains conveniently anonymous (especially since such proxy servers rarely keep any records).

Requests to a destination machine (be it for email, ftp files or web pages, etc.), will frequently require it to identify (authenticate) the user, to ensure it delivers only items that the user is allowed (authorised) to access. This might be done by checking the IP address of the request's source (enabling access to be restricted to particular machines), and/or by asking for a username and password, or an encrypted certificate (key). User accounts (identities) may be individually created for users known to the machine's owner(s) and the password/key (credentials) be given to them in person. On publicly accessible Internet sites this is rarely possible, so user accounts need to be created on-demand, with users often being asked to provide a validated email address or a certificate issued by a trusted third party, to reduce the number of bogus accounts that are created. Users that misuse a website can be banned or their account deleted, but if creating a new user account is quick and easy (as it usually is), this doesn't actually resolve the problem. How identity can be reliably established on the web, especially in the face of concerted attacks, is an important research area (Hardt, 2005).

One of the most significant security-related technical innovations is undoubtedly public-key encryption. It enables communications to be encrypted so as to guarantee they remain private and non-repudiable. It is also used as the basis of so-called digital certificates, that go some way towards establishing trusted identities. Lessig (1999) pointed to potential dangers of such certificates, while Hosein et al. (2003) discuss regulatory aspects of Microsoft's CAPI. Other technical developments of late include a number of more sophisticated versions of the anonymous proxy server, including onion-ring routers (such as TOR), which attempt to overcome the proxy's vulnerability to statistical pattern analysis of input/output packets by utilising multiple proxies, possibly in different countries, making it practically immune to legal (political) interference. Another recent addition to the anonymizer's arsenal has been software that explicitly removes records of browsing, email, etc., from a user's machine when they finish their work, especially important (to the paranoid) if surfing the web from a public machine. And there is now the added complication of wireless (wi-fi) networks that can allow anyone to join the network and then leave without trace. Such "removal of evidence" severely handicaps computer forensics; a science which is improving, but still very limited in comparison with its real-world counterparts (Panda, Giordano, and Kalil, 2006.) There is no obvious end to this technology war, a clear indication that a fundamental values dichotomy exists. These social aspects are now considered.

Social Aspects

Many of the early netizens were overtly anti-establishment and anti-big business (Barlow, 1996.) They believed in democracy and freedom of speech, and saw anonymity as the only way to ensure that governments could never interfere with or restrict these rights. They claimed that anonymous communications also enabled political dissidents and whistle blowers to speak out freely, and pointed to the advantages it had for ordinary citizens to discuss their personal, medical or family problems with others, without fear of embarrassment.

Such arguments have proved extremely forceful. If you are truly anonymous, then obviously (by definition), the state cannot locate you and hence cannot stop you expressing whatever opinion you wish. Try as he might, Big Brother cannot interfere. The cloak of anonymity naturally safeguards freedom of speech (expression) along with democratic rights to unfettered political discussion.

Opponents of anonymous communications take a slightly different view, relying on accountability and openness to ensure democratic freedoms. While acknowledging that anonymity may well encourage ordinary people to speak freely about their personal problems, and about political and commercial wrongdoings, they question how much credence should be placed in such messages. Without knowing the originator of a message there is no way to judge its validity and it would surely be unwise to commit lives or sully reputations without more substantive verification. Besides, there are legitimate limitations on the right to freedom of expression; one cannot make false accusations against another or incite others to violence (Mill, 1860.) To redress the balance and restrain individuals who would cause harm to other members of society, it is vital that they can be found, i.e. that they can be held accountable. Indeed, the right to free speech itself presupposes that the speaker can be held accountable. Its purpose is to protect the speaker against those who would silence them, be they the moral majority, big business or the government. Those who oppose anonymous communications also point to the fact that, were such communications available, they could also be used by the state (Davenport, 2002.) It was a passionate belief in democracy and free speech, and a deep distrust of government, that led to calls for anonymous communications in the first place, but the result may just have the opposite effect. A government—legally—able to act anonymously would be an extremely dangerous proposition, and the same is true for religious, business and criminal groups, as well as individual citizens. Better, claim the proponents of accountability, to rely on openness and honesty, and retain the safety net offered by the legal tier, than to risk a spiral into anarchy (for better or worse).

Before leaving the topic of anonymity, it is appropriate to mention the issue of privacy, a concept that has further confused the debate over anonymity. How much privacy individual members of a society enjoy is entirely up to the community. The full range of privacy options is observable online. Some forums afford no privacy whatsoever; the messages, usernames and originating IP numbers being permanently visible to everyone on the web. Others may log the IP number, but make it visible only to members and/or the system administrator, while other (more chat-like) systems may keep no records whatsoever. While there are real world communities that afford members no privacy at all, citizens of most modern (western) democracies have come to expect a certain level of privacy in their affairs. In particular, they expect their communications to be confidential—a right written into the UDHR—thus, in most countries, illegal wiretapping/eavesdropping carries heavy penalties. Of course, the concerned citizen can always encrypt the contents of their message, so this is not really an issue for those on either side of the divide. However, when public messages are posted to online forums, privacy advocates insist that the origin of the message should also remain hidden. To be truly anonymous, communications must thus stop anyone from knowing who is communicating, rendering such communications utterly private. In contrast, accountability demands that the originator of a message be traceable, which potentially entails some loss of privacy. Accountability does not, however, require communications be traceable by everyone; even the recipient of a message need not know or be able to determine its origin. All that is required is that the courts, if necessary and subject to due process, be able to locate the sender (or at least the sending machine, further evidence usually being needed to determine who was actually using the machine.) While everyone might agree that this affords a degree of anonymity appropriate for whistle-blowing and the discussion of personal problems, fundamental differences remain (though perhaps less acutely in a post 9/11 world obsessed by the threat of terrorism).

Copyright Matters

The general dislike of commerce and the ethos of sharing that grew out of the early days of the web, has led to another conflict, one undoubtedly fuelled by the lack of accountability, but one in which there are also genuine differences of opinion. Today, many web users see nothing wrong with freely sharing copyrighted software, music and even films, yet to the creators of such intellectual "property" those users are thieves who are robbing them of their livelihoods. Illegal copying of intellectual works, especially music and software, has reached epic proportions in recent years. Estimates by the Institute for Policy Innovation put global losses in the music industry at around $12.5 billion every year (RIAA, 2007.) The Business Software Alliance (2006) survey showed global software piracy running at around 35% and costing an estimated $40 billion. The following sections look at the technology and social aspects of this conflict.

Technology Aspects

Digital technologies now facilitate the copying and distribution of all forms of intellectual property at essentially zero cost, disrupting the established system which relied on the sale of physical copies of the work for its income.

Not surprisingly, the software industry was the first to experience piracy as a result of the new technologies. It applied the obvious solution, a software "key" that the user had to enter when installing the program and without which the program simply could not be used. This naturally frustrated the tech-savvy, who responded by sharing keys and developing program patches (cracks) that circumvented such copy-protection schemes. A running battle ensued (and continues to this day) with software manufacturers developing ever more complex protection schemes and the pirates taking up the challenge, developing their own technologies/tools with which to undermine whatever measures the manufacturers came up with. (Barber and Integralis, 2001) Physical keys, in the shape of hardware dongles that had to be plugged into the computer for the software to work, were also tried, but failed to gain user acceptance. Hardware manufacturers even tried producing processors with unique, software readable ID numbers etched into the silicon, but these were quickly removed as a result of privacy concerns (McCullagh, 2000). The Internet has opened up new possibilities. For example, Microsoft's XP operating system requires an activation key which the company checks and records online, ensuring its uniqueness. Similarly, their Genuine Advantage program validates the software is a legal copy before allowing updates to be downloaded. Online multi-player games have also successfully exploited a subscription service-based model.

The longer-established music industry has been hard hit by the advances in technology. From pressed vinyl records which were very difficult to reproduce, through to cassettes and CDs, which consumers could record themselves, the industry's business model remained unchanged. Piracy grew steadily once recording equipment became widely available, but illegal copying on a commercial-scale was limited since creating and shipping physical goods was comparatively risky and expensive, and, until the advent of digital technology, the quality of such copies was always relatively poor; it was thus only the comparatively high end-user prices that made the risk worthwhile. The film industry had experienced similar difficulties with the pirating of its video cassettes, so when DVDs were developed they tried to make sure that they were encrypted and that consumer equipment would only play DVDs for their particular region. It was not long before computer geeks managed to break the encryption, allowing legal & pirated DVDs to be played on computers. Fierce legal battles ensued with no obvious winner (Simons, 2000). Besides, it is impossible to stop copying by such means, because of the so-called analog hole. Music has to be decoded for legitimate users to listen to it and at that point it can be re-recorded. The film industry suffers a similar form of piracy, whereby movie-goers sneak camcorders into a cinema, secretly record the latest blockbuster movie and then burn it onto a CD and sell it, or share it with other fans on the web. Computer programs are also susceptible to the same fate when run on virtual machines.

The real revolution and another bout of technology creep began with developments in compression technology. Music compressed with the MP3 algorithm was practically indistinguishable from the original uncompressed version, yet occupied only a fraction of the space. Suddenly it became viable for consumers to store and play music on their computers and new portable audio (MP3) players. They could compile collections of their favourite tracks and "share" them with their friends. As storage costs fell and communications speeds rose, huge repositories of music (software and films) were created on remote Internet servers from which everyone could (often illegally) download whatever they wanted. When the music industry took legal action to close down such file-servers, music sharing simply went back underground. MP3s were kept and swapped directly between users' personal machines instead. For users, the only problem was locating another user with the files they wanted. This difficulty was solved by Napster, which automatically created a centralised index of the music files stored on each of its users' machines (McCourt & Burkart, 2003.) Users could then search this index and simply click on the file they wanted to start downloading, peer-to-peer (P2P), from whichever users happened to be online at the time and, if the connection happened to break, Napster could automatically continue downloading from the next machine it found available. Being a centralised system, however, Napster too was vulnerable to legal action and was eventually closed down, but not before millions of (new, normally law-abiding) users had developed a taste for free music. As a result, it was not long before distributed P2P indexing systems, more resistant to legal action, were being developed. Some of the more unscrupulous copyright holders flooded download services with virus files or music files that were corrupted, so additional "quality ratings" began to be added to these indexes.

The same technology that facilitated illegal sharing also made it easier for publishers to locate & prosecute users, at least the relatively unsophisticated ones who failed to take precautions to hide their identity. But taking 10 year olds to court only served to alienate users. Realising they were losing the battle, music companies changed tack and tried to encourage legal downloading. By making it cheap and easy for music lovers to legally purchase individual tracks from an album, usage of online services such as Apple's iTunes exploded and their portable player, the iPod, became a modern icon, spawning numerous imitators. But there was a catch; the downloadable music was often encrypted and could only be played on particular machines. Digital Rights Management (DRM) software requires a special certificate/key to decrypt the music for the user, and so harks back to the initial attempts by the software industry to protect its products using software keys. Not surprisingly, DRM has drawn the same response; angering users and challenging hackers. To make matters worse, some publishers used the control that DRM gave them to introduce additional restrictions, for example, limiting the number of times the media could be played or removing the ability to make backup copies or play it on a different machine. Public outcry over such restrictions on "fair-use" has already persuaded some publishers to remove DRM controls entirely. (Anderson, 2008 & Stone, 2008).

Social Aspects

Underlying these battles are two conflicting views of the role of copyright in the information age. Copyright, as outlined in the Berne Convention, assigns to the creator of a work the moral right to claim authorship and the commercial right to restrict distribution and reuse, and to claim payment for such. Commercial rights can be transferred to a third party. For hundreds of years, artisans only got paid for the work itself, for live performances or, for a lucky few, by commission from a rich patron. The technology to record and mechanically replicate performances, enabling artisans to claim income from the sales of such recordings, is a comparatively recent and very successful innovation. However, today's digital technologies have made obsolete the business model that relied on the distribution of physical copies of the media, leaving artists and their representatives (publishers) desperately trying to protect their livelihoods. Understandably, copyright holders who believe they have a moral right to be rewarded for their work, attempt to stop illicit (unpaid) copying of their creations by whatever means they can. This has included technical options (such as DRM), as well as legal action (enacting and aggressively enforcing ever stricter copyright laws, such as the DMCA), and awareness campaigns designed to educate the public (especially children) to the plight of artists. None of these measures seem to have had much real impact, other than alienating customers.

The protectionist approach contrasts sharply with the perception of cyberspace as a "free-for-all" frontier world that cannot be regulated. Those on the other side of the divide fall into two broad categories; the "pirates" who share by infringing copyright, and those who use copyright to protect the right to share.

There are a number of reasons why the illegal sharing of music, software, films, etc. continues. For one thing, most people don't view it as stealing. What could be more natural than sharing things you like with friends in the comfort and privacy of your own home? No one will ever know; on the web you are anonymous! Besides, it isn't really stealing, is it? After all, copying doesn't deprive the creator (copyright owner) of the work itself, only the income they might have made from that particular copy. There is also a general perception that prices are too high. Buyers typically contrast the fortunes accumulated by pop stars, publishers and software CEOs, with the low cost CDROM or downloaded file they get for their hard earned cash, and feel little sympathy or inclination to add yet more to the coffers of the super rich. Music lovers usually appreciate the creative effort of the musicians themselves and their need (right) to earn a living from their talent, but can still find it hard to justify the price being asked. While some of those illegally downloading do have the money to legally purchase the music (games, software, videos, etc.), many do not. Prices are rarely adjusted in line with income so that the poor, whether in the developed world or less well-off countries, simply cannot afford them. Of course, this doesn't justify theft, but, then, it isn't exactly stealing, is it?

But piracy is not just a matter of economics. It has already been noted how DRM software has undermined existing notions of "fair-use" and, as some users have found to their cost, even if you do pay (via subscription service or DRM keys), your rights may vanish if, for example, the service goes out of business or simply decides not to support the product any longer (Thompson, 2007.) It was a similar worry, combined with the lack of any right to modify software (Williams, 2002), that led to perhaps the most significant change in this area, the Free Software Foundation/Open Source Software (FOSS) movement. The FOSS community demonstrated a completely novel form of software production founded on mutual help and sharing. The Internet provided the platform necessary to bring people together for such egalitarian purposes. Copyleft licenses re-purposed copyright law to ensure that users always retained the right to have and modify a program's source code. While such software can usually be downloaded and used for free, this is not essential and programmers can chose a form of license that still requires users to pay. Creative Commons licenses extend this notion, promoting the reuse of all forms of intellectual work, so sparking similar movements in other areas.

The web may have produced a new breed of artisans, with websites such as Wikipedia, Blogger, YouTube and Flickr, but it has not yet entirely solved the problem of how they can make a living from their talents. Commercial concerns such as Google are pushing an ad-sponsored approach, giving websites a proportion of income from targeted advertisements embedded into the site's web pages. Another option for musicians in particular, is to get money from live concert performances, relying on websites such as YouTube for free publicity and distribution. Programmers too, can benefit from contracting jobs that may come about through contributions to open source projects. All this, however, is simply a return to the original old-world business model. In the new Internet-connected digital world there is another more novel option gaining ground. A quiet revolution is underway (Davenport, 2005) as more and more websites begin to sprout "Donate" buttons (generally linked to PayPal or Amazon's services.) Visitors who find what a site offers (be it information, software, music, etc.) useful or enjoyable, can easily contribute whatever monies they feel are appropriate. This solves the dilemma faced by users who are unable to afford or are unwilling to pay the fixed asking price, perhaps because they are unsure of the benefit they will derive from the work. Encouraging such positive behaviour could help make piracy a thing of the past and open up new markets allowing everyone young and old to gain some legal (and taxable) income from their artistic talents.

Discussion

Social values and beliefs pervade our actions and our artefacts, but this usually only becomes apparent when there are opposing viewpoints. It then manifests itself in technology creep, the technical arms race that ensues as each side tries to promote its views through the creation and use of technical products. Technology can help support a particular viewpoint because of its role, alongside ethical and legal means, in maintaining social order. This paper examined this relationship and offered an analysis of it that emphasized the importance of accountability in maintaining social stability. Two cases involving conflicting value systems were used to illustrate this: anonymity and copyright. Analysis of the conflict between anonymity and accountability is particularly revealing. The lack of accountability on the web enables cybercrime to continue unabated and so threatens social order. Yet efforts to change the web's infrastructure to allow evidence necessary for law enforcement to be gathered are frustrated by those who see anonymity as society's only safeguard against a potentially all powerful state. In the case of copyright, itself doubtless fuelled by the lack of accountability, instances of technology creep are especially obvious. Of particular interest though, is the use by both sides of mixed forms of regulation, not just technological, but legal and ethical as well. Despite new technologies being responsible for the (re)emergence of the conflict, the case of copyright is nevertheless striking for the novel, socially beneficial (technical) solutions that appear to be evolving.

If this analysis is correct, then designers must recognise that the conflicts are fundamentally social:

"Future socio-technical designers may face questions of what should be done, not what can be done. There seems no reason why software should not support what society believes." (Whitworth, 2006, p537)

This paper suggests that designers already face such choices and that the real challenge is to be aware of the values underlying them, since society is rarely homogeneous in its views. This is even more important given the special role that technology, especially information technology, plays in maintaining social order. Designers have always known that they should consider the needs of the user when determining a product's functionality. They gradually became aware of the need to consider safety issues and, more recently, environmental concerns. Socio-technical design explicitly reminds them that other social concerns must be included too; that is, designers must consider not just the users of their technology, but others in the community. Our analysis emphasizes the need to include those who may have opposing values/views, something already very apparent in the case of security.

This paper has focused primarily on information technology and its role in building stable, harmonious societies, but it is clear that one must attend to and view the ethical, technical & legal forms of control together. "Social technologies" need to be an integral part of the STS design world.

Postscript: STS Design in a Web 2.0 World

The infrastructure of today's web is the result of serious engineering design, much of it done by companies and research institutions. Increasingly, though, applications that run on this foundation are being built very quickly by groups that are not fully aware of the effects their programs may have. Rather than being carefully crafted, software today seemingly just evolves! How relevant is STS design to the world of software development opening up with Web 2.0 (O'Reilly, 2005); a world where everyone contributes, where users are developers, a world of perpetual upgrades with shorter and shorter development cycle times; a world changing so rapidly that making sense of it is difficult enough, much less controlling it.

Major Open Source projects (such as, Apache, Firefox, etc.) still tend to have a relatively small core group of developers who provide stability and direction. They are often experienced engineers who understand the importance of systems that are amenable to change and thus strive to provide a secure modular platform upon which others can safely build. The FOSS community has gradually developed tools and techniques (e.g. CVS, testing frameworks, bug tracking systems, CMS, etc.) to help ensure their efforts remain viable, but this can only continue if the platforms themselves remain open to everyone.

Provided people remain vigilant, STS principles will continue to serve us well and hopefully permeate engineering practice. If the core developers do their "job" as best they can, having lots of people watching over the results should help ensure appropriate solutions. The so called "Wisdom of Crowds" (Surowiecki, 2005) may not provide absolute control, but at least with many people involved and able to see any conflicts that arise, new innovative solutions to these conflicts are likely to be found much sooner.

ACKNOWLEDGMENT

The author would like to express his gratitude to the editors, Brian Whitworth and Aldo de Moor, and to Robin Turner, Murat Karamüftüoğlu, Markus Schaal, William Sawyer, Fazli Can, Eray Özkural & Derya Davenport, for helping to clarify the arguments and shape the paper.

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KEY TERMS

Accountability: The ability to hold a person responsible for their actions, allowing them to be questioned, restrained or punished.

Anonymous: Namelessness; an agent who is "unnamed/unknown" (that is, an agent who cannot be identified in such a way as to be held accountable); also referring to the creations and acts of creation, of such an agent.

Socio-Technical Systems Design: An approach to design that explicitly recognises technology's symbiotic relationship with society, and so tries to involve end-users in the creation of the technical products that will affect their lives.

Spoof: To provide false information so as to fool a system and so render it useless.

Traceable: The ability to establish a causal link between the source and destination of a communication.

Technology Creep: The "arms race" that develops in situations where groups having opposing social values try to make use of technology to enforce their views.

Chapter V
Socio-Technical Theory and Work Systems in the Information Age

Ken Eason
Loughborough University, UK

Josè Luis Abdelnour-Nocera
Thames Valley University, UK

ABSTRACT

This chapter sets the traditional focus of socio-technical systems theory on primary work systems in a modern context where information and communication technology (ICT) has a major influence in the way work is undertaken. The chapter begins with a summary of the original work of the Tavistock Institute of Human Relations and critically reviews the major concepts to emerge from these studies. This is followed by a review of recent studies of the impact of ICT on work systems and how socio-technical systems concepts are used to interpret these findings. Finally, concepts and methods of designing socio-technical systems are reviewed in the context of current ways of designing and implementing customizable and generic ICT systems in organizations. The authors call for a recognition and evaluation of socio-technical systems as never completed but evolving over time; placing an emphasis on the emergent behavior resulting from the use of new technical systems.

Technology presumes there's just one right way to do things and there never is.

—Robert M. Pirsig

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ORIGINS

Socio-technical systems theory was originally developed by the Tavistock Institute of Human Relations in the 1950s to explain how new technology impacted primary work systems (Trist et al 1963, Rice 1958). The main case studies concerned the impact of mechanisation on work systems that wove cloth and mined coal. The issues addressed were the way the new technologies of the day disrupted the social systems and work roles of the people engaging in these work systems and what kind of joint technical and social system design was necessary to create effective, integrated socio-technical systems.

INTRODUCTION

The purpose of this chapter is to set the traditional focus of socio-technical systems theory on primary work systems in a modern context where information and communication technology (ICT) has a major influence in the way work is undertaken. Today ICT also provides the means by which new communities can come together, e.g. in the use of social networking systems. However, the focus remains on primary work systems. In this case ICT is supporting people in work roles who are co-operating together to undertake the primary work of their organisation in banking, retail, local government, education, healthcare among other domains. The aim of this chapter is to re-evaluate the original concepts of socio-technical analysis and design in the light of the modern forms of work system that are made possible by ICT.

The chapter begins with a summary of the original work of the Tavistock Institute of Human Relations and critically reviews the major concepts to emerge from these studies. This is followed by a review of recent studies of the impact of ICT on work systems and how socio-technical systems analysis concepts are used to interpret the results of these studies. Finally concepts and methods of designing socio-technical systems are reviewed in the context of current ways of designing and implementing ICT systems in organisations.

Work Systems as Socio-Technical Systems

After the Second World War many companies mechanised their production systems in the confident expectation of great improvements in productivity. In many instances, however, the results fell far below expectations. The Tavistock Institute of Human Relations in London undertook a number of studies to explore why the results were so disappointing. In one of these studies Trist et al (1963) studied the introduction of longwall coal mining techniques in two coalfields in England. In longwall coal mining the traditional small coalface worked by a small group of miners using pick and shovel was replaced by a long coalface in which the coal was ‘shot fired’ and then loaded onto conveyor belts that ran the length of the face. What the investigators found was that, although the technology made it easier to win coal, the social structure of the work roles of the miners had been completely changed in ways that made it difficult for them to co-operate. Whereas the small team at the coal face had previously worked closely together to complete the whole mining process, there were now three shifts of miners on the longwall coalface undertaking different activities on different shifts, e.g. one shift was devoted entirely to dismantling equipment and moving it forward. Each shift now had its own specialised staff devoted to the tasks that were intended to be undertaken on their shift. The new organisation was proving inflexible and whenever problems occurred, a very common occurrence in difficult underground conditions, the work of whole shifts could be lost. The authors coined the term socio-technical to demonstrate that, whilst the technical system might be an improvement on the old one, if its use disrupted the tightly organised system of work roles that was the social system, the result would be sub-optimal performance of the overall work system.

A similar pattern was found by Rice (1958) in his study of a weaving mill in Ahmadabad in India. Traditionally weaving had been undertaken by a weaver who hand operated a single loom. Mechanisation meant it was possible to set up a group of looms and then run them mechanically. The weaver was, in theory, only needed at the beginning and end of the process and could therefore manage a group of looms. It was expected that productivity would be much greater but, in an 'experimental shed' in Ahmadabad where they introduced these semi-automatic looms, the result was poor productivity and poor quality. Ken Rice was asked to investigate and he found that a new form of social structure had grown up that was not coping with the demands made on it. The weavers could not cope with a group of looms on their own and an army of specialised helpers had been created; people to help set up the looms, to cut down the cloth and carry it away and 'crash hands' to help sort out the mess when a loom became tangled. In practice, producing a piece of cloth now required a lot of people and, of course, all the weavers needed the same help at the same time. As a result the looms stood idle a lot of time, waiting for the right help to become available. Like his colleagues working in the coal mining industry, Rice pointed out that cloth was produced by a socio-technical system and that the social and technical sub-systems were not effectively integrated with the result that there was sub-optimal overall performance.

In both of these studies, the investigators looked for solutions. In the coal mining industry, they found that in one of the coalfields the longwall method had been implemented with considerable productivity improvements and that, whilst the technology was the same, the organisation of the miners was different. In this case, rather than adopt different work roles for different shifts, the miners were organised in one large group and were all multi-skilled so that they could take on any duty that was needed when they came on shift. They were, in effect, a large and flexible pool of human resources that meant that production could continue no matter what problems were encountered underground. In India Rice suggested that the workers organise themselves into small teams and ensure that within each team they had the capacity and skills necessary to keep a group of looms running. Both of these solutions were what became known as semi-autonomous work groups and contained within them the notions of flexible allocation of flexible, multi-skilled people. The authors drew attention to the fact that there was organisational choice; that for any given technology there were alternative ways of organising the social system. They also pointed out that some forms of organisation, notably those involving work teams, led to more effective socio-technical systems.

In the second half of the 20th century the socio-technical systems ideas originated at the Tavistock Institute of Human Relations spread around the world and, in particular had a lot of impact on the design of primary work systems in the production and process industries (Weisbord 1987). The approach was adopted in a very significant way in Scandinavia where socio-technical systems theory became almost synonymous with semi-autonomous group working. In almost every case, when a new socio-technical system was created, the social system was created in the form of group working.

A feature of the development of socio-technical systems thinking in this period was the emphasis placed upon industrial democracy and the quality of working life (Davis and Cherns 1975). Many workers in the industries of the day undertook routine, specialised work that had very little intrinsic interest. Working in semi-autonomous work groups gave people the opportunity to develop as multi-skilled individuals and to contribute in a flexible way to major work tasks (Herbst 1962). As a consequence socio-technical systems theory became associated with the search for more meaningful and worthwhile work and with broader issues of worker democracy (Emery and Thorsrud 1964).

Significant as these developments have been, they meant that other important conceptual developments in socio-technical systems theory triggered by the work at the Tavistock Institute of Human Relations have been given less prominence. These were the systems concepts that were applied to the way in which the work system tackled its shared work task. The early Tavistock workers, especially Fred Emery (Emery and Trist 1964), were very much influenced by the open systems concepts of von Bertalanffy (1950) and, in their analysis of work systems, developed techniques for describing the inputs from other systems, the way outputs served other systems and the way the 'relevant environment' created turbulence that the work system had to deal with. The theme was an 'open' work system having to cope in a wide variety of situations in order to keep delivering its output rather than a closed system that could control all its boundaries and optimise its internal workings. The systems approach also emphasised the task transformations needed to get from inputs to outputs and the interdependencies between the component tasks. Variance in inputs, for example, could be transmitted through the task interdependencies with the result that they could have effects many steps away from their point of origin. The development of these forms of work system analysis by, for example, Phil Herbst (1974), had powerful design consequences. Task interdependencies can be classified in terms of their strength and where there are tight interdependencies, for example, between the tasks undertaken by two different work roles, it signals a need for good communication and co-operation between the work roles.

This kind of analysis of a work system also draws attention to perhaps the most important characteristic of a socio-technical system; the tight interdependency of the human being undertaking a task and the technology they use. Vicente (2004) has drawn attention to the fact that this interdependency exists at many levels, i.e. at the overall organisational level, the work system level, the level of a work team and of the individual operator. It is the rich interplay of human action aided and/or constrained by technology that results in the outputs of the work system. This tight interplay has been noted in other arenas of human endeavour. Pickering (1995), in describing 'the mangle of practice' notes, for example, that the development of science is unpredictable because it is the result of the interplay of social, technological and natural factors, as well as the state of theoretical understanding at the time, that shapes the development of a scientific field.

Despite the recognition of the tight interdependencies in socio-technical systems theory, the socio-technical systems tradition identified with the Tavistock Institute is best known for its work on the social system part of the work system. Many of the early studies took the technology as a given and examined how best the social system could accommodate to it. The early researchers did not accept that there was 'technical determinism', i.e. that technical change led to inevitable human and social changes. Indeed the title Trist et al adopted for the book on the coal mining studies was 'Organisational Choice', to make clear that there were a variety of social structures that could be created in relation to any technical change. Although they recognised that there could be organisational change, the early theorists did not identify the 'social reconstruction of technology', i.e. the way in which individuals and work teams defined and used technology in their own terms. This may, in part be because the workers in the systems they studied had relatively little discretion with respect their use of technology. If as a miner you were employed on a shift to dismantle conveyor belt equipment, move it forward towards the coal seam and then re-assemble it, that is what you did. For the Tavistock investigators the point where change could be made was in the re-design of the organisational structure so that each miner not only moved conveyor belts but engaged in all the other tasks required to mine coal.

As a result, the Tavistock approach has contributed much to the examination of the human values to be pursued in the design of work, to the design of jobs and to the functioning of work teams etc. In so doing there has been a tendency to treat the business process, the technology and the interaction with other systems not as part of the design agenda but largely as a source of conditions the social system has to address.

We now turn to a consideration of modern work systems in which information and communication technology is a prominent part of the technical part of the socio-technical system. As will be seen, it is the neglected features of socio-technical systems theory that have greater salience in this setting than the work team approaches for which the Tavistock Institute tradition is now better known.

The Analysis of the Impact on ICT on Work Systems

Most modern work systems are heavily reliant on ICT; it has, for example, facilitated the development of systems for undertaking work in global business, virtual teams, closely coupled supply lines, outsourcing, e-business, e-government and working from home.

The majority of ICT implementations are introduced to update or 'modernise' existing work systems. Companies faced with growing competition in their traditional areas of business may, for example, undertake a 'business process analysis' to look for ways of 're-engineering their business' to make it less expensive and more streamlined. They may then turn to ICT suppliers for the electronic systems to support new visions of the business process. It is increasingly the case that IT suppliers offer 'enterprise' systems that incorporate a range of information storage, processing and communication facilities to support the business functions of organisations. For economic reasons the vendors need to deliver a standardised product and this can mean that the technical system that is implemented is not closely based on how people actually work in a specific organisation. Since the technical systems are designed to support the business process, any company that implements them finds there are implications for their work organisation and working practices. In effect there is an existing socio-technical system engaged in daily work production and the new technical system has to engage with the way it undertakes the work. There have been many evaluation studies that have studied what happens when these technical systems are implemented. What the figures show is a high failure rate or a painful and partial adoption of the new technology (Standish 2007). What they show in particular is two simultaneous responses; the existing socio-technical system changes and work is undertaken often in ways that were not intended and the facilities of the technical system may or may not be adopted.

The researchers who have studied this process do not necessarily use traditional socio-technical systems terminology to explain their findings. Pinch and Bijker (1987), for example, propose the term 'social construction of technology' to identify a theoretical framework and body of research that looks at the way the technology is interpreted and used in local settings. These authors are part of a tradition within the social sciences referred to as 'the sociology of technology', which groups the work of Latour (1986), Bijker (1995), Akrich (1995) and Mackay (2000) among many others—for a good overview of the field see (Oudshoorn & Picnh, 2003).

These researchers focus on understanding socio-technical change and evolution and, in particular, identifying the social, cognitive, material and political elements that influence this process. The knowledge produced from this perspective is aimed more at understanding social phenomena surrounding technology than at evaluating and informing the design of socio-technical systems. However, concepts and findings from this perspective have been successfully adopted and developed by researchers of ICT and work systems as they also address critical socio-technical concerns. As an example, the work of Orlikowski (2000) describes how users have 'a practice lens' through which they determine how they will use technical systems in the work they do, i.e. in their 'practice'.

Based on Bijker's (1995) concept of 'technological frames', Abdelnour Nocera (2007) studied the use of an Enterprise Resource Planning (ERP) system in companies in different countries and gives many examples of different patterns of use emerging from the use of the same technical system. His research shows how this concept can be used as a framework to analyse how the usefulness of ICT is re-defined by user groups, and to identify the assumptions that developers have about users and their context. As his findings demonstrate, it is often the case that generic ICT, such as the ERP system he studied, fail to meet the requirements of organisations since its functionality does not fit the specific socio-technical systems in place in these organisations.

The original studies of the Tavistock Institute emphasised the impact of the technology on people at work: they showed a social system struggling to adjust to a changing work process caused by new technology. In the industrial settings in which these studies were conducted it was not a question of whether the technology would be used; it was a question of what form of social organisation could best work with the technology. Studies of the impact of ICT show something different; the existing work systems appear to be much more resilient and find ways of accepting, rejecting, re-shaping and accommodating the new technology in many 'emergent' ways. One common occurrence is that the existing technical systems continue to be used alongside the new ones. Many electronic systems are introduced, for example, in order that there can be 'paperless offices'. What is frequently found, however, is that people find ways of using both electronic and paper resources and, as a result, completely 'paperless offices' remain hard to find. All of these studies point to the active way in which users respond to technological implementations by adopting and adapting them to local circumstances.

In his evaluation studies Eason (1996, 2001, 2006) has drawn attention to two contrasting responses by users. There are many circumstances where the new technology is not directly coupled into the way the work is done and users have a choice of whether or not to use it or whether to use some features of the system rather than others. They might, for example, choose to meet colleagues in person rather than use an electronic conferencing facility or to work with paper files rather than electronic ones. In many cases, as a result, new systems do not get used or only a small part of the available facilities gets used. In other circumstances it is necessary to use the technology to get the work done. Operators in a call centre, for example, have little choice about using technical facilities to respond to callers directed to them by the technology. Sometimes the way the technical system works does not fit what the user needs to do to complete the task and a lot of the creative energy of people at work is devoted to finding 'workarounds' in these situations in order to keep the work flowing. One general conclusion is that, faced with having to do the real work, the users in the existing work system finds ways of assimilating the new technical system that are often not what the planners had in mind (Eason 1996).

If we return to the original socio-technical concepts to examine how best to explain the impact of ICT systems, it is those concepts that relate to the primacy of the collective task of the work system that are most salient. The concept of the work system containing an array of tasks that contribute to the successful completion of the overall task helps to explain the way the impact of new technology on a specific task can have impact elsewhere in the work system. The concept of an open system that has to cope with daily turbulence in its environment, and also with longer term changes, puts an emphasis on both the adaptability of the work system and on the uniqueness of each work system as it adapts to the local demands made on it. If the technical system design is based on a normative or prescribed version of the 'business process' (the set of interdependent tasks) it is unlikely to match the specific circumstances of the different local work systems in which it is implemented. As a result local staff have to find ways of coping with mismatches. What the literature shows is that when users have little discretion they have to find individual or shared ways of coping by devising 'workarounds'. Where they do have discretion they can adopt technical facilities that match task needs and ignore those that are irrelevant. Emergent behaviour can therefore be seen as an outcome of staff in the existing socio-technical system finding ways of utilising or rejecting the new technology in their daily efforts to complete their tasks. New work practices emerge as a result.

Designing Socio-Technical Systems

The process by which ICT implementations normally occur is dominated by the need to install technology but often includes a management of change strategy in recognition that changes in work practice and work organisation will be necessary. The target of the management of change strategy is to implement the prescribed work practices that go with the operation of the new technology. As the studies described above make clear, when the planned work practices do not match the demands of the local work process, the emergent behaviour may not be as planned and many facilities of the new technology may not be adopted. It may be that what emerges is a good 'fit' between the existing system and the new technology but there is no guarantee of this; the emergent behaviour may be a collection of covert and piecemeal adaptations by individuals as they cope with the new situation that confronts them and the overall result may be a dysfunctional system. The coping behaviour of one person may, for example, feed through the task interdependencies to make the work of another person more difficult. The problem is that there is no planned or collective process by which the staff of the existing socio-technical system can work together on the creation of new work practices that exploit what the new technology has to offer in their specific circumstances.

In the Tavistock tradition, socio-technical systems theory has always been about the design of socio-technical systems. A fundamental aim of socio-technical systems design is to optimise the integration of the social and technical subsystems. To accomplish this many socio-technical systems specialists have worked in action research roles with the technical developers and potential users during the process of designing and implementing new systems. As a result they have devised socio-technical design processes that seek to design the technical and social subsystems together. Hill (1971), for example, outlined an analysis and design procedure for integrated socio-technical systems developments that has been used in process industries in order to achieve an integrated system. Pava (1983) reformulated socio-technical design methods to cope with work in the office environment and the ETHICS methodology, (Mumford 1993), was developed to enable users to select compatible social systems and ICT systems. These methods presume that it is possible to start from a fundamental review of the requirements for a new work system and then to select and develop social and technical sub-systems that will work together effectively to meet the requirements. They are founded on the premise that both the technical system and the work organisation can be 'designed' and that end users can participate in these decisions.

Unfortunately most ICT implementations are not undertaken in these 'greenfield' conditions. It is much more likely that a previously designed and generic technical system will be introduced into an existing work system and there will be no review of what is needed, technically or organisationally, to serve the reality of the local situation. So what form of socio-technical design intervention can be helpful in this setting? There is a need for processes in which the stakeholders (designers and users) can work together on the socio-technical issues of implementing a new ICT system. The designers of generic ICT systems, however, will undertake their development in a different time and space to the many different user communities who may ultimately adopt their products. So in what sense can socio-technical systems be jointly designed? It is useful to review this first from the perspective of the design team of a generic product and second from the perspective of local user communities in existing work systems.

The Design of Generic Products

To serve many different work systems, generic products are designed with standard functionality to serve many different work systems. This functionality is usually selected following study of the common procedures in the business processes to be supported, often with a view to encouraging whatever is regarded as best practice. The result can be a product that does not match the precise needs of any particular work system. The socio-technical system principle of 'minimum critical specification'

(Cherns 1976,1987), formulated to address this issue, proposes that technology is designed with the minimum of fixed procedures, i.e. it should contain options and facilities for customisation so that it can be matched to local needs and can evolve as the demands on the local work system change. This means that ideally generic product design should aim for flexible technical systems that can be configured and integrated with local socio-technical systems. However, for certain generic products, especially those in the ERP market for small and medium enterprises (SME), customisation is expensive and generally unaffordable for its users (Abdelnour Nocera, 2007). In consequence, SME adopting generic ERP systems face the challenge of assimilating heavily configured software tools that could constrain the discretion of users in local work systems. The only option in these circumstances is for users to integrate these tools into their practices through different workarounds and this may or may not be effective. It can lead to efficient solutions supporting a balanced socio-technical system or it can be no more than a coping strategy that maintains a work process in a dysfunctional way, as indicated in the previous section.

Generic product design teams are constrained not only by the pressures of the economies of scale of the global software market but also by their own understanding of the needs of their users. The limited possibility for a socio-technical understanding, for example, of culturally different and geographically scattered user communities makes it difficult to develop software solutions that are relevant to all intended users. Even if some designs meet the principle of minimum critical specification, key requirements might not be met in cultures that are radically different from that of design teams.

Despite these difficulties many products are now designed with many options and include powerful tools that make it possible for local user communities to configure them to their own requirements. The question then is what use the local users are able to make of these opportunities.

The Design of the Local Socio-Technical System

Re-designing the existing socio-technical system in a work system in the light of a new ICT system requires some co-ordinated work at the local level. It is likely to need the input of local users who both understand the current system and own the requirement for the future system. It will also need the input of local technical staff who understand the new technology being implemented. This will be especially the case if the system is configurable; re-design could then include making use of customising possibilities to undertake local design of the technical system. Many socio-technical systems practitioners have now made contributions to this kind of system re-design.

In her approach to the design of socio-technical systems Lisl Klein (2005) has argued that the local user community needs space and time to review socio-technical design options away from their usual operational tasks. She has emphasised the need for some kind of 'transitional system' to be created that can allow new ideas to be explored and developed. In most cases of ICT implementation, because the existing system usually has to stay operational throughout any change process, it can be difficult to create the time or the space for people to do socio-technical planning. Time and space is needed to enable several things to happen. First, it has to be a space in which the people who might use the new technical system can explore what it might mean to use it in relation to their working practices. Secondly, it is a space in which people can see how, if they changed their behaviour, it would help or hinder other people in the work system. Thirdly, it is a space in which local technical staff and users can meet to develop a shared understanding of the overall system that is needed and what the possibilities are for both technical and organisational re-design.

There are a number of ways in which time and space can be created for these purposes. An ideal arrangement is to implement a pilot or prototype technical system into part of the organisation. Klein and Eason (1991) report a case where a pilot system was implemented in one of the branches of a national freight forwarding company. This provided staff and technical experts with the opportunity to try the system and understand its organisational implications. In this case, the effect was dramatic. The company staff saw that the system could challenge the entire working practice of the branches and this led to a change of policy about the kind of system to implement. Unfortunately, the live running of pilots can be an expensive process and in many cases may not be possible. An alternative is to create socio-technical scenarios in which case study narratives are developed in which work is carried out by the existing work system but with a vision of the new technical system in place. These scenarios can be a focus for meetings in which the various stakeholders come together to work through the implications of these visions of potential futures. During her work at Greenwich Hospital, Lisl Klein was struck by the way the staff had created their own scenario to explore the inter-departmental implications of a new computer based information system. (Klein 2005). They had created a patient called 'Poor Old Henry' who had everything wrong with him and they used his need of many departmental services to explore the use of the new system. Eason (2005) has recently used a scenario approach in another part of the health service to help staff understand the implications of one of the electronic healthcare records applications being implemented as part of the NHS National Programme for Information Technology (NPfIT). Similar methods have been used in the design of mobile digital communicators for Danish hospitals, (Hansen, 2006), and dependable domestic systems, (Sommerville & Dewsbury, 2007), in which scenarios are refined through the iterative evaluation of narratives and, once the design lifecycle evolves, prototypes are developed and evaluated.

An approach toward socio-technical system design is also being followed by the project Village e-Science for Life (VESEL)[1]. This project involves the design of mobile technologies to support Kenyan rural villagers in the exchange of farming knowledge and environmental information relevant to their type of crops. Scenarios have been created and evaluated across a multidisciplinary project team to facilitate reflection on the socio-technical implications of the ICT being designed. The key problem in this case is to engage end-users for a valid evaluation of these scenarios. This is less a problem of access and communication than one of different cultural expectations of the participatory design process and the problems users believe should be solved. Even if access to users has not been continuous and free from cultural misunderstandings, looking at scenarios has allowed the project team to identify key elements of the villagers' socio-technical system that should be taken into account when designing these technologies.

The key feature of this work is to create a socio-technical vision of what it would be like to work with the new technology and to help people examine its implications. If this is done before widespread 'roll out' of the new application there are often opportunities to redesign work practices and to customise the technology in order to create an effective socio-technical system.

An important way in which these experiences go beyond the early Tavistock Institute work is that the action researchers ask more questions about the technology being installed. In the early Tavistock Institute studies the technology was installed and the investigators looked for alternative forms of work organisation in order to find one that was compatible with the technology. Action research in modern ICT developments tends to begin before technology is installed and includes alternative forms of technology within its investigative scope. It may well be, for example, that testing proposed new technology through prototypes or scenarios reveals that it is an inappropriate solution and that this triggers a search for better technical solutions. In the freight forwarding case, the work led to a search for a technical system that was compatible with the current work practices that management wished to sustain. In the health service cases, the technical system was 'a given' but it had been designed with a degree of 'minimum critical specification' and offered choices in the way it could be implemented at many levels which had important implications for local working practice. There were, for example, opportunities to configure the system in different ways for use by a work team so that either everybody had access to everything or people with specific responsibilities were the only ones with access to and the right to change particular parts of the system.

One of the problems of working with prototypes and scenarios is that local staff tend to accept the version of the technology they are offered and to focus on its organisational implications. Too often this means that the opportunities for technical system customisation are not explored and the system is implemented in standard 'default' forms. Having struggled to get 'minimum technical specification' into design thinking it is now important to recognise that users may be ill-prepared to make use of the flexibility that is available. Further work is needed to develop methods of uncovering these opportunities and helping users to explore them.

A lesson from the research on the implementation of these systems is that, however much planning precedes implementation, the work system will continue to evolve. This may be because it takes time for staff to gradually explore new ways of using the technology or it may be because the demands on the work system from its environment continue to change. Whatever the cause, there is a need to keep the socio-technical system under review and Eason (2005) reports that this process can be stimulated by adopting an action research approach, in which data is gathered regularly about how the system is working and this is reviewed by staff who can take action to re-design both the technical and organisational aspects of the work system. For example, in the continued evolution of the Zetoc system, an electronic information system that provides universities with bibliographic information about the holdings of the British Library, three data gathering exercises were undertaken over a period of three years that were used by design staff and users to re-shape the service (Eason et al 2006). In addition, analysis frameworks based on concepts like 'technological frames' will help in the identification of key social, cognitive and technical elements shaping the evolution of the socio-technical system.

Summary and Conclusions

The chapter has reviewed the original concepts of socio-technical systems theory that began with the work of the Tavistock Institute of Human Relations and noted in particular that the socio-technical systems for which they were developed were primary work systems. It has then reviewed studies of the impact of ICT on the work systems of today and concludes that many of the original concepts of an open work system can help to explain the phenomenon of emergent behaviour that many studies report. In particular the implementation of a standardised, generic ICT system into work systems with their own local practices can create many mismatches that local staff have to find ways of resolving.

The original form of socio-technical systems theory was particularly concerned with the design of integrated socio-technical systems. Reviewing the processes that have been proposed for socio-technical systems design, this chapter concludes that the opportunity for 'greenfield developments', i.e. the creation of new and compatible social and technical systems, is a rarity today. Instead there is a need for re-design strategies that recognise that the technical system will be a generic development that is intended for implementation in many existing and different work systems. The concept of 'minimum critical specification' offers a design approach that would mean that generic products were customisable and configurable to match local requirements. If local adaptation to new technical systems is not to be piecemeal and perhaps dysfunctional, there needs to be a strategy for local socio-technical system planning when a new system is introduced into an existing work system.

The chapter has reviewed methods for engaging local users and IT specialists in such planning activities and points to the need to create various forms of 'transitional system' to support this work. Ideally this process should be based on prototype or pilot implementations because they enable end users to experience working with the new system before its specification is finalised. However, where that is not possible, the use of socio-technical scenarios is proposed as a solution in which future narratives can be 'walked through' to elicit opportunities and issues around which collective action can be decided. Finally, in recognition that a socio-technical system is never completed but needs to evolve over time, there are action research methods that collect evidence of emergent behaviour resulting from the use of new technical systems over time and maintain a socio-technical system review capability to ensure compatibility between social and technical elements of the work system is sustained.

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KEY TERMS

Work System: The collection of interdependent human and technological resources deployed to produce the operational outputs of an enterprise

Open System: A system that sustains its equilibrium with and through its interactions with its relevant environment

Minimum Critical Specification: Socio-technical design that proceeds by specifying only that which must be defined at each stage of the design process

Semi-automous Work Group: A group undertaking operational work that has discretion over the way it utilises its resources in the performance of its shared task

Task Interdependence: The degree and form of relationship that exists between the sub-tasks to be undertaken in the completion of an overall task

Workarounds: Informal practices for handling exceptions to the normal workflow procedures in the operation of a work system

Action Research: A reflective process in which problem solvers engage in research activities to inform the action strategies they adopt

Transitional System: A temporary system or institution established to facilitate reflection and evaluation of alternatives as one system is replaced by another

ENDNOTE

[1] See www.veselproject.net for more information.

Chapter VI
An Engagement Strategy for Community Network Research and Design

Peter Day
University of Brighton, UK

ABSTRACT

This chapter introduces the community engagement strategy of the Community Network Analysis (CNA) project and considers its significance to research and practice in socio-technical design and social networking systems within the context of community technology. CNA uses a participatory action research (PAR) methodology grounded in community development principles. Employing the Community Development Foundation's "involvement ready" model, the project adopted a mixed methods approach to data collection and analysis—community profiling, social network analysis, participatory learning workshops, and community communication space prototyping. The immersive nature of the project's engagement strategy was designed to facilitate an interpretevist understanding of the complexities of West Hove community ecology. The project's community-based participatory research approach is described together with the project's contribution to knowledge, some of its significant outputs and outcomes and the tensions between the practices of community research and community development actions.

...we must always put people before machines, however complex or elegant the machine might be.

—Cooley (1996, p. 69)

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INTRODUCTION

When considering issues of import to socio-technical design and social networking systems within a context of geographic community or neighbourhood, one of the first issues facing a researcher and/or designer is the question of engagement. As outsiders to the community or neighbourhood, how do researchers and designers engage with geographic communities to design effective socio-technical systems and networks? This paper introduces the community engagement strategy of a participatory action research, (Wadsworth, 1998; and Tacchi, Slater & Hearn, 2003) project and considers the implications of introducing a community development orientation to the research and practices of community networking.

The project in question, the 'Community Network Analysis (CNA) & ICT: Bridging and Building Community Ties' project, was funded to explore potential uses of ICT in developing and sustaining community network ties and social capital in the Portland Road and Clarendon Neighbourhood Renewal area (West Hove). The community development perspective was adopted by the CNA team because the main areas of research focus—enabling community communications and strengthening community relationships and building social capital—are significant components of community development work, (Gilchrist, 2004a).

The population of the Portland Road and Clarendon Neighbourhood Renewal[1] area is just under 11,000 (Neighbourhood Renewal Unit, 2003). Of these, 54% are women and 46% men. 56% of the local housing stock is owner-occupied, with an increasing proportion of this stock being bought by London-based commuters. This has had the resulted in forcing house prices beyond the reach of many locals—ironic in an area where the majority of accommodation was originally built for artisans and factory workers. However, the recent construction of 'social housing' and a fairly large sector of privately rented accommodation (29%) means that the socio-economic profile of Poets Corner ranges from comfortable affluence to social deprivation and poverty. West Hove is a multi-ethnic neighbourhood characterized by its social and cultural diversity.

Despite significant community activities—such as reclaiming Stoneham Park and the annual summer festivals and family fun days —and the best efforts of community development agencies, the grass-roots community and voluntary sector witnessed a weakening of social relationships between organizations along with an apparent growth in territorial tensions. Priorities within the community are often unclear and some local residents and community groups have been critical of the work of a number of the local community groups —perceiving them as 'closed'. In the main these perceptions arise from poor communications within the community infrastructure. Shrinking resources have meant that dialogue with the community at large is at times close to non-existent. Whilst it is fair to say that some community organizations are inward looking and inimical to new ideas and new people, significant numbers of groups are keen to engage with community citizens in a more effective and communicative manner.

The old community forum (West Hove Forum), which stagnated due to political infighting and factionalism, has been re-launched as the Portland Road and Clarendon Forum under the auspices of a community development agency—the Trust for Developing Communities. Evidence from the first year points to a desire to bridge division within the community infrastructure and collaborate for the collective good. There is a growing interest in establishing cross-community relationships and ties. Groups who hitherto felt excluded from the community infrastructure, such as the 'Bluebird Society for the Disabled' and the 'Switched On' club, which helps teenagers with special educational needs gain IT and creative skills, together with a growing number of ethnic and cultural groups, have expressed an interest in engaging in dialogic communications and community networking. We do not wish to overstate the situation at the moment because in some cases it is no more than an expression of interest. However, the fact that growing numbers in both the community infrastructure and the community at large understand that open and dialogic communications are central components of developing and sustaining healthy community network relationships is, in our opinion, a step in the right direction and something to be supported at policy level. Before introducing the community engagement strategy, methods and results of the CNA project, the next section examines the project's community development underpinning by situating the research within an appropriate body of literature.

Situating the Research

In 1955, the UN defined community development as, "a process designed to create conditions of economic and social progress for the whole community with its active participation and the fullest possible reliance on the community's initiative" (United Nations, 1955. p6). For many community developers, this has meant formulating strategies and planning activities—with communities—that met the needs of the community at a specific point in time (Alinsky, 1971; Jones, 1995). Smith (2006) puts this into context by contending that community development should concentrate on improving local democracy; promoting mutual aid; encouraging local networks; and supporting communal coherence.

Around the millennium, community informatics emerged as an academic construct concerning itself with the investigation of community-based ICT applications (Gurstein, 2000, Keeble & Loader, 2001). Of course community informatics is not the sole preserve of academic researchers. It possesses inherent practice-based activities that focus on the application of ICT in support of community processes and in pursuance of community objectives (Gurstein, 2003). Keeble & Loader expand on this by suggesting that effective community informatics "emphasizes a grassroots perspective whereby community members are centrally involved in the application of ICTs for community development" (2001, p.4). A worldview embraced by the CNA community research partnership.

This however, raises two significant questions: 1) Can the use of ICT by communities make a significant contribution to community development activities located in the everyday environment of people's lives and built on processes of empowerment and participation; 2) Can ICT enable and support communities to question their lived realities and affect action for change (Ledwith, 2005)? Answering these questions through effective community informatics research requires the development of community engagement strategies and such relationships do not appear over night. Building the trust and mutual respect required takes time and effort and even more time and effort to nurture and to sustain.

Even in the most well intentioned community research projects power imbalances can emerge. Biklen describes power as "the ability to get someone to do something he or she would not ordinarily do" (1983, p10). In community ICT related research, 'expert' knowledge of the technologies can influence the shaping and implementation of research agenda in unanticipated ways. Validity—"whether you are measuring what you think you think you are measuring" (Stoecker, 2005. p32)—becomes a factor. If the processes, outcomes and results of community research can not be understood, or used by the community, then it is not valid as community development research. In order to achieve relationships of trust and reciprocity in effective community research partnerships we suggest mutual power sharing become an agreed goal from the outset of the project, alongside open, honest and respectful dialogue.

To this end this narration of methodological approach and methods adopted by the CNA team in West Hove is intended as a model to stimulate discussion about what constitutes appropriate methodological approaches for community technology research projects and what lessons exist therein for the broader fields of socio-technical design and social network systems.

Introducing CNA Research Methodology and Methods

The CNA project adopted what is generically known as a community-based participatory research approach. Our intention was to employ processes, generate knowledge and achieve outputs and outcomes useful to our community research partners (and interested academic audiences) by utilizing diverse methods and emphasizing collaboration (Stoecker, 2005). We adopted what the Community Development Foundation (CDF) describes as an 'involvement ready' model (Chanan, Garratt & West, 2000) to determine research partnership involvement. Preliminary interviews suggested that the community infrastructure, i.e. the groups, clubs, associations and organizations, would provide partners most capable of participating. This provided an interesting focus for the project. Chee contends that most studies of this nature are focused at the individual level (2006), that is to say they present community from individualistic rather than collective perspectives. CNA's focus on networks in the community infrastructure enables a broader understanding of the structure and organization of community life to emerge. This in turn provides opportunities for situated or contextualized research into the individual and familial components of community networks to be conducted later.

We were initially invited by the Poet Corner Community Society (PCCS) to assist in generating local knowledge and understanding of the information and communication processes in the community. As awareness of the project's activities spread among the community infrastructure so interest grew and other community organizations became involved. CNA's orientation toward both research and development meant the project had a dual purpose of generating knowledge and affecting community action (change) by improving the effectiveness of the community's communication processes. This duality required a degree of flexibility and responsiveness in our methodological approach (Dick, 1999) —reflected in the development of inter-related participatory methods. This was achieved through an innovative blending or mixing of community research and community development tools and techniques.

A Mixed Method Approach

The project comprised 4 distinct yet inter-related components of investigation and community network development:

1. Community profiling;
2. Social network analysis;
3. Participatory learning workshops; and
4. Community communication space prototype design and development.

Immersing ourselves in the diverse and often contested social reality of geographic community we adopted an interpretevist approach to our research. The mixed methods design permitted us to develop understanding of the complexities of the social phenomenon of West Hove by capturing the diverse perceptions of how the community infrastructure understands its environment.

[This] *means that instead of ultimately producing one integrated account or explanation of whatever is being researched (integrative logic), or a series of parallel accounts (parallel logic), one imagines instead 'multi-nodal' and 'dialogic' explanations which are based on the dynamic relation of more than one way of seeing and researching.* (Mason, 2006, p.10)

The four phases (see above) of the project were sequentially designed so as to enable the gradual building and interlinking of nodes of understanding within the research partnership. Community profiling enabled us to develop rich, detailed pictures of community life and the relationships existing in the community infrastructure. The social network analysis survey instruments provided insights into communication behaviour and patterns, and communication media preferences. From this we were able to develop detailed pictures of the relationships and ties within and beyond the community infrastructure networks. Both profiling and network analysis informed the shaping of the participatory learning workshops (PLWs). The PLWs provided data on addressing community communication needs and observational date on community learning and network relationships. This in turn informed and shaped the design and iterative development of the prototype community communication space.

Each phase of research and development contributed to the overall understanding of communications and networking in the community infrastructure as well as the dialectical tensions and relationships existing between the project's conceptual frameworks of community development and community informatics; the data generated during the project; and the analysis strategy. That is to say that the project team needed to develop a strategy that would enable them to address the knowledge and presentational needs of both community and academic audiences. Analysis varied across project phases, in keeping with a mixed methods approach. Qualitative data analysis was thematic in nature. In keeping with the principles of participatory action research, data collection and analysis was conducted in partnership with community partners in order to ensure it reflected the experiences of participants.

The CNA Community Profile

Community profiles are community development tools used to describe a process or processes of community knowledge generation about a specific area or community. Particular emphasis is placed on community perceptions in order to identify and address problems in the community (Hawtin, Hughes and Percy-Smith, 1994). The purpose of the profile was to map the community infrastructure in order to create a database of community assets, which could be used by the community[2] (Kretzmann & McKnight, 1998), and identify the information and communication needs of the community infrastructure. This was achieved using a mixed-methods approach which included secondary analysis of a city-wide GIS system; in-depth and story-telling interviews (Waller, 2003); reflective and scenario workshops; transect walks with local historians and community activists; observation of community meetings—formal and informal—and engagement in diverse community activities.

The immersive nature of these profiling techniques provided access to insights into the social fabric of community life that would otherwise have been hidden from exogenous researchers. For example, enabling people to share personal stories precipitated a process of 'critical consciousness' (Ledwith, 2005) within the community infrastructure that enabled reflection on existing community practices and highlighted the need for improved social networking.

Interestingly, even before we engaged in the social network survey, we discovered a number of 'informal' network structures in the community and that these tended to possess characteristics of openness and dynamism whilst being transient in nature. Networking often occurs in public spaces, e.g. Stoneham Park, local pubs and coffee shops, or serendipitous street meetings. This agora 'effect' provides opportunity for comfort and support contacts to be made and local knowledge exchange to occur. Communication transactions in these circumstances tend to be both self-organizing and mutually reinforcing, especially where familial and/or friendship ties predominate. The centrality of Stoneham Park in West Hove makes it an ideal informal communal meeting and activity space, where networks of informal associations gradually evolve. Repeated recognition, shared or parallel activities, nodding acknowledgement of presence, anonymous conversations en passant, name exchanges and gossip often lead to friendship networks developing. Informal, or weak, neighborhood network ties (Granovetter, 1973) are formed through an accumulation of social interaction; initiated for no specific social purpose other than the human need to communicate and interact.

Community communications then, tend to be rooted in the fabric and practice of neighbourhood life. Within this fabric the nature of informal networks in West Hove appears to fall into two categories —spontaneous and planned. Spontaneous informal networks tend to be unstructured and spur-of-the-moment. During the collection of personal narratives we learnt that a local cat had gone missing. Neighbors immediately organized a search of the area. In another street, learning of the arrival of a new family, neighbors collectively left bags of clothes and toys on their doorstep as a welcoming gesture. People visiting each other's homes for a chat and coffee: reinforcing and developing social bonds, illustrates the spontaneous nature of informal community networks.

Planned informal networks are more structured and preconceived but have no formal membership. A curry club—where participants get together to try new curry recipes and socialize—is organized at irregular intervals by email, and a book club—run along much the same lines as the curry club—is organized by mobile phone. Circles of baby-sitters and parents requiring 'sitters' that evolved through the local grapevine are maintained by landline telephone, SMS text messaging and face to face contacts. Key holder groups, formed by neighbors in the same street, where spare keys are cut and distributed in case of need or emergency (especially among the elderly) are another example of organized but informal networks in the community. Networking activities such as these illustrate that people are increasingly comfortable using communication technologies such as email and mobile telephony to support their network structures and facilitate communicative exchanges. This degree of comfort in using familiar communication technologies encouraged our considerations of how we would approach the subsequent participatory learning workshops that were intended to provide both content and context for the design of a prototype community communication space that are intended to support the networks of community and community networking in West Hove.

Social Network Analysis

Whilst the focus of the CNA project is geographic community networks, we believe our methodology can be adapted to inform the design of communication systems in other contexts. Whether located in the community and voluntary sector—as is the case with CNA —or the communities of interest/communities of practice found in the public and private sectors, knowledge of how and why communication occurs or does not and an understanding of social network structures and organization are issues central to the design of effective socio-technical network systems.

As the project had no mathematicians on the team, the use of social network analysis might appear to be a strange choice of method to include. However, its inclusion has more to do with community development than the dense and often impenetrable math of social network analysis and graph theory (Wasserman & Faust, 1994). The rationale was to encourage community partners to think about the effectiveness of network relationships within the community infrastructure[3] by getting them to reflect on: 1) the nature of their ties within the infrastructure, and 2) the significance of communications to community activities and practices. This was only possible by collecting and analyzing data that showed the reality of community relationships.

Data collection involved surveys of two significant areas of community communication activity: 1) the organization of the family fun day and summer festival, and 2) community infrastructure communication patterns.

The first survey focused on the communications of the summer festival/family fun day organizing committee. The second collected data on formal network relationships within the community infrastructure. The intention here was to build a representation of the community network structure and organization by plotting transactional exchanges, i.e. communication, in a way that illustrates, in graphical form, the connecting elements and nodes (Csermely, 2006) in the community network. Frequency, purpose and mode of communications were also identified in order to stimulate critical reflection of existing communication and relationship patterns within the infrastructure at large.

Preliminary analysis supported the profiling results by identifying 3 large clusters or affiliate networks; 6 smaller clusters; a dyadic network and a number of individual community entities. At first glance it appeared that the majority of communication takes place within clusters, especially the larger one, suggesting the existence of strong network ties and bonding social capital as the underpinning forces of the community infrastructure. However, a more detailed analysis reveals a more complex picture. We found evidence of bridging social capital through weak network ties but much of this occurs during formal monthly or bi-monthly community meetings such as the Portland Road and Clarendon community forum or community safety meetings. In addition much of this networking is undertaken by a small number of key stakeholders, or hubs, from each cluster.

Whilst these hubs, i.e. highly connected elements of a network (Csermely, 2006), provide the shortest routes between clusters and are effective community communicators, they are also what Csermely describes as keystone species (2006). Their removal from the communication ecology of a community could result in the fragmentation of the community network. Another point to note was that bridging social capital and the weak network ties that often underpin it appears to be more widespread during the planning and organization of the Fun Day and summer festival.

The survey also provides interesting evidence about the significance of linking social capital. Even groups with limited community relationships indicated the importance of their connections to exogenous community development and neighborhood renewal resources and funds and government agencies and offices. With this in mind, the CNA team developed working relationships with the Neighborhood Renewal team, the Trust for Developing Communities and Brighton & Hove Community Initiatives and were invited to become members of the Portland Road & Clarendon Forum with a view to ensuring that all CNA actions and activities are transparent and contribute to community attempts to build social cohesion in the community.

The data generated about community communications can and will ultimately be used in a more traditional social network analysis. In the meantime we used the process to assist the community in understanding the significance and implications of community communications and effect behaviour changes where necessary. For us as academics, social network data enabled us to generate knowledge in 3 areas central to socio-technical design and social network systems—1) the structure and organization of the community infrastructure, its networks, the nature of the network ties and relationships and preferred communication media; 2) the significance of weak network ties to sustaining community network communications; and 3) the support of informal networks through community forums and stakeholder networks in ways that encourage social cohesion and build and sustain social capital.

When exploring and analyzing this data with community partners, we avoided the dense mathematical expressions and graphs generated by complex social network analysis software packages that resemble 'plates of spaghetti'. Instead we created a colorful, layered PowerPoint presentation which gradually presented sequential graphical representations of the social realities of communications within the community infrastructure.

In this way we were able to stimulate dialogue and critical reflection about community communication processes and behaviour, which proved to make a significant contribution to the community network learning process. The next section considers how the project stimulated community learning in a variety of workshop environments through the contextualized introduction of communication technologies.

Participatory Learning Workshops

Traditional community ICT training courses often lack social or community contextualization and are typically driven by the performance indicators and target demands of funders. Training is often task based and aimed at individual users rather than members or participants in a community network.

In contrast participatory learning workshops afford interactive ICT learning spaces which provide and share knowledge of and skills in the use of network technologies for community building. Our approach to community technology learning acknowledges 2 main considerations. Firstly, learning is contextual and affected by the environment in which it occurs (Lave & Etienne, 1990; Boettcher, 2007). Secondly, social interaction is a crucial component of learning. Participatory learning workshops provide spaces for diverse community stakeholders to situate their engagement with ICT in a community context. They actively encourage open participation and knowledge sharing through social networking and dialogue (Nielsen, 2002).

The type of technologies introduced during the workshops, together with other community learning needs, were determined by community participants prior to the workshops—highlighting the significance of the dialogue between researchers and community. Workshops were designed to stimulate critical reflection of the social appropriation of technologies and encouraged community networking. This was achieved by: the employment of participatory and interactive learning techniques; working at the community's pace; working with technologies and applications that stimulated participants interests as well as meeting community need; and wherever possible, using content generated by workshop participants.

As the project developed so hybrid workshops evolved to meet community needs, which extended beyond the static environment of the Talkshop[4] ICT suite. Mobile participatory learning workshops emerged because people were not always able to attend the Talkshop workshops. In order to include these people we utilized Wifi networked laptops to take the workshops to the community at times and locations appropriate to their needs. The second factor was technology related. A significant proportion of participants expressed an interest in learning to use digital cameras and digital camcorders. Some wanted to learn how to use their mobile (cell) phones and portable media players to generate content. This approach enabled us to facilitate situating community learning in community contexts, and enabled community groups to generate their own digital content.

A third type of workshop also emerged during the project—the scenario participatory learning workshop.s These workshops are built on the philosophy of open participation, knowledge sharing, social networking and dialogue found in the other workshops. Harnessing these characteristics to collectively consider and solve community problems. A community issue or problem is presented in scenario format to participants who, drawing on local knowledge and experience, collaborate to find solutions. Due to the diversity of participants this usually requires some effort in establishing common ground before solutions can be identified. The use of scenarios in this way is an excellent way of highlighting the significance and potential impact of social networking in both theory and practice.

During the first round of workshops we worked with a range of community groups to develop their skills in recording and archiving the activities that have taken place during the summer festival as well as other community events e.g. local history walks, holistic health days, tai chi in the park, poetry, art and music. Digital video, photography and podcasting have proved popular activities in the community and we are planning to work with interested parties to create digital community story maps for the community as part of the community communication space.

Community Communication Space

The purpose of the community communication space was to provide an ICT mediated support platform for community networking activities. During the design and implementation of the prototype we sought to achieve this by embedding it as an integral part of the community infrastructure and community activities. This approach was complex and at times frustrating and presented challenges to researchers and community participants alike. Achieving consensus for a project across the community is not without its problems and building the requisite levels of trust and respect to create effective partnerships takes time and effort—resources often at a premium in both academic and community sectors.

Balancing the competing demands of program funders and community partners is no simple matter. Researchers risk getting caught up in the day to day excitement of community life and losing sight of the fact that the investigation is a funded research project—we were probably guilty of this on occasion. Impatience also adds to the complexity. It is important to understand that as spaces of diversity and difference, communities, like people, learn at different speeds. People also engage in different ways and accommodating difference and diversity is not always straightforward.

Similarly, the choice of technical platform compounded the complexity of the project, especially during the times when we had inadequate technical knowledge in the project team. Ensuring appropriate levels of technical support before commencing a project such as this is essential. We believed, when we set out, that we had appropriate levels of knowledge, practical experience and support in place but circumstance and staff changed. The loss of our technical expert from the project team posed problems for the social scientists and community practitioners who remained, even those with reasonable levels of techno-savvy. At times our collective lack of knowledge about the open source technical platform we had committed to provided us with what appeared to be insurmountable obstacles.

Built on the open source, Plone content management system, the prototype went through a number of iterations as workshop participants learnt to use it and numbers engaging with the project increased. Enabling all the usual group pages, blogs, notice boards, visitor pages, local diaries and news facilities that you might expect from a community web site, the prototype also supported video and audio podcasting, digital story-telling, digital art, poetry and music activities. Discussion forums were added to support the community development/building processes and a range of social networking applications are also being considered.

Since the project's funding ran out we have worked to turn the prototype into a live community communications space. A new series of participatory learning workshops designed to transfer content from the prototype to the live site and work with the community to plan and implement an effective strategy for diffusion and use are being planned. The next section of this chapter reflects on a number of conceptual issues arising from the use of the CNA research methodology.

Reflections from the CNA Methodology

In reflecting on the project's methodology and community development activities, we pause briefly to clarify CNA's interpretation of the term 'ICT'. Of course, interpretations or understanding vary across the community. This is as true for ICT as it is for any other cultural artefact. During the project we encountered all manner of attitudes. Such attitudinal diversity was repeated across the community infrastructure groups where differences in attitudes were matched by differences in access to, and therefore uses of, ICT. Our discovery that communication media takes many forms and have many uses in the community environment impacted on our subsequent interpretation of ICT.

Even in a small, relatively resource poor area like West Hove, information is required, acquired, stored, distributed and exploited in all manner of ways and communications takes place at different levels using different media. For example, a community newsletter—the West Hove News (WHN)—is pivotal to community communications, serving as an important source of community information and knowledge exchange. In West Hove, the WHN is regarded as an important community ICT. In order to understand community ICT and communication processes, it is necessary to understand the media that the community have access to; are comfortable with; and are able use. The more we learnt about community communications the more we broadened our interpretation of community ICT and included all modes of community communication that the community use or are interested in using.

Community Networking and ICT

Community-type organization is a feature of all human societies, and studies of humans and other higher primates suggest that we share an inherent sociability, a willingness to connect and to cooperate. (Gilchrist, 2004b, p.1)

Pointing to relationships between social networks and their role in structuring modern community life, Gilchrist illustrates an interesting sociological constant. Regardless of changes in the structure and organization of society, humanity has, down the ages, adapted to social change and continued—sometimes in the face of extreme adversity—to socialize, develop relationships, plan events and organize activities in the name of community. The desire for community, whatever form it takes, is a feature of human behaviour. The communicative behaviour of networking referred to by Gilchrist is the glue, or social cohesion, that forms and sustains community.

In a seminal text on the emergence of 'new', i.e. ICT based community networks, Schuler explains that community networks existed as a sociological concept—i.e. community communication patterns and relationships—long before the web-based community networks we know today emerged (1996). From this perspective community networks can be viewed as important factors in community development. Interestingly however community networks are increasingly referred to as technological artifacts and appear to be understood in terms of the connectivity they give to ICT (e.g. Halcyon Consultants, 2003) rather than the community building links to social capital they afford within communities.

In our experience, establishing what lies at the heart of community networking, i.e. the purpose and nature of the social relationships within communities and their attendant processes of communication, is central to understanding community (Day, 2008). It provides a starting point for addressing the challenges that accompany the design, development and sustainability of technology mediated community networks. Put simply, knowledge of what shapes and energizes community life is pivotal to developing effective community networks. Connected through dialogue, community activists give purpose to social capital. They influence community norms; develop trust and sustain community networks. We believe that if community informatics activists and researchers engage with communities in ways appropriate to community needs then ICT can impact significantly on building and sustaining social capital in community networks (ESRC, 2006).

Social Capital: Communicative Networks of Trust and Purpose

Of course, making and sustaining social network relationships can be problematic. Communities are contested spaces comprising difference and diversity (Ledwith, 2005). Conflicts can and do arise. Celebrating and respecting diversity through the promotion of a culture of shared communication, shared values and shared knowledge, or social cohesion (Gill, 1997), is a big step toward building healthy communities. However, establishing and maintaining social connectivity can be challenging. Social cohesion requires "stocks of social trust, norms, and networks that people can draw upon to solve common problems" (Sirianni and Friedland, 1997) known as social capital. Putnam suggests that, "social capital calls attention to the fact that civic virtue is most powerful when embedded in a sense network of reciprocal social relations" (2000, p.19). However, as with other forms of capital, its value is found in the purpose to which it is put. It was during the participatory learning workshops, when individuals and groups—sometimes meeting for the first time—started to build relationships and plan activities in an environment of contextualized community learning. The capacity of people connected in community networks to communicate with one another and use their knowledge to identify problems, plan agenda, agree and execute actions, and evaluate outcomes in this way is what Schuler calls 'civic intelligence' (2001). A theory that "describes the capacity that organizations and society use to "make sense" of information and events and craft responses to environmental and other challenges collectively" (Day & Schuler, 2006. p.34).

A growing body of literature relating to ICT, social capital and community capacity is emerging. However, much of the studies are still in their infancy. Hypothesizing that ICT will affect both bonding and bridging social capital, Gaved and Anderson warn that the analyses that currently exist, based as they often are on surveys conducted only 6 —12 months into an initiative's lifecycle, are "often too shallow and too soon" (2006, p.8). If, as Resnick suggests, "social capital is a residual or side effect of social interactions and an enabler of future interactions" (2002) then those communities with existing stocks of social capital are likely to benefit more from initiatives that enrich social capital (ESRC, 2006). One of the distinct challenges facing the CNA project was to identify whether ICT might contribute to building stocks of social capital in a community such as West Hove, where social capital stocks had been in atrophy for a number of years. Although too early to evaluate the effects of the community communications space in terms of its direct impact on social capital (Gaved and Anderson, 2006), we did observe some interesting phenomena. By using community technology as a tool and space for community learning —relationships, trust, friendship between workshop participants were observed and evidence of organization and resulting actions were also noted.

Analyzing the affects of the community communications space on network ties, social cohesion and social capital requires an understanding of how effective the processes of utilizing ICT in a community development context have been. CNA is ostensibly a project about processes—community development processes; community networking processes; community learning processes; community communication processes and community technology processes—Resnick's model of social capital forms and facilitated interactions (2002) provides us with a useful framework for understanding ICT as process. That is to say the process or processes that connect people through situated community ICT learning; for purposes of information sharing, communication, participation, network ties strengthening and trust building.

As community engagement with the methodological approach of the CNA project increased we have witnessed the building and strengthening of relationships, sometimes new and sometimes re-established, among community groups using a range of networked media technologies to assist and support planning, organization and action activities among the community infrastructure.

CONCLUSION

Within community informatics a considerable literature focusing on the use of ICT as tools supporting community activities exists (see e.g. Day and Harris, 1997; Shearman, 1999). However, whilst the community communications space can be understood as a tool that supports community activity, describing it as a tool and nothing more paints a limited picture of its versatility. Intended to support community communications, as well as the social and organizational activities of community groups, the community communications space has the potential to be much more than a simple tool. It supports information transfer and knowledge sharing and can be used to generate community content and community contexts. It is an approach, a platform, a technological artifact that supports community communication and social networking. In this way ICT can understood as space or environment (Preece, 2000) in which people engage in dialogue, network with one another and develop relationships in a virtual world that build, support and sustain relationships in the physical community environment.

Although a fuller picture of the community communications space is beginning to emerge, we can say that it is much more than a combination of tools and virtual environments. During our work in West Hove we encountered a strong desire to share stories and meaning in the community. We also discovered an eagerness to learn how communication technologies might assist in supporting and sustaining the community ecology. As the community communications space moves into a community diffusion phase we will explore innovative and creative ways of developing community voice and memory initiatives that promote community networking. During, what we see as simply the first phase of the CNA project, we learnt that if technology mediated community networks are to support the diversity found in community environments, then the artifacts and the processes attached to it should contribute to the development of safe and welcoming spaces that encourage and facilitate participation and engagement. Enabling people to interact with one another by constructing narratives and sharing meaning in convivial environments is central to effective community networking.

In order to address some of the fears about technology that exist in communities, ICT should be relevant to the needs, wants and interests of community life. This is as true in geographic communities as it is in small businesses, public sector services, community of interest networks and many other social environments and we believe that the methodological approach discussed in this chapter can be adapted to meet the needs and wants of diverse 'community' types.

Community technology/media environments need to be accessible, convivial and use language that encourages common ground thinking in determining community uses. Local communities need to feel in control of technologies rather controlled by them. Again, the same is true in other 'community' environments. A sense of community autonomy is fundamental to a sense of well-being and an understanding of one's place in the world and in the community. Trust breaks down when power imbalance occurs.

When CNA engages with community groups we seek to contextualize ICT in ways that relate to their environments and activities. Learning about the community environment, its practices and its relationships is paramount. Conducting community profiles and speaking to people, is not only a great way of breaking the ice between researcher and community, but provides knowledge crucial to the effective design of community networks.

During our time in West Hove, we have contributed to the body of academic knowledge in community informatics. In addition, and in keeping with our ethical responsibilities to our community partners, we have generated knowledge and processes that support community development and community networking. The CNA methodology has:

1. Demonstrated that the use of personal narratives—story-telling—is a useful tool for facilitating critical consciousness of the community environment, which in turn is paramount for building effective community development practices and strategies.
2. Shown that communities are interested in learning how to use and apply ICT that are appropriate to their needs. Technologies such as digital camcorders and cameras, mobile phones, PDAs and iPods are particularly useful in providing support for community voice and memory activities and often provide contextualizing 'hooks' or act as a catalyst for communities wanting to learn about the potential benefits of other ICT. In addition to this we have shown that by collaborating with others to appropriate ICT for community purpose, communities can build and increase their stocks of social capital.
3. Developed a suite of PLWs that support community learning situated and contextualized in the day to day realities of the community ecology. PLWs are grounded in a philosophy of information sharing, open participation, social networking and dialogue.
4. Highlighted how, through the use of social network analysis techniques, critical awareness of community communication patterns can assist in understanding the strengths and weaknesses of a community's social relationships. This in turn can lead to improved communication, common knowledge, community

identity, shared values, obligations, roles and norms and trust.

5. Illustrated how, despite an inherent focus in academic circles on the significance of bridging and bonding social capital, 'linking' social capital also plays an increasingly crucial role in sustaining the community infrastructure. An important lesson that we as CI researcher take away from this project is to engage with community development and government agencies; seek to raise awareness of, and support for, community networking activities; and commence dialogue about how CI can support community development.

In closing, we emphasize 3 key points from our experience that we hope will stimulate further discussion. The first is that in order to be valid, community technology research, as with any form of socio-technical design, should be of use to the community in which the researchers are engaged. In this respect, we concur with Keeble and Loader (2001) who contend that the community informatics research agenda should emphasize grass-roots needs and perspectives. For the CNA team, this means locating the application of ICT, and associated learning processes, within a community development context. By community development we mean development that occurs in the community environment and grounded in processes of empowerment and participation of and by the community citizenry (Ledwith, 2005). Secondly, designing, implementing and developing technology mediated community networks requires a grounded understanding of the social network structures, organization and communication processes that comprise the community environment. Finally, the capacity of people in community networks to communicate with each other in order to share knowledge and collectively solve community problems is a crucial component of civic intelligence (Schuler, 2001). Finding ways of assisting communities to develop their capacity to shape and sustain their own community networks should be an integral part of all community research partnerships.

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KEY TERMS

Community Network Analysis (CNA): Grounded in the ecology of community life, CNA is a research and development project that investigates potential uses of ICT for community development purposes.

Participatory Action Research (PAR): A methodological approach involving 'users' in all stages of the research cycle.

Community Research: A methodological approach in which knowledge is generated for practical community purposes (as well as academic use) and in which community 'ownership' of the research process(es) is/are encouraged.

Community Profiling and/or profile: Community development tools used to describe a process or processes of community knowledge generation about a specific area or community.

Social Network Analysis (SNA): A methodological approach used to analyze the nature of the relationships and ties between ties in a variety of social networks. In this case the nature of communication ties and relationships existing in a geographic community.

Participatory Learning Workshops (PLWs): A range of community learning techniques developed by the author as part of the CNA project. PLWs afford contextualized learning spaces (static, mobile and scenario) in which community participants engage with and learn about a range of communication technologies in a collaborative and dialogic environment for the purpose of building and sustain community networks.

Community Communication Space (CCS): is a community website that supports and contributes to the social communication ecology of a geographic community. The community communication space blends the social and technological networks of a community together as tools, spaces and processes that support community development.

Community Development: A process of capacity and skills building, through which individuals and groups are empowered to deliberate, shape and effect change in their own communities.

Community Engagement: Processes by which academic researchers develop relationships with community partners; and community partners engage and identify with, eventually developing a sense of ownership of, a community initiative, project, activity or action.

ENDNOTE

1. Community infrastructure is defined as the not-for-profit clubs, organizations, associations, groups, etc that provide the basis of social and cultural activities in the community environment.
2. Talkshop is a small community centre—converted by local people from a disused council storage building in a rundown 'park' inhabited at the time by drug dealers and disillusioned youth. Stoneham Park has since been reclaimed by the community and is a thriving community space.
3. The database was used by the Trust for Developing Communities (see above) to inform the community infrastructure of the relaunch of a community forum, which had been moribund for some time. The forum is currently flourishing.
4. See http://www.neighbourhood.gov.uk/page.asp?id=3 for an introduction to Neighbourhood Renewal in the UK.

Chapter VII
On the Alignment of Organizational and Software Structure

Cleidson R. B. de Souza
Universidade Federal do Pará, Brazil

David F. Redmiles
University of California, Irvine, USA

ABSTRACT

This chapter reviews the socio-technical relationship between organizational and software structure. It describes the early theoretical work about this relationship, the empirical studies that identified this relationship in practice and, more importantly, identifies two main approaches for exploring this relationship. The first one is based on the construction of tools to facilitate software development, while the second is a more theoretical one aimed at investigating the consequences of this relationship in the work of software developers. Furthermore, the authors hope the theoretical background presented in this chapter will not only motivate other researchers to study software development as a socio-technical endeavor, but also assist practitioners in the understanding of the aspects necessary to make software development succeed.

INTRODUCTION

Software development is a typical socio-technical endeavor. Any non-trivial software development effort requires both technical skills and the ability to efficiently coordinate the work of hundreds of people (Brooks, 1974). Researchers and practitioners of software engineering have recognized this relationship for more than 30 years. Conway (1968), for instance, postulated that the structure of a software system would reflect the communication needs of the people performing the work, a relationship that became known as Conway's Law. Later, Parnas (1972) suggested that by reducing technical dependencies between software modules, it was possible to reduce the communication needs

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of software developers, thus creating a managerial advantage. As postulated by Conway and Parnas, the socio-technical relationship occurs between the organizational structure and the software structure. This has been validated by several different empirical studies. For instance, in a seminal study, Curtis et al. (1988) recognized that "occasionally, the partitioning [of software components] was based not only on the logical connectivity among components, but also on the social connectivity among the staff." There are several qualitative studies with similar results (de Souza & Redmiles, 2008; de Souza, Redmiles, Cheng, Millen, & Patterson, 2004; Rebecca E. Grinter, 1998; Staudenmayer, 1997), as well as quantitative studies (Cataldo, 2007; Cataldo, Wagstrom, Herbsleb, & Carley, 2006; Sosa, Eppinger, Pich, McKendrick, & Stout, 2002).

This socio-technical relationship between organizational and software structure is relevant to both researchers and practitioners because it impacts the coordination of software development efforts. In other words, this relationship can also be understood as a relationship between coordination of software development efforts and software architecture[1]. Despite this long-term interest, it had not been sufficiently explored to understand or facilitate software development activities until recently (Cataldo, 2007; Cataldo et al., 2006; de Souza, 2005; Trainer, Quirk, de Souza, & Redmiles, 2005; Valleto et al., 2007). This chapter reviews the research literature about this relationship presenting the theoretical arguments, empirical studies, tools and approaches that build on this relationship.

The rest of this chapter is organized as follows. We begin by presenting a literature review focusing on both the theoretical arguments and the empirical studies on the socio-technical relationship between coordination of software development activities and software architecture. Two approaches have been adopted by researchers to explore this relationship. The first one is based on the construction of software tools to provide useful information for software developers and is described in Section 3. And the second one is a more theoretical approach aimed at investigating the consequences of this relationship in the work of software developers. This approach, called socio-technical congruence, is described in Section 4. We conclude with final remarks in Section 5.

Literature Review

The relationship between the coordination of software development efforts and software architecture has been studied in two different research areas: software engineering and computer-supported cooperative work (CSCW). Software engineering researchers are concerned primarily with dependencies in the software architecture and their impact on both the quality of the software being developed and the process of developing it (Sommerville, 2000). CSCW researchers' main concerns are with the coordination of collaborative work and how computational tools can support this task (Schmidt & Bannon, 1992). In this section we review both the software engineering and the CSCW literature to properly understand the relationship of interest. We will start reviewing approaches for handling software architecture (i.e., components and their dependencies) between software development artifacts.

Software Dependencies

The first approach aimed to handle software dependencies was Parnas' information hiding (Parnas, 1972). When Parnas proposed this principle, he also suggested that it would bring a managerial advantage: reducing dependencies between software modules would also reduce developers' dependencies on one another, therefore reducing communication needs and facilitating the coordination.

Software engineers have created additional techniques, tools, and principles to deal with dependencies. One of the most influential approaches adopted by software engineers is based on the notion of cohesion and coupling. While cohesion measures the degree of dependencies that occur within a module, the term coupling is used as a measure of the dependencies between two modules (Stevens, Myers, & Constantine, 1974). A module has high cohesion if all of its elements are related strongly, and low cohesion otherwise. In addition, if two modules depend on each other heavily by having strong interconnections, they are said to have high coupling, otherwise, the modules are said to have low coupling and are almost independent of each other. Both concepts help in establishing the quality of a particular design (Sommerville, 2000). In fact, by designing modules with high cohesion and low coupling, maintainability is achieved: if it becomes necessary to change a system, the part to be changed is easily identified because it can be found in a single place.

In addition to these concepts, dependency analysis techniques have been developed. These techniques are able to handle the different abstractions used in the construction of software systems: programs (Ferrante, Ottenstein, & Warren, 1987; Podgurski & Clarke, 1989), components (Vieira & Richardson, 2002), and software architectures (Stafford & Wolf, 2001). These techniques are important because by minimizing dependencies between software components, several tasks in software development are facilitated. For instance, program dependencies are used to improve software testing, maintenance, parallelization, computer security, and code optimization (Podgurski & Clarke, 1989). Component dependency analysis is crucial to effective maintenance, evolution, testing, debugging, and management of component-based systems (Vieira & Richardson, 2002). In addition, architectural dependency analysis techniques can be used to support architectural reuse, change impact analysis, regression testing, and software understanding (Zhao, Yang, Xiang, & Xu, 2002).

Dependency relationships in software engineering have also been studied in the context of traceability. In this case, instead of focusing on programs, components or software architectures, the focus is on relationships between different types of artifacts. Software traceability is defined as "the ability to relate artifacts created during the development of a software system to describe the system from different perspectives and levels of abstraction with each other, the stakeholders that have contributed to the creation of the artifacts, and the rationale that explains the form of the artifacts" (Spanoudakis & Zisman, 2004). In a survey of the area, Spanoudakis and Zisman (2004) identified seven possible types of relationships between software artifacts: dependence is one of them. The existence of a dependence link between the requirements and the analysis, and later to a design document that implements this requirement, is seen as something positive or beneficial, because it indicates that the software being built has addressed this particular requirement. Furthermore, some authors argue that dependencies between requirements can support software reuse: if similar requirements are identified when the stated requirements are compared with existing requirements, then this indicates a possible reusable component (Dahlstedt & Persson, 2003).

Theoretical Work

In 1968, Conway (1968) claimed that "organizations … are constrained to produce designs which are copies of the communication structures of these organizations." According to him, in any design process, several design options are "automatically" made *not* available to an organization because they do not reflect communication patterns of its members. Conway argues that the system structure will be stamped out with the communication structure of the organization because the communication needs of those doing the work are inevitably reflected in the system. This relation has become known as Conway's Law and is also commonly stated as: "If you have four groups working in a compiler, you will get a four-pass compiler." This argument is more adequate to the initial version of a software system and it is based on the assumption that the organizational structure is immutable. Years later, Brooks (1974) used Conway's Law to explain some of his observations during the development of the IBM 360.

It is important to recognize that Conway's argument should not be understood as a prediction, because organizations might change to facilitate the coordination of product development (Adler, 1995; Thompson, 1967). Instead, Conway should be read as an advice suggesting that software development can be facilitated by aligning the organizational structure and the software architecture. Indeed, Conway's Law has been interpreted as an organizational pattern (Coplien & Harrison, 2005, pg. 192):

If the parts of an organization (e.g., teams, departments, or subdivisions) do not closely reflect the essential parts of the product, or if the relationships between organizations do not reflect the relationships between product parts, then the project will be in trouble.

According to this point of view, Conway's Law is seen as a bi-directional relationship between the software and the organizational structure, i.e., between the software architecture and software developers' tasks assignments, which explains the relationship between software architecture and the coordination of software development. Conway's argument acknowledges the importance of social aspects in software development. To be more precise, he acknowledges the importance of communication between software developers dealing with dependent parts of the software architecture. Based on this argument, Conway also pointed out directions for future research:

Even in a moderately small organization, it becomes necessary to restrict communication in order that people can get some 'work' done. Research which leads to techniques pointing to more efficient communication among designers will play an extremely important role in the technology of system management.

In fact, four years later, Parnas proposed the principle of information hiding, which minimizes communication needs among software developers by restricting the information they exchange. Parnas suggested that by reducing dependencies between modules, it is possible to reduce software developers' dependencies on one another, creating a managerial advantage (Parnas, 1972). Nowadays, this is a well-known argument among researchers and practitioners that can even be found in textbooks:

If a design is composed of highly independent modules, it supports the requirements of large programs: independent modules form the basis of work assignments to individual team members. The more independent the modules are the more independently the team members can proceed in their work. (Ghezzi, Jazayeri, & Mandrioli, 2003, p. 241)

Parnas's information hiding principle has been applied in other domains in addition to software engineering. In these other fields, it simply has been called modularity. Modular product design has been adopted by several industries, including aircraft, automobile, consumer electronics, and personal computing, among others (Sanchez & Mahoney, 1996). Baldwin and Clark (1997) even argue that the modularity adopted by the computer industry is the key factor for its success.

Organizational science has also benefited from modularity: "the creation of modular product architectures not only creates flexible product design, but also enables the design of loosely coupled, flexible, 'modular' organization structures" (Sanchez & Mahoney, 1996). This is possible because well-defined interfaces between the products being developed facilitate coordination practices, reducing the need for management and control over the module's associated personnel (Mintzberg, 1979). Some authors even assert that modularity in the design of products leads to—or at least ought to lead to—modularity in the design of organizations that produce such products (Langlois, 1999).

In short, Parnas' and Conway's arguments suggest that software dependencies shape the coordination and communication activities performed by software developers, and, at the same time, these dependencies reflect these coordination and communication activities. That is, dependencies between software components create a need for communication and coordination between developers, and similarly, dependencies between the development tasks are reflected in the software architecture. Therefore, the alignment between the organizational structure and the software architecture is essential to effective software development. In fact, several empirical studies corroborate that, as we will discuss in the following section.

Empirical Studies

Both Parnas' and Conway's arguments have been validated by several different empirical studies. In 1988 for example, Curtis et al. (1988) discussed, among other things, how the system architecture affected the communication required among project personnel and at the same time he recognized that "occasionally, the partitioning [of components to reduce dependencies between components] was based not only on the logical connectivity among components, but also on the social connectivity among the staff" (Curtis et al., 1988, pg. 1280).

Eppinger and his students at MIT have conducted different studies to explore the socio-technical relationship between product architecture and task coordination, that is, how the structure or architecture of a product relates to the organizational structure (the division of labor in teams and their interactions). For instance, Morelli and colleagues (1995) found a strong (81.1%) correlation between dependent components in a system and the frequency of technical communication among the team members dealing with these components. Later, similar results were found in a study of a telecommunications organization (Sosa et al., 2002). In this case, Sosa found out that communication frequency correlates positively with dependency and organizational bonds, but decreases with distance. This result holds across all media studied suggesting that "apparently, people involved in critically dependent tasks or who share strong organizational bonds engage in a broad spectrum of communication means." Even when team members were non-collocated, higher communication frequencies were observed for highly dependent pairs when compared to non-collocated independent pairs. These results reinforce the importance for managers to identify critical dependencies in their organizations to facilitate communication among the team members involved in them. In addition, the authors argue that by documenting communication frequencies, managers can uncover the underlying structure of products, or, more importantly, unidentified dependencies. To quote the authors: "tracking electronic-based communication frequencies can provide an easy and non-disruptive way to obtain the dependency structure of a development project."

Similarly, ethnographic studies (de Souza, Redmiles, & Dourish, 2003; Rebbeca E. Grinter, 2003; Staudenmayer, 1997) suggest that technical dependencies among software components create "social dependencies" among software developers. That is, given two dependent pieces of code, the developers responsible for developing those pieces need to interact and coordinate in order to guarantee the smooth flow of work. For instance, Grinter (2003) described the process of "recomposition," that is "the work necessary to ensure that a software product can be assembled from its component pieces." Recomposition is seen as the natural complement for decomposition, but while decomposition happens only once in the beginning of the project, recomposition occurs several times along the development process. Obviously, the process of recomposition needs to take into account the dependencies of a particular piece of software. Under this light, recomposition is then defined as "the work of coordinating and communicating enough to maintain a shared understand of the dependencies." Grinter's work illustrates how dependencies between software modules need to be properly managed by the software developers implementing or maintaining them. Furthermore, it illustrates how these technical dependencies require additional work to be managed, pointing to the influence of organizational factors in these dependencies: dependencies were established—or removed—between software components because of organizational decisions. Finally, dependencies are seen as inevitable part of any software developer's work either as a desired goal (for instance when a developer can simplify his work by reusing other developer's code) or a problematic situation (whenever another developer's code breaks the build, therefore making everybody else's work more difficult).

In an important qualitative study, Staundemayer (1997) describes the strategies adopted by six different software development teams to deal with software dependencies in their work. She describes how some of these teams tried to minimize the influence of other teams' dependencies by, for example, assigning developers the primary responsibility of communicating with the external developers who provide software components to the team. Staudenmayer's research is the first to explore the *effects* of the relationship between organizational and software structure, or between coordination of the work and software architecture: she suggests that there is a positive correlation between the management of dependencies and performance. Among the six teams that she studied in two different organizations, those actively seeking to manage dependencies in their work were the ones with best performance. The issue of performance was revisited in the work of Cataldo and colleagues (Cataldo et al., 2006) and is discussed in more details in the following section.

The different empirical studies described in this section only confirm an unsurprising relationship: software engineers developing dependent pieces of code are more likely to engage in communication and coordination activities than developers working in unrelated pieces of code[2]. *What is surprising, however, is that such an obvious relationship has not yet been leveraged as much as possible to facilitate software development activities.* This is especially surprising because software systems allow the automatic identification of their dependencies. A few exceptions are discussed in the following sections.

Software Tools

Ariadne

Ariadne (de Souza, 2005; Trainer et al., 2005) aims to explore the socio-technical relationship between software architecture and coordination of software development activities. Specifically, Ariadne is designed to perform automatic dependency analysis on software projects shared in configuration management repositories and generate visualizations of social dependency information. The visualizations generated by Ariadne can be used by software developers to identify two important pieces of information: who they depend on and who depends on their work. In other words, Ariadne allows one to generate visualizations of the social relationships among software developers that are automatically created from the dependencies that exist among the software components (i.e, the software architecture) these developers are creating. In this regard, Ariadne provides results similar to ownership architectures (Bowman & Holt, 1999), but it does so automatically.

A recent empirical study (de Souza, Hildenbrand, & Redmiles, 2007) in a large software development organization has shown that software developers in their daily work recognize the relationship between software architecture and coordination, and, more importantly, they make use of it to get their work done. This is achieved without the use of technological support however, and it is an error-prone process. *In that regard, Ariadne aims to facilitate this software developers' work*. Ariadne was not designed to replace software developers' approaches, but instead to *complement* them.

Ariadne is implemented as a Java plug-in to the popular Eclipse IDE. As such, it is integrated into this environment and makes heavy use of Eclipse functionality and its plug-in model. The dependency processing functionality is encapsulated in a main control plug-in that delegates source-code analysis, annotation of the source-code analysis data, and visualization of the created data structure to sub plug-ins. As a result, Ariadne offers users the flexibility to use dependency generators for a diverse set of source languages, configuration management repositories, and methods of visualization.

Theseus

Ariadne was later extended to allow the integrated visualization of both social and technical aspects (Fonseca, De Souza, & Redmiles, 2006). This new tool, called Theseus, automatically identifies situations when there is a mismatch between dependencies and communication among software developers. This includes two situations. In the first case, there is a dependency between two components, but the software developers dealing with them are not engaging in enough communication. This might mean that those developers are not aware of each other, a usually problematic situation (de Souza et al., 2004). The second case happens when two developers are communicating with some frequency but there is not a dependency between their components. This situation might suggest a need for re-structuring the architecture of the system (that's why they are communicating) or that possibilities for software reuse are being lost (Sosa et al., 2002).

TESNA

As it will be discussed in the following section, both Cataldo (Cataldo et al., 2006) and Valetto (Valleto et al., 2007) discuss, as future work, the implementation of a tool that provides the automatic measurement of congruence metrics. In their work, Amrit and van Hillegersberg (2008) describe a tool, TESNA, that performs exactly this task. However, instead of focusing the congruence between social and technical aspects, these authors focus on what they call Socio-Technical Structure Clashes (STSCs), i.e., the points where social and technical aspects are not aligned, the points that lead to low degrees of congruence. STCs are equivalent to what Fonseca (Fonseca et al., 2006) calls mismatches in the Theseus tool. TESNA automatically identifies the socio-technical clashes based on the software architecture—through dependency analysis—and the communication networks—created from email and instant messaging exchanged among software developers. TESNA was used in a software development organization, however, the results were not conclusive: the clashes were not automatically identified and there was no evidence that the clashes manually identified really indicated problems in the coordination of the project.

The Concept of Socio-Technical Congruence

Cataldo and colleagues (2006) propose a way to investigate how good the alignment or fit is between the organizational structure and the software architecture. The measure of fit they proposed is called socio-technical congruence or simply congruence. In their work, the technical aspect of software development work is understood as tasks to be performed during maintenance activities, while the social aspect is measured based on the communication between software developers using instant messenger tools and email. While Ariadne's technical dependencies are created using dependency analysis techniques, Cataldo's work is based on historical information: his approach is based on the identification of files that are changed together (Zimmermann, Weibgerber, Diehl, & Zeller, 2005). To be more precise, dependencies between software components are extracted by mining change repositories and identifying evolutionary coupling between components. This is done by creating association rules between files that are changed together: files that are co-changed are likely to be coupled, even though traditional dependency analysis of these files does not indicate such coupling. Because co-changes are built out of historical changes, they are called evolutionary dependencies (Zimmermann et al., 2005).

Using this approach, Cataldo analyzed a large software development project using his congruence metric and his results suggested that high degrees of such socio-technical congruence correlate with task performance, i.e., more productive software developers are those who have high degrees of congruence.

These results can be seen as additional evidence of the impact of the alignment between social and technical aspects of software development[3].

More recently, in his dissertation Cataldo (2007) analyzes the concept of socio-technical congruence in four different distributed software development teams. According to him:

As expected, when developers coordinate their work appropriately, the likelihood of failures is reduced. ... analyses showed that only MR congruence [analysis of discussion between software developers about a modification request (MR)] is relevant in the context of failure proneness of modules ... coordination activities over the MR tracking system were critical in terms of quality relative to other means of communication and coordination [such as, those that arise out of collocation or team membership].

Cataldo's concept of congruence was extended by Valleto and colleagues (Valleto et al., 2007) who propose two definitions of congruence: arc mirroring and node ties. Arc mirroring measures to which extent an (dependency) arc between two software development artifacts (a technical aspect) is mirrored in the social network graph representing the software developers (a technical aspect). The concept of arc mirroring is equivalent to the concept of congruence defined originally by Cataldo and colleagues (Cataldo et al., 2006). On the other hand, node ties indicate that two or more software developers who are responsible for the same module (a technical aspect) should engage in coordination activities (a social aspect). Valetto argues that these measures allow both global (i.e., over the whole network), as well as local measurements (i.e., over a region of interest). In addition, these measures of congruence may be considered separately or combined, e.g. as a weighted combination.

Final Remarks

Software development is a typical socio-technical endeavor where both technical and social aspects need to be aligned to guarantee the timely delivery of the software product. This socio-technical relationship has been known for decades based on both theoretical arguments, provided by Conway and Parnas, and several qualitative and quantitative empirical studies.

Despite the widespread acknowledgment of the socio-technical relationship between software organizational and software structure, or, coordination of software development and software architecture, only recently has this relationship begun to be explored by researchers in the software engineering and computer-supported cooperative work communities. Two approaches have been adopted: the first one is based on the construction of software tools that use this socio-technical relationship to provide useful information for software developers, while the second one is a more theoretical one aimed to investigate the consequences of this relationship in the work of software developers.

This chapter provided an overview of the theoretical aspects of this relationship, discussed the empirical studies and the major results they provided, and, more importantly described the approaches that have been recently proposed to explore this relationship and, consequently, facilitate the construction of software systems. We hope the theoretical background presented in this chapter motivates other researchers to study software development as a socio-technical activity.

ACKNOWLEDGMENT

This research was supported by the Brazilian Government under grants CAPES BEX 1312/99-5 and CNPq 479206/2006-6, by the U.S. National Science Foundation under grants 0534775 and 0205724, and by an IBM Eclipse Technology Exchange Grant.

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KEY TERMS

Computer-Supported Collaborative Work or CSCW: This term addresses how collaborative activities and their coordination can be supported by means of computer systems.

Conway's Law: Argument proposed by Melvin Conway in 1968 that argues that the software structure will be stamped out with the communication structure of the organization because the communication needs of those doing the work are inevitably reflected in the system.

Dependency or Dependence: Is a relationship between two entities that exists because one must interact with the other to accomplish something "larger" than the entities themselves. For instance, task dependencies exist when the actors responsible for these tasks need to interact to finish them properly. Similarly, software dependencies arise out of the interactions (method calls, data exchange, etc) between software components.

Organizational Structure: Describes how an organization is structured into different parts (e.g., individuals, teams, sub-teams, departments, or subdivisions) to accomplish its goals.

Software Structure or Ssoftware Architecture: Is used to indicate how a software system is organized into parts and how these parts are interconnected, that is, the components or modules of a software system and their dependencies.

Socio-Technical Congruence: A metric used to investigate how good the alignment or fit is between the organizational structure and the software architecture.

ENDNOTES

1 In this chapter, the term software architecture is loosely used to indicate how the software is organized into parts and how these parts are interconnected, that is, the components or modules of a software system and their dependencies.

2 Of course, other kinds of dependencies can occur in software development, but these studies focus on key communication aspects about technical dependencies between software components.

3 To some extent, Staudenmayer (1997) was the first to explore the impact of the misalignment between the social and technical aspects of software development. However, her work focused on the performance of the *team*, while the work described in this section focuses on the performance of an *individual* software developer.

Section II
Socio-Technical Perspectives

Socio-technical perspectives impact both social and technical systems

This section builds on the first by giving specific socio-technical perspectives that impact socio-technical systems, and addresses questions like:

1. How do social concepts like privacy and leadership impact technology?
2. How does the socio-technical perspective affect organizational work systems?
3. What social factors impact collaborative technology participation?
4. What causes anti-social hacking and cyber-crime?
5. How do social field theories apply to tele-conferencing and eBay?
6. How can socio-technical systems support business innovation?

Prologue
Socio-Technical Perspectives

Ronald K. Stamper
Independent Scholar, UK

The road is made by walking—that is the first tenet of every adventure.

—Paulo Coelho, New Statesman 11 August 2008

Reconciling the Social and the Technical

What does the hyphen in "socio-technical" represent? While joining two words, it also stands for a yawning gap between two fields of enquiry. Having worked in industry and observed many technically good information systems that failed organisationally, I decided in 1969, on joining the team at the London School of Economics developing teaching and research in information systems, to explore the deep, dark valley separating the social and the technical. I want to give you a perspective on its exciting terrain by outlining one possible route linking these two very different and often antagonistic, institutionally entrenched, intellectual communities.

We are not alone. The physical sciences have no hang ups about working in their deep valley between cosmology and the sub-atomic realm but they acknowledge the difficulty of finding their holy grail, a unifying theory. The biological sciences are reconciling organic chemistry and molecular biology with the far distant realms of ecology and anatomy and physiology, on lines described by EO Wilson in his 1998 book *Concilience: the Unity of Knowledge.* If they can, I'm sure we can.

The scholars writing in this book are making tracks into this valley but mainly from the sociological end. Many readers will be starting their research careers and I would encourage them to explore the problems in the valley where the opportunities for thrilling scientific advances must be balanced against some dangers.

One needs to have confidence that the social and the technical perspectives can be united. Initially, I had that confidence, more from ignorance than knowledge, but that ignorance saved me from the daunting awareness of the institutional opposition from both poles to any venture outside their established frames of reference. Be prepared to face these opponents should you decide to work on reconciling the social and the technical.

The technical study of information systems, associated historically with electronic engineering and with mathematics and logic, is justly proud of

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its achievements in the 'hard' end of the subject. Importing 'soft' social ideas often into that community often meets resistance. I respond by arguing that all studies of information belong properly to the social sciences. (Can you hear the sharp intake of breath preparatory to a strong emotional reaction?) The physical and formal properties of the signs and signals studied by the technical disciplines would hold little interest outside academe unless some people can use these tokens to inform other people of their meanings and intentions. Signs and signals have no value until they affect the attitudes, beliefs and expectations of people. Information is intrinsically social. IT could add the concepts of meaning[1], intention and the human value of information to its pallet with a mission to inject some of their rigour into a part of social science.

At the social end, one often encounters a reciprocal emotional distaste for work on the technical side, but they more readily acknowledge that all social phenomena involve information and communication. Even the self-appointed queen of the social sciences, economics, reluctantly admits that today. When I arrived at the LSE, I immediately asked what economics had to say about information: virtually nothing, beyond being told that "price contain all the necessary information"! The fact that society only exists because people exchange information in all manner of interesting ways may seem at first an uninformative truism, worthy of little attention but it actually opens another perspective.

Fortunately, semiotics, the study of signs, provides that perspective; quietly evolving over the last two-and-a-half millennia, it links the social and the technical[2]. Belatedly, the Artificial Intelligence and Data Base communities now acknowledge that the greatest modern semiotician, CS Peirce (1839-1914), anticipated their work on conceptual structures and on relational systems, while de Saussure (1857-1913) and followers have developed a social semiotic[3]. The gap is closing; but the study of signs is just one route through the dark valley between the social and technical citadels.

Semiotics informs our own work. In particular it already treats the technical aspects of information as essentially social and social phenomena as information based. Moreover, given the unifying force of semiotics, it suggested the strategy of leaving aside the physical, statistical and formal properties of sign, which have the hardware, communications and software industries looking after them, to focus on the essentially social properties of signs: their meanings, intentionality and value. We aimed to express the social aspects of an information system (a social institution) precisely and formally, rather in the spirit of the technical community.

But progress depended on a major extension to semiotics. Up to now semiotics has resembled optics before we understood the interactions between light and the orbiting electrons in the atom. We hit upon the equivalent of the atom by deciding to study social norms, observing that people behave in an organised manner because they share the norms governing their beliefs, behaviour, values and perceptions. In particular we noticed that many large institutions exist to give effect to a few hundred pages of norms expressed in legislation: a national system of social security, for example is like a huge organism grown from an egg containing its genetic material in the form of legislation[4]. Norms govern the behaviour of people, as programs govern the behaviour of computers, but not mechanically. The computer does not know the meanings of the variables in the conditional part of a program statement or who intentionally reported them; a person uses the meanings of the condition of a norm and takes account of the intentions behind the information supplied. Whereas the computer just acts if the condition is right, a person can choose whether or not to perform the prescribed, consequent action, thereby expressing an intention. So we decided to search for a formalism for expressing social (eg: legal) norms[5], conceived in the spirit of the social sciences.

This legally orientated language has nothing specifically to do with computers or other information technology although its formal precision allows any useful, related, distributed computer programs to be generated from it automatically, thereby justifying our strategy of leaving the technical aspects of information aside. Specifically however, the language does handle meanings with as much precision as necessary in a given cultural context and it makes the expression and interpretation of human intentions quite explicit. Essential to achieving these functions, the language forces the user to account for the human responsibilities associated with every facet of the knowledge involved in the activities of the chosen social system, at least to a useful degree of precision. Just consider for a moment each data item in any system, whether social or technical: someone bears responsibility for it, perhaps as an observer or as the designer of a mechanical monitoring device. Even in a technical system, information can never be free from human choice. Also essential to achieving its functions, this language only allows one to talk of what exists here and now. Wow! So what about the past and the future? The language allows one, of course, to talk about the signs standing for past and future things, that do exist in the here-and-now, thus forcing its users to make explicit the social processes of constructing everything beyond the present place and time. Society builds itself and its understanding of the world by using signs in a responsible way: we are answerable for what we say and how we interpret what we hear.

From our rather technical-looking treatment of social norms, we arrive at the mechanisms of sign-usage that lie at the heart of all social phenomena. Thus, I contend that we have constructed one open highway through the deep, dark valley of problems linking the sciences of society to the sciences of information.

The authors of many papers in this book are looking for norms to provide the answers to their chosen research questions, which suggests that they already have in mind some intuition of these ideas. As our work has always proceeded through examining concrete problems, my colleagues and I are well aware of the daunting complexity of social phenomena. How far our methods can take one towards useful understanding of problems in the social sciences will not be revealed without much more work. I recommend using the methods because our experience has repeatedly shown that rigorous analytical tools focused on a problem, like the microscope, reveal many unexpected features. I admit that I am a little rash in making this suggestion because learning the methods, for the moment at least, depends on searching through many papers, theses and dissertations in obscure places[6]; however, I hasten to add that adequate texts are in preparation.

If you do decide to explore the forgotten lands that belong neither to the technical or the social science citadels, you may still incur their wrath. Beware of those of their citizens who misinterpret your work by fitting it into one of their established frameworks. This makes funding difficult to obtain. Nevertheless, we did obtain funds from both poles but not without difficulties I hope you will not encounter today. For example, one reviewer on the technical wing said that our work, having something to do with the law, could not be real science and should not be funded by the (then) Science Research Council; similarly, a reviewer for the (then) Social Science Research Council dismissed out work because "the law is not just a system of rules"—a view we also rejected!

Don't be daunted. The thrill of exploring the land of the hyphen between 'socio' and 'technical' brings enough intellectual rewards. Although presently rather weak institutionally, that will change provided enough people do enough work of high, convincing quality. Even our limited efforts have produced methods that cut by a factor of ten the costs of developing, supporting and maintaining computer-based system: industry wants more results of that kind and eventually their mounting pressure will change academic attitudes.

ENDNOTES

1. But not in the mechanistic style of most work on the semantic web.
2. Wikipedia has good introduction and references.
3. See Semiotic Encyclopedia Online
4. Interpreting Dworkin's concept of memes (*The Selfish Gene*, 1989) as norms might be a fruitful line of research.
5. Stamper, R.K. "Extending Semiotics for the

Study of Organisations" in *Proc. Semiotics in Information Sciences, Toronto, 21-22 October 1998,* Umiker-Sebeok and Danesei (eds), University of Indiana Press (?)

6 Some you will find at: http://www.orgsem.org/ and I am happy to enter into correspondence with serious researchers.

Chapter VIII
Privacy and the Identity Gap in Socio-Technical Systems

Catherine Heeney
The University of Oxford, UK

ABSTRACT

The chapter discusses the traditional expectations about privacy protection and argues that current models for the governance of data do not adequately fulfil these expectations. The traditional models of privacy protection are based on the assumption that strict anomymisation of released statistical data is the way to protect privacy and ensure public trust in the research enterprise. It will be argued that the main barriers to privacy preservation and the perpetuation of public trust are due to the capabilities of information technology on the one hand and the availability of numerous data sources on the other. Furthermore, both types of resource enable certain types of organisation to 'read' and categorise other people. The realities of data-processing technologies challenge the dichotomy, present in the legal framework for data-protection, between 'personal' and research data. This dichotomy, moreover, is not useful in the protection of informational privacy. The chapter will refer to several examples of uses of data in what are in effect 'socio-technical systems', which arguably challenge accepted methods of privacy protection in this area.

So act that you use humanity, whether in your own person or in the person of any other, always at the same time as end, never merely as a means. (Ak 4:429)

—Kant, I, 1997 Translation,
Groundwork of the Metaphysics of Morals
Cambridge University Press

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INTRODUCTION

Research organisations maintain that strict anonymisation of disseminated results is the bedrock of privacy protection and the best way to ensure public trust. In this chapter it will be argued that the realities of data processing within certain 'socio-technical systems' mean that the process of anonymisation, which is applied to statistical data, does not alone satisfactorily achieve these aims. The chapter considers traditional approaches taken to the protection of the privacy of data subjects by research organisations. It will be argued that these must be rethought in the light of the availability and use of sophisticated data-processing technologies and multiple data sources. Research organisations rely on a traditional model of anonymisation and informed consent to ensure ethical treatment of data and this approach is still the standard (Lowrance, 2002). This model ostensibly allows data-subjects to control the circumstances in which they provide data and ensure that direct consequences arising from the provision of data will be limited. However, there are many challenges to the efficacy of this model in protecting the values it intends to protect, including privacy and related benefits (Vedder, 2001). The chapter will discuss ways of understanding privacy and consider how certain types of reuse of data, such as profiling, are outside the original organisational context, challenge accepted norms of data classification and as a result undermine the ability of the current data protection framework to protect privacy. Nissenbaum's (1998) concept of 'contextual integrity' will be used to explore likely expectations with regard to privacy. The chapter will refer to the use of outputs of National Statistical Institutes (NSIs) in 'socio-technical systems' such as that constituted by the information super-bureau, Experion. NSIs provide a good example of a visible public sector organisation, which compiles and disseminates statistical or anonymised data.

The chapter will provide an example of how data disseminated by NSIs can be incorporated into socio-technical systems which reside primarily within the private-sector. It will be argued that within the type of 'socio-technical systems' discussed here, secondary use of data may turn out to be quite different from that what is ordinarily understood as 'statistical.' The chapter will discuss the role that information technology plays in blurring the distinction between identified and statistical data. The reason for this blurring, it will be argued, is primarily due to uses of data analysis software to group people into categories and the subsequent use of these categories as a basis for decision-making. Nissenbaum deals with the issue of identified data being used outside of its original context (1998, 2004). However, she also introduces the reader to the threats posed by profiling, which functions by combining identified and statistical data (Nissenbaum, 1998, 2004). In this chapter it will be contended that 'contextual integrity' is also at issue where data which is not recognised as 'identified' or 'personal data' by legislation (see Dir 95/46/EC) is used in combination with 'personal data' to create profiles, which are then used to ground decisions about individuals. The concept of 'contextual integrity' will, therefore, be extended to include non-identified data. The relationship between the uses of data discussed here and privacy does not correspond to the legal position on data protection. The legal view is that there is a data-dichotomy with 'personal data' on one side and statistical or anonymised data on the other. The corollary of this is that privacy protection is only seen as being relevant for the former. It will be argued that the consequences of certain uses of outputs from NSIs mean that the distinction between statistical and non-statistical data is lost. In other words, the quality of the information is ultimately less important than how it is used and the consequences of these uses. The question then, becomes one of whether the data is used in a non-statistical way. The guidelines of the International Statistical Institute characterise statistical uses as follows: 'Statistical data are unconcerned with individual identities. They are collected to answer questions such as 'how many?' or 'what proportion?' not 'who?' (ISI, 4.5, 1985). Below it will be argued that statistical data can be and is used in focusing upon and uncovering details related to individuals. The use of this data, moreover, can reveal what Goffman (1968) has called 'discrediting' information, which the individual may not have wished to be widely known. The ways in which some 'socio-technical systems' support this process will be discussed here.

'Personal' and Statistical Data

Whether or not data is defined as identifiable or not has important consequences for how it is managed and how secondary use and access is governed. The Organization for Economic Cooperation and Development (OECD) produced the 'Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data' in 1980. These guidelines have been subsequently incorporated within the EU Data Protection Directive (Dir 95/46/EC), which member states, including the UK, have been obliged to incorporate into national legislation. In Article 2(b), of the Directive 'Personal data' is defined as data that can be directly linked to an individual or indirectly linked via the use of an identification number, for example. Article 6(b) stipulates that member states must ensure that data is 'collected for specified, explicit and legitimate purposes and not further processed in a way incompatible with those purposes.' Article 13, exempts statistical data from the constraints placed on 'personal data' provided it is made safe. 'To determine whether a person is identifiable account should be taken of all means reasonably used either by the controller or by any other person to identify the said person' (Article 13, Dir 95/46/EC). Processing for statistical purposes is not incompatible with the original purposes of data collection provided that 'appropriate safeguards' are put in place (Article 6(e), Dir 95/46/EC). '[A]ppropriate safeguards' refer to measures taken to prevent the re-identified on data-subjects.

The key issue here is that it should not be possible to find out more about identified individuals either by hacking into the systems which store the data or as result of deducing the identity of data-subjects from released data. The former concern is dealt with by physical and technical safeguards which are fairly standard for data used in research. These include: secure servers, restricted access, locked doors and filing cabinets. Another strand of protection involves minimising the possibility that somebody could guess that a unit in dataset is a particular individual based on the information in the dataset.[1] This process is termed 'disclosure control'. In a society where there are a variety of available datasets and sophisticated data analysis tools, which could assist in re-identifying individuals, this can involve a complicated and technical set of procedures. To avoid disclosure, account must be taken of the variety of ways in which an individual could be re-identified in a dataset. This involves being aware of data, which could be cross referenced with the released dataset, and developments in information technology (Elliot, 2001; Torra, Domingo-Ferrer and Torres 2003). Crucially re-identification would challenge the *non* 'personal' nature of the data. Identity disclosure, where the identity of a data subject is revealed is, for the reasons mentioned above, perhaps the most worrying form of disclosure for an NSI. However, there are other recognised types, such as attribute disclosure wherein information could be inferred about an individual due to the availability of a dataset containing information about the group or population of which they are a member. [2]

Information Technology and the Data Dichotomy

The legal view is that statistical data cannot affect privacy where the identity of the individual in a dataset cannot be uncovered. However, it has been argued that there is more to identity than this simple dichotomous view of data allows (Soleve, 2001; Vedder, 2001). Individuals in the digital world as in the real world can be categorised by assigning them to existing groups based on their observable characteristics. Information technology can facilitate not only this process of assigning individuals to groups but also the very creation of groups. For example, a process known as data-mining uncovers links between variables relating, it could be argued, to the identity of individuals. Data-mining, which is a part of Knowledge Discovery in Databases (KDD), is the process of identifying valid, novel, potentially useful, and ultimately understandable, patterns in data (Torra et al 2003). These technologies permit entirely flexible hypothesis free trawling of datasets. 'A data mining tool does not require any assumptions; it tries to discover relationships and hidden patterns that may not always be obvious' (Groth, 1997:3). In other words data-mining reveals relationships between characteristics that would otherwise remain hidden. It is "the process of automating information discovery" (Groth, 1997: 1). These automated processes can be used to build profiles of groups who share particular characteristics. Relationships between variables can be quantified by attaching probabilities to them (Torra et al 2003). On the basis of their displayed or obvious characteristics, individuals can be assigned a probability of having other traits, which were shown as being statistically related during the data-mining process. The distinction between 'discrediting' and 'discreditable' information made by Goffman (1968) is useful in this respect. Some characteristics about the self are difficult or impossible to hide, things such as sex, race and age (to a lesser extent) are examples of 'discredited' information. Traits, which are not obvious but if widely known could be detrimental to the social standing of the individual concerned, are 'discreditable' (Goffman, 1968). Borrowing from Goffman, therefore, profiling could be understood as the process of inferring 'discreditable' information from 'discredited' information.

Categorisation in Action

'C10' is a classification designed by a marketing company, dunnhumby (a subsidiary of Tesco), to delineate a group of individuals with a specific lifestyle, income bracket and set of consumer preferences (Tomlinson and Evans 2005). These classifications or modes of categorising individuals are based on profiles, which are constructed using aggregated data, statistical inference and probabilities. The data used in this work is held in Crucible, a massive database of customer information. dunnhumby makes use of Zodiac, a software which facilitates the production of detailed profiles from Crucible in combination with data supplied by the Office for National Statistics[1] and other data sources such as the electoral roll (Tomlinson & Evans, 2005). Such companies use statisitcal data from NSIs to build up area profiles, which can then be linked to the profile of an identified individual (Tomlinson & Evans, 2005). On the one hand, organisations, such as those involved in direct marketing, are keen to point out that there are no direct infringements of privacy because there is no direct identification of individuals or households. On the other hand, they are equally eager to point out the proficiency of these systems in accurately determining the characteristics of those who may or may not pay for a particular product or service (Sleight, 1993). The users of Crucible and Zodiac have admitted that they expend "great effort" in working creatively with classifications of their data in order to avoid problems with the UK Data Protection Act (Tomlinson & Evans, 2005).

The process of profiling is the delineation of groups according to a set of characteristics shared by members. As in the example presented above, profiling involves making estimates about the likely behaviour of individuals, which can then be used as a basis for subsequent decisions about them. That there is a difference between having a file of identifiable data on a particular individual and inferring the characteristics of an individual from statistical data, is not disputed here. However, if inferences are used to inform judgments about what an individual is likely to want or to do, the consequences for privacy may not actually be very different. This is perhaps especially true where the individual does posses all or at least most of the characteristics, which the profile attributes to them. However, leaving aside the question of the extent to which a profile does apply to an individual, perhaps the most significant issues is that they are being judged as if it did. This practice involves applying what Vedder (2001) termed 'non-distributive profiles' to individual members of a group. Those using the profile for decision making purposes work on the assumption that it relates in the same way to all members of a group when in reality it applies in to varying degrees to individual members. Furthermore, the relationship of an individual to the information contained in a profile is probabilistic i.e. non-direct.

From a legal perspective this sort of data falls outside the classification of 'personal' data. However, the use of 'non-distributive profiles' *can* potentially have direct consequences for individuals if the profiles are used as a basis for decision-making. Direct marketers are able to study identified datasets for 'look-alikes' who fit profiles discovered in the non-identified datasets (Sleight, 1993). Inferences can be made about characteristics that are not represented in the identifiable data but *are* in the profile. This means that people who fit the profile can be inferred to have characteristics that match the profile. These inferences rely on statistical probability and are not precise with regard to any individual, nevertheless they may often be close enough for the purposes of marketing and service provision. The fact that sometimes certain aspects of the profile are incorrectly applied to particular individuals is, at best, an uncertain way of protecting privacy. This situation raises privacy issues if one accepts the proposition that people will seek to protect information that they fear may be wrongly interpreted or place them in an unfavourable light. As Goffman illustrates in 'Stigma', withholding this sort of information is a method by which individuals manage their interactions with others and avoid damaging and limiting labels (Goffman, 1963). Furthermore, the practices discussed here are characterised by a lack of transparency: in most cases individuals will not be aware of the existence of the groups to which they are assigned. They are, therefore, in no position to raise objections.

Access to Research Data

There are strong arguments for making data available to a wider community of users. These include gaining maximum benefit from the data by allowing its use by a variety of organisations. It is persuasively argued by some that opening up access to research data for secondary uses will be of huge benefit to the scientific community (Wellcome Trust 2003). However, despite the utility of releasing data it is important to acknowledge the social consequences of the availability of anonymised data. This could include a challenge to 'categorical privacy' (Vedder, 2001) and the matter of a loss of the original context in which the data was provided. The context in which information was provided may have its own internal logic and rules, which informs their expectations about its future use. 'The settled rationale of any given context may have long historical roots and serve important cultural, social, and personal ends' (Nissenbaum, 2004). I use context as Nissenbaum (1998, 2004) does, in order to define the parameters of the situation in which information is given. This includes contact with the original researchers, familiarity with the organisation collecting the information and the rules governing the management and use of the data. Quite simply, respect for these parameters in relation to the use of information is 'contextual integrity' (Nissenbaum, 1998, 2004). Challenges to 'contextual integrity' come of both from information technology and from the will of the research community and others to reuse data outside of the context in which it was collected. I.T allows data to be stored, analysed and transmitted, thus facilitating its transfer and reuse. Sweeney (2001) identified three data collection trends that are supported by information technology: collect more, collect specifically, and collect it if you can. Those who wish to exploit data to its maximum potential see a dataset as a resource, which is wasted if it is only used to answer one set of hypotheses (Wellcome Trust 2003). This climate of data reuse by the scientific research community has been termed 'Thrifty science' (Hine, 2006). The characterisation of data as a resource entails that it will sooner or later be used in a context different to the one in which it was originally provided.

There are many examples of reuse of data by the social-scientific community, notably the Essex Data Archive. (Projects funded by the Economic and

Social Research Council (ESRC) must be lodge their data with the Data Archive). This fits with a wider push to see data as reusable and to present data which is available for reuse as being a wasted resource, whether the data originates from research projects or from administrative processes (See UK Clinical Research Collaboration, 2007). For example, the definition of databases as resources, archives and banks is an idea gaining increasing currency within the biomedical research community. This is evidenced by the UK Biobank. Biobank seeks to open up access both to data collected under the auspices of the Biobank project and anonymised records sourced from the National Health Service for research purposes (Ethics and Governance Council, 2007, Section B). As argued above liberalisation of access to data, breaks down the original context, wherein information was gathered for a particular set of research purposes by one set of investigators under particular conditions. 'Contextual integrity ties adequate protection for privacy to norms of specific contexts, demanding that information gathering and dissemination be appropriate to that context and obey the governing norms of distribution within it' (Nissenbaum 2004). Moreover, Onora O'Neill (2003) argues that individuals frequently judge the research they are entering into by reference to the context more than what they are explicitly told. Therefore, this situation challenges not only the efficacy of traditional means of dealing with control over data, such as informed consent, but also the social and ethical presumptions of all of those involved in the original data collection. For example, when providing a family history to a geneticist employed by the National Health Service, an individual would undoubtedly be rather surprised if the information were used to make judgements about matters relating to her finances. The case of reuse of statistical data is obviously different from this example as the connection between the person providing data and outcomes would be less direct. Indeed it is this indirectness that informs the legal position that anonymised data is no longer connected to the individual data subject and is therefore a direct relevance to her. From this perspective, moreover, it would seem that concerns about the outcomes of uses of aggregated or statistical data are much less compelling than public-good arguments for the availability of this sort of data (ISI 1985).

Capabilities

The demand for data is met (and perhaps created) by technology, which facilitates capture, transmission and analysis of information. Sweeney cites the information collected at birth registration by the U.S government as evidence of a trend towards collecting more data. In 1907 there were seven pieces of information required to complete this process. In 1999 there were two hundred fields of information requested (Sweeney, 2001). In the digital world the capacity to store information is potentially infinite. Provided an individual or company has the purchasing power or expertise to develop information systems and interpret data the potential for collection and analysis of data is apparently endless. The power to extend knowledge about groups and individuals and the relationships between them is increased by the ability to capture, hold and process data. It is also facilitated when data can be cross-referenced to other datasets and data sources. Nissenbaum (1998), talks about a shift in the 'quality' and not only the quantity of data where data is combined and analysed in particular ways. A few isolated pieces of information may be innocuous and insignificant in one context but where data can be analysed in combination with other data held in other datasets it can potentially provide a detailed picture of an individual's lifestyle. Nissenbaum suggests that it is the alignment of technology, data and a human will to process information to increase social and economic advantage which renders these capabilities a cause for concern. 'We have powerful information technology coupled with an insatiable desire to know—whatever now may be useful to someone, somewhere, or what may become so in the future' (Nissenbaum, 1998, 30). A concrete example of this is provided by certain socio-technical systems, which are engaged in the creation and use of group profiles.

The capacity of organisations to capture, hold and process information has an enormous effect on the ethical and social consequences of the availability of datasets. These capabilities determine how and to what extent available data is exploited and have a bearing on the usefulness of the 'personal'/statistical data dichotomy. Not everybody has the ability to make sense of hundreds of data items on millions of people or to segment the population on the basis of this data. Such capabilities belong to only a small number of organisations. Many of these organisations reside in the private sector. '[S]till more recently commercial institutions such as credit card companies and internet marketers, also have the power to create new ways of 'reading people' (Jasanoff, 28, 2004). Therefore, secondary use and open access have different implications for different actors due largely to the matter of capabilities. Combining data sources increases the threat that the release of statistical data can pose to privacy. An example of this is provided by the fate of No. 4417749, a customer of the internet provider AOL. This company released information it had gathered about the search queries of 4417749 and her fellow AOL customers. This data presented a detailed picture of this person based on the interrelated preferences, concerns and interests of this person, as embodied in their search data. A New York Times reporter was able to deduce the identity of this person on the basis of the amount and type of information released (Williams, 2006). However, leaving aside the problems posed by the fact that a person was directly reidentified, there is no evidence that 4417749 had ever consented or expected that this rather detailed picture of her preferences would be distributed, even in anonymised form. For those with the right motivations and the necessary technologies, as in the case of dunnhumby, it is very easy to put individuals into categories and subsequently use these categories as a basis for interaction with them.

Nissenbaum argues that it is important that motivations and capacities are taken into account when possible outcomes for data subjects are considered, 'When we evaluate sharing information with third party users of data, it is important to know something about those parties, such as their social roles, their capacity to affect the lives of data subjects, and their intentions with regard to subjects. It is important to ask whether the information practice under consideration harms subjects; interferes with their self-determination; or amplifies undesirable inequalities in status, power, and wealth' (Nissemnbaum, 2004, 137). This suggests that the motivations and capabilities of those using the data are more important considerations than whether the data is anonymised or 'personal' or a combination of the two. Nissembaum argues moreover, that an issue of 'privacy in public' arises due to the circulation of information not being understood as a privacy issue (1998). This happens for two reasons; first, the legal position on statistical data implies that it is necessarily innocuous and second, there is no recognition of the potentially cumulative threats posed by the availability of numerous datasets and data sources (Nissenbaum, 1998). Nissenbaum (1998; 2004) uses the example of a project designed to be used in market segmentation, 'Lotus Marketplace: Households' to argue that the will to differentiate groups of people and to assign individuals to these groups, means that consequences arising from the circulation of anonymised data are not harmless. This company uses information technology to capture, combine and compare data in order to discriminate between different groups of potential customers. 'Used in this way, a profile may be seen as a device that offers a way of targeting people as the likely means to someone else's ends' (Nissenbaum, 1998, 590). The potential impact of socio-technical systems such as these is not accounted for in the governance framework generally assumed to protect privacy. For example, given that the data used in profiling comes from many sources, is a mixture of inferred, aggregated and identified data it is unclear how the legal dichotomy of 'personal' and non-'personal' is useful.

The Case of Experion

Experion is an example of a 'super bureau' bringing together data from a vast array of sources, state of the art data processing technologies and a corporate agenda, which includes supporting the goal of increasing profit making by being better able to 'understand' customers and their 'needs' (Experion-Scorex 2006). In a report written in 2006 on Marketing Optimisation, the 'traditional approach' to 'data driven marketing' is said to have the following stages: Data warehousing, Analytics, Planning, Execution and Channels. 'Profiling' and 'Segmentation' appear under the heading of 'Analytics'; 'Targeting and selection' are part of 'Planning' and 'Customer management systems' comes (somewhat ominously) under 'Execution.' The report talks about several different approaches to selling a variety of products to a range of customers, who have different preferences, economic standing and likelihood of responding to offers. Customers are ranked in a variety of ways so that the highest profit may be returned for the minimum amount of effort and expenditure by the marketing section of a company. This will involve some customers not being offered products or prices that other customers are offered. However, this is criticised as being 'one dimensional targeting.' The report advocates the use of a new more sophisticated tool for direct marketing. This is called 'Mathematical, constrained optimisation.' Apparently this tool allows questions such as 'What is the best set of campaign offers to assign to customers in order to achieve our business objectives' and 'How do I implement a contact policy to ensure customers don't get multiple, conflicting or less profitable offers in the future…' (Williams, 2006: 12). This tool will not only take into account all available information about the customers which could allow prediction of future behaviour, receptivity and spending power, it also compares this with data on other interactions the company has had with the potential customer. This allows a highly focused approach which will enable the targeting of those individuals likely to spend most on a particular product and be most receptive to it.

This system will combine individual and profile data or 'information about actual and potential customer events' (Williams, 2006: 18). Experion uses a system called Mosiac to bring together a variety of data sources including those produced by NSIs, to produce profiles. 'In addition to the 2001 Census data sources for Mosiac UK include the 'edited electoral roll, Experian's lifestyle information, house price data, council tax returns, customer credit behaviour and ONS local area statistics' (Experian 2008). Organisations involved in so called market segmentation have long been aware of the value of secondary use of statistical products released by NSIs. The importance of data disseminated by NSIs, for building up a profile of the people living in a given area, is well-recognised by marketing organisations. In the UK, Small Area Statistics (SAS) are used in the creation of area profiles. 'Experions Mosaic UK combines over 400 separate data sources and devides the UK adult population into 61 different types and 11 groups covering the full spectrum of British and Northern Ireland society' (Experian, 2008). SAS data also helps to ascertain the homogeneity or heterogeneity of an area, which helps to further reduce the possibility of incorrect inferences of the characteristics of residents. The Sample of Anonymised Records (SARs) provides a picture of the phenomena to be found in those areas. Marketers point out that they use a probabilistic, rather than direct, approach to the characteristics of individuals (Sleight 1993), which is unproblematic in terms of the legal framework, as they are not attempting to re-identify individuals from anonymised data sets. Here, accuracy is less important than 'narrowing the odds' in favour of the data processor (Sleight, 1993).

Helping in this process of narrowing the odds is information supplied by what Nissenbaum (1998, 24) refers to as 'super-bureaus'. These organisations are in the business of collecting all available data from financial transactions to official records in order to create profiles of groups and individuals. Organisations such as Experion make use of powerful computing facilities to collect, store and analyse information. This type of organisation employs a mixture of inference, comparison against statistical norms and identifiable data. Again statistical information supplied by NSIs as well as other lists and information from the public sector has an important role to play in this process. As Nissenbaum (2004) points out, the reality of I.T enabled data processing spans dichotomies and renders them unhelpful in many cases. One question is whether exemptions, which apply to research and statistical data, ought to apply to data used in profiles. Prior to the IT revolution, the difficulty of amassing large amounts of data protected privacy by default for the most part. 'But these conditions no longer hold. In their place we have powerful information technology coupled with an insatiable desire to know whatever may be useful to someone, somewhere or what may become so in the future' (Nissenbaum, 1998, 292).

The Law and the Place of Accuracy

The fact that statistical data does not contain individual names and other direct identifiers makes it appear that there is no relationship between privacy and statistical data. The legal framework for statistical activity, Council Regulation 322/97/EC, and data protection, Directive 95/46/EC, at the European level emphasise the necessity of protecting the anonymous nature of statistical data. As has been argued above, non-'personal' data may nonetheless be used to target individuals and this can have direct and even negative consequences for their ability to manage their own social and economic interests. NSIs are concerned to prevent direct disclosure of the identity of individuals or the possibility of accurately inferring their attributes. However, there are two possible uses of data that mean there could be consequences for individuals. Firstly, technologies, such as those used by Experion, can allow the incorporation of data of different types from a variety of sources. These technologies enable the demarcation of relatively small groups of individuals due to the detection of subtle relationships between variables. Secondly, the links between variables and the patterns that they constitute are sometimes used to ground decisions as if the links were causal rather than probabilistic (Vedder 2001). Statistical and research organizations who provide secondary access to their data take great care to make data safe against accurate re-identification. However, this does not protect against uses of data where accuracy is not seen as of primary importance. This is the case, for example, where the motivation is to segment the population in order to make the most efficient use of marketing resources.

This is a privacy issue if one accepts that privacy enables individuals to control the flow of information relating to them. Control in turn allows individuals to manage the dissemination of 'discrediting' data which they are aware may harm their interests and make them the subject of discrimination. These considerations can apply to anonymised data when it is processed and used in the ways described above (Vedder, 2001). There is a focus in law and policy on identifiable data and preventing its unauthorised disclosure. There is no acknowledgement that privacy can relate to individuals as members of a group. Moreover, profiling may well produce a picture, so stripped of its social meaning and simplified, that individuals themselves may not recognise it. Profiles are only able to incorporate the baldest facts about an individual. Moreover, these facts will be interpreted narrowly due to the parameters of the 'socio-technical system' which defined the questions to be answered and the modes of answering them. Where this is the case, individuals will not be able to represent themselves in a way that they might see as fair. On this basis it could be argued that profiles, even if the 'facts' are reasonably accurate, give a misleading picture of individuals (Gandy 2002). These issues may not always look like privacy issues but control over one's identity and misappropriation thereof are matters which do come under the set of interests usually protected by privacy.

DISCUSSION

By now it should be apparent that the problem that this chapter is addressing is not that of the unchecked flow of identifiable data but that of misunderstandings about the use of non-identifiable or non-'personal' data. However, the reason why the latter is a problem is precisely because it, on occasion, gives rise to similar consequences, for individuals, as the former. Vedder coined the term 'categorical privacy' because categorisation can lead to something which is in every respect like an invasion of privacy except for the role of aggregated data and inference in the process of making judgements (Vedder, 2001). The legal position on the dichotomy between anonymised and identified data coupled with a willingness on the part of certain companies to adhere to the letter of the law (but perhaps not the spirit) means that the protection offered to individuals' ability to control what others know about them is weakened. Moreover, the legal stance on this matter does little to support individuals who would otherwise challenge these activities. The automation of systems of data processing and decision support presents further challenges to accountability and transparency. 'A person who begins receiving unsolicited marketing mail and e-mail may have a clue that some entity has disclosed her personal information, but that person often will not be able to discover what entity was the culprit' (Soleve, 2001, 1444).

Results from empirical work, moreover, support Soleve's (2001) claim that people have a perception of a lack of control or accountability in the dissemination and use of data. The sheer lack of clarity of the origins of both certain decisions about access to goods and products and the 'targeted' mail that people receive is an example of the absence of meaningful control in the current system. One study, carried out to look at the perceptions of individuals who were participating in the United States Census in 2000, found a widely shared perception that personal data was 'out there' (Gerber, 2001). There is clearly some confusion with regard to receiving mail-shots and experiencing other consequences as a result of circulation of information (Gerber, 2001). This confusion arguably undermines trust in research organisations and may ultimately undermine public support for research. Indeed when information on these sorts of uses of data is made public, as was the case of 'Lotus Marketplace: Households', it has been met with clear opposition (Nissenbaum, 1998). The results from the interviews carried out with individuals whose records are held by or utilised by government bodies indicate that people are concerned about how I.T capabilities will affect an organisations' ability to protect informational privacy (Hedges 1996; Gerber 2001). Findings from some studies moreover support Nissenbaum's claim (1998; 2004) that people regard 'contextual integrity' as very important in terms of protecting privacy. Hedges' study found that individuals pictured a 'transaction box' which imposed restrictions on access and use of the data they provided to particular organisations for a given purpose. Although research organisations, such as NSIs, cannot be held directly responsible for the uses of data disseminated by them, these uses may still affect public trust. Loss of public trust may in turn have long term detrimental consequences for publicly funded research.

CONCLUSION

The uses of these resources within the types of socio-technical systems discussed in this chapter do raise issues of privacy and the ability of individuals to protect their own interests. These problems are difficult to conceptualise within the current legal and ethical frameworks, which splits data into an identified/non-identified dichotomy. Privacy theorists have been arguing for a number of years that the consequences of data use should be the focus of concern, not whether the quality of the data itself (Soleve, 2001). 'Use of certain options in information technology, such as the production and application of group profiles by private and semi-private organisations, may create relatively new social problems which cannot yet be adequately captured in terms of current legal and moral vocabularies' (Vedder, 1997, 216). Data mining techniques can discover relationships between variables that would otherwise remain implicit (Torra et al 2003). Characteristics, which may not be obvious but which can also form the basis for prejudice if they are widely known, such as religion, political affiliation and class, may be inferred using such techniques. A question that has great bearing on personal privacy in relation to secondary uses of aggregated data is; what is acceptable exploitation of non-'personal' data and IT (Soleve, 2001). There is perhaps a lack of understanding about how research data fits into the process of profiling and the consequence of being negatively categorised for marketing or credit purposes. Worryingly these uses of data may begin to undermine individuals' willingness to share their data and this would have consequences for research organisations whose work depends on the cooperation of the public. The threats to privacy posed by the use made of non-identified data in some socio technological systems need to be acknowledged in future systems for the governance of research data.

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KEY TERMS

Anomymisation: This process involves removing identifiers from the data. This can be done in number of different ways often in combination, these include: Removing variables (The first obvious application of this method is the removal of direct identifiers from the data file.); Global recoding (global recoding consisting in aggregating the values observed in a variable into pre-defined classes, for example, recoding age into five-year age groups); local suppression (which consists in replacing the observed value of one or more variables in a certain record). Anonymization is one solution to minimize the risk of identity disclosure when distributing microdata.

Categorize: This means assigning an entity to a category. It involves the classification, labeling of entities so that they can be assigned to a class or a category. This can be done by existing categories (for example age) or specially designed ones, which can, for example be used to segment populations on the basis of a number of different characteristics that they have.

Context: Context involves the organization, or set of researchers or professionals who collected data and explicit or implicit agreements that were established with data-subjects. Context can mean the physical situation but also involves a number of understandings and expectations about what one can expect from data given in a particular situation under a specific set of conditions. An example of a breach of context would be if data provided to one's doctor for medical purposes was used by a credit company to assess an individual's financial viability.

Data-Dichotomy: This relates to the distinction between 'personal' and statistical data, or the split between identified and non-identified data. The dichotomy between statistical and personal data is constantly reiterated and is relevant to how individual privacy in relation to data is protected.

Socio-Technical Systems: These are associations of information technology organizations and people. The term embodies recognition that there is interaction between people and technologies. The term also refers to the interaction between societal structures and values and human behaviors.

Personal Data: This is simply identifiable data. In Article 2(b) of EU Directive 95/46/EC, 'Personal data' is defined as data that can directly or indirectly be linked to an individual, through an identification number, for example, or to a particular characteristic that would indicate a person's identity.

Privacy: Liberal political theory recognizes this capacity in the rational individual and tends to advocate the protection of the individual's ability to use this capacity. From this is derived the notion that privacy is one way in which the individual could be protected from becoming subject to manipulation by others. An important point is that the concept of privacy in this chapter is almost always informational privacy or privacy as it relates to information disclosed by an individual. How the concept of informational privacy is derived will be crucial to understanding the way in which other central concepts are used.

Profiling: This relates to the recording and classification of behaviors. This occurs through aggregating information. This often collating information often derived from a number of resources to build profiles on individuals in order to sell products and to sell model and predict behavior. These profiles may be used by marketers for target advertising. Companies may link profiles to individual's identities.

Statistical: Statistical data is legally a separate entity from the 'personal' data covered by data protection legislation. Statistical data is said to answer questions about number, amount and percentages rather than about individuals.

ENDNOTES

1 Attribute disclosure is attribution independent of identification. This form of disclosure is of primary concern to NSIs involved in tabular data release and arises from the presence of empty cells either in a released table or linkable set of tables after any subtraction has taken place. Minimally, the presence of a single zero within a table means that an intruder may infer from mere knowledge that a population unit is represented in the table and that the intruder does not possess the combination of attributes within the cell containing the zero. (OECD 2005) Glossary of Statistical Terms, available at http://stats.oecd.org/glossary/detail.asp?ID=6886, accessed 01/05/08)

2 ONS is the Office for National Statistics the UKs National Statistical Institute

Chapter IX
Privacy Regulation in the Metaverse[1]

Ronald Leenes
Tilburg University, The Netherlands

ABSTRACT

Second Life can be seen as a social microcosmos in which fairly normal people lead a social life and where social needs develop. Privacy is one of those needs. It is a need that is seemingly at odds with the key characteristics of Second Life: social interaction, transparency and openness. This chapter sketches the state of privacy in Second Life and how privacy is regulated in and around Second Life. It argues that the current governance model in Second Life is inadequate to provide proper privacy protection. The chapter concludes by briefly discussing current developments towards self governance that may improve the situation. The chapter aims to show that virtual worlds, such as Second Life, are interesting environments to study social phenomena and their governance.

Privacy is like oxygen, we really appreciate it only when it is gone.

—Charles Sykes (1999)

INTRODUCTION

In 1992, Neil Stephenson published the sci-fi novel Snow Crash. In this novel, Stephenson sketches the US in a distant bleak future where government has been almost completely replaced by private organisations and entrepreneurs who run sovereign suburban enclaves, called 'Burbclaves'. The book's fame, however, mainly derives from one of its key features, 'The Metaverse', a computer generated 3D environment in which the book's protagonist spends considerable time. In the Metaverse, players move around as Avatars. The basis of the Metaverse is 'the Street' which is '… subject to development. Developers can build their own small streets feeding off the main one. They can build buildings,

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parks, signs, as well as things that do not exist in Reality, such as vast hovering overhead light shows, special neighbourhoods where the rules of three dimensional spacetime are ignored, and free combat zones where people can go to hunt and kill each other.' (Stephenson, 1992, p.23).

The Metaverse clearly was the inspiration for what is now known as Second Life (SL), an online game offered by Linden Lab.[2] Snow Crash also contributes to Second Life on another level. The burbclaves described in the novel may turn out to be the governance model to which Second Life is moving. Second Life is therefore turning Stephenson's thought experiments[3] into reality in more than one sense.

Second Life has evolved into one of the popular online Multi User Virtual Environments (MUVEs) with at present some 14 million Residents.[4] Unlike the related Massively Multiplayer Online Role Playing Games (MMORPGs), Second Life lacks a content-driven plot; the users define what SL is used for.

Perhaps because SL lacks a plot and instead provides a powerful platform for social interaction, the idea has been coined that SL can be regarded as a social microcosmos which would potentially make it a unique research platform for the social sciences and clinical therapy (Yee et al., 2007).

One of the interesting phenomena to study is that of privacy. Privacy is a basic human and social need (e.g., Westin, 1967). It is a multidimensional concept, with physical (e.g., bodily integrity), spatial (e.g., home as a private sphere), relational (e.g., private conversations), and informational dimensions. Since the rise of ICTs, informational privacy has gained importance. Informational privacy is often associated with the notion of informational control: 'being in a position to determine for [oneself], when, how, and to what extent information about [oneself] is communicated to others' (Westin, 1967 p. 7). Informational control allows individuals to define social contexts in which they present different aspects of themselves. For instance, your boss (generally) does not enter your bedroom, and your grocer does not (need to) know where you work. Audience segregation is considered to be an essential aspect of identity (cf, Goffman, 1959) and necessary to create and maintain social relationships (Rachels, 1975).

Privacy is a value worth protecting in itself, but is also instrumental to other values, such as personal autonomy, emotional release, and self-evaluation. It also plays an important role in society at large. Free speech, which is essential for public debate, is served by anonymous speech, for instance. Privacy therefore is not only an individual value, but also a social one. Privacy is, or should be, built into systems and organisational practices and procedures (e.g., Regan, 1995).

The meaning of privacy and the way people and society value privacy changes over time. ICT developments have an eroding effect on informational privacy because ICTs create data traces that can easily be stored, combined and exchanged (Koops & Leenes, 2005). This has led some to conclude that we no longer have any privacy (e.g., Froomkin, 2000; Sykes, 1999). The middle ground is that even in social networks privacy is considered important, even though users don't act according to their concerns (e.g., Acquisti and Gross, 2006).

Second Life offers its users an almost unlimited means to expose themselves. This provides an interesting test bed to explore privacy and the changes over time in its valuation. Questions that can be raised include the following: SL residents have a certain amount of informational control, but how much control do they have? How is this control affected by other players and the environment's architecture? How is privacy regulated in this environment? Is this adequate, given individual and societal concerns? The malleability of the technology and rules/regulations even allow SL to function as a test bed to explore the effects of certain privacy regimes on the users attitudes and needs (Bradley & Froomkin, 2003). However, this is beyond the scope of this contribution.

Studying privacy in Second Life is challenging because of the permeability of the virtual world real world border. Inworld privacy concerns, such as anonymity, reputation and control over who is watching, and when (EPIC & PI, 2006) are also 'real' concerns. Value created within the game (in Linden$) can, for instance, be exchanged against US$ at the Linden Exchange (the LindeX), making virtual value real value. Furthermore, SL Residents also have Real Lives and talk about their First Life inworld, and also inworld activities may have real world ramifications. In this chapter we will mainly look at inworld privacy, but we will also explore some inworld—real world issues.

We will start by exploring SL privacy issues and privacy regulation. Next we will see how Residents and game creators handle privacy issues. Finally, we will look at the state of governance and its current problems. We will conclude by looking at some current governance developments and what effects they could have on privacy.

Privacy in Second Life

Social interaction is an important motive for people to assume a Second Life. The system clearly supports social interaction. Second Life offers its Residents facilities to make new friends and locate and meet existing friends. The system's defaults are openness and transparency of its users. Sharing information is an important aspect of social interaction, yet information sharing is not unconditional. People also need to be able segregate audiences (Goffman, 1956) and to play different roles in different arenas. I present, or rather others construct, a different image to my colleagues than to my girlfriend or to my buddies at the pool club. Individuals need to be able to control who has access to what information as part of their right to informational privacy. Control, however, is not absolute, nor has the individual an absolute right to withhold all personal information from others. I have a legal obligation to show my driver's license when requested by the police, but not when requested by my neighbour.

The privacy configuration—by which I loosely mean the amount of transparency of an individual to others, the control one has over one's personal data, the kinds and incidence of privacy infringements, and the regulation relating to privacy and personal data—is in constant flux. Furthermore, the Real World privacy configuration differs from that in Second Life.

In the following sections we will discuss the inworld privacy configuration in Second Life. I will not discuss Linden Lab's role as an entity that could infringe on the privacy of the players here (this topic is addressed in Leenes (2008)), but only consider Linden's role in SL governance—setting the game's regulatory framework and enforcing the rules.

The Default Privacy Configuration

By way of illustration we will first explore some of the environment's default settings.

Residents engage in Second Life by moving around their digital identities (their avatars) in a 3-D environment. They observe the scene either from a first person perspective—looking through the avatar's eyes—or from a third person perspective—a camera that hovers somewhere above the scene. In first person perspective the avatar cannot move and interaction with the environment is similar to that of a real person in the real world. This is different when the third person perspective is employed, which is the default in SL. This perspective allows the player to move the camera independently of the avatar and even take it far away from the avatar. The camera can therefore be used as a spying or stalking device to unobtrusively observe other Residents and their interactions. It can even be attached to another avatar without its consent or awareness. The third person perspective extends the individual's field of vision considerably when compared to the real world, and allows the Resident to intrude other Resident's personal spheres without being noticed so as to observe them and their interactions.

In the Real World individuals can move about relatively anonymously in public spaces. Most people can go about anonymously on a market square of a medium sized city. This is different in Second Life. Although Residents can easily, and radically change their appearance which makes it difficult to recognize them, this does not make them anonymous because the avatar's name hovers above its head giving away its identity.

The avatar's name does not expose the Resident's Real Life identity because it consists of a freely chosen first name and a surname selected from a list of predefined surnames during registration. The avatar's name is the identifier to a Residents online identity, or *digital persona* (Clarke, 1994). It not only allows Residents to recognise each other, but also serves as the pointer to information about a certain digital persona accumulated over time. Finding out the basics about a certain Resident is made very simple by right-clicking on an avatar, or by using the system's global search function which brings up their personal profile. This profile contains sections about their 2nd Life—including photo, date of birth, partner, group memberships, and a 500 char description of the Resident –, websites of interest, inworld interests, and 1st life—where one can provide information about one's real world identity. Residents control their own profile and therefore control what others get to see about them. Many profiles contain little information. Residents tend to display their group memberships and areas of interest in SL, but usually keep their 1st Life field empty. This suggests that users want to keep their 1st life private and really treat Second Life as an alternative life. Within their Second Life they are open to social interaction and therefore signal their interests to find similar souls.

Second Life also has powerful facilities to locate Residents to facilitate social interaction. It has an extensive directory that allows any nameable item to be found. Residents and places can be found by entering partial names or words. The location of the requested places can be shown on a map, and the Resident can be teleported right to it. Residents can easily find out whether another Resident is online by sending an Instant Message (IM). It is also possible to maintain a Second Life personal directory about their inworld friends which automatically shows online status.

Residents communicate by means of typed text and by voice (which was introduced to the game in 2007). In the text mode Residents can use chat and instant message to communicate. In chat mode, all communication within a radius of about 20 metres is visible to the player (96 metres for shouts, 5 metres for whispers). This allows them to monitor the communication between other nearby Residents, much like in the real world. A difference being that one can't whisper in SL; all conversation is visible. In voice mode, a Resident can hear voice, chat within a distance of 60 metres (first person perspective), or when the 'ears' are associated to the camera in the third person perspective from up to 110 metres away. When private conversation is desired, one has to switch to instant messaging, which resembles RL phone conversations. In the default mode, Residents and their interactions are more transparent than their masters are in their real lives. This is probably intentional because many aspects outlined can be seen as features to enable social interaction instead of as bugs that affect the players' privacy.

Exercising Control

Many players adjust the settings in the game or take other actions to gain control over the data they disclose to others in the game and to limit the information others can collect.

The privacy preferences can be modified. User configurable options are whether your profile shows up in a search, and whether your online status is visible to friends. It is also possible to manipulate your online status; you can mark your status as busy or away while you are in fact online and at play. Both settings suggest unavailability of the avatar which provides a way of going about in the game undisturbed by your friends (unless one bumps into one of them, of course).

Another way to gain privacy is residing on a private island (private estate). Access to such an estate by teleporting can be controlled by its owner which makes them enclaves where only the 'happy few' can go thereby offering a maximum level of privacy. Another method of seclusion is living in a skybox, a private home high up in the sky that can only be reached by avatars equipped with flight assist scripts.

Alternate Accounts or Alts provide a more relevant way to obtain privacy. Alts can be created by any SLer and allow the user to maintain different identities in SL linked to a single email address. You can go to an island as a primary avatar and switch to an Alt when visiting another. Alts are unlinkable for the other Residents and therefore facilitate audience segregation. Alts are popular among users who engage in SL as part of their business or profession. For instance, companies such as IBM have a significant inworld presence. IBM employees active in SL have primary accounts that mark them as IBM employee. Instead of creating separate accounts for their private SL activities, many IBM users use their Alts when they don't want to be recognisable as IBM employees.

Alt accounts are also abused by those who want to avoid accountability for their actions. Misconduct, such as 'griefing'—making other Residents' lives miserable by acts such as trolling, flaming, and spamming—is one of the obvious uses of Alt accounts. When introduced, Alt accounts were only available to premium users. Currently all users, including those with basic—unverifiable and therefore anonymous—accounts can create Alt accounts. This has not led to and increase of abuse in SL; there has been no increase in Alt abuse reports (Linden Lab, 2006c). Alts may not be very popular in practice. The 2007 EPN study (EPN, 2007) shows that almost 75% of the Dutch respondents don't have Alts. Yet the study also reports an average of 1.6 avatars per respondent, meaning that the remaining 25% of the players must have many Alts.

Inworld Privacy Infringements

Many real world privacy infringements have their counterpart in SL due to its resemblance to the real world; people are curious and nosy in SL as they are in RL. Whenever Residents interact there is the possibility that others listen to their conversation. These conversations reveal information about the participants and keen observers can use the tools outlined above to find out more about them. Inworld conversations are not restricted to inworld activities. In fact, judging from our own experience, certain areas of SL—0031, the Dutch island for instance—are used as virtual market squares where just about anything is discussed, especially relating to what people do in the real world. You can therefore easily learn about other Residents' real world identities and use Google to help fill in the blanks.

If you want to know more about a particular Resident there is even inworld help to obtain information. There are inworld detective agencies, such as the one run by Markie MacDonald (Linden, 2005), which can be hired to spy on avatars or to set up 'honey pots' to uncover inworld infidelity. These activities clearly affect the privacy of the targets and their effects need not be confined to the 'game'. These covert operations aim at monitoring or inducing behaviour exhibited by individuals (by way of their avatar) and therefore relate to real people. Hamlet Linden's interview (Linden, 2005) with one of Markie's customers (Laura Skye) illustrates this. Laura stated that discovering her inworld partner, who also is also her partner in Real Life, to be unfaithful inworld she would not only terminate her SL relationship with him but also terminate her real life relationship.

Bugs and Devices and Information Leaking into the Real World

There are also numerous devices—bugs—to monitor conversations and chats on sale in SL (Linden, 2007). These bugs can be placed anywhere within SL, including on Residents. As we shall see later on, these devices are illegal within the game, but this does not stop people from using them, just like in the real world. Not only conversations can be monitored, but also avatar whereabouts and relations can be monitored. For example, the SLstats watch (Mistral, 2006) which reports the location of the watch wearer plus any other avatars near the watch to a database outside the SL realm on http://www.SLStats.com. This site maintains a list of the watch wearer's friends based on avatar proximity and duration. This in itself infringes the privacy of these 'friends' because most of them will be unaware of the watch's function, but the effects are even bigger when you consider that the database is hosted on a website outside SL. This means that anyone, not just Residents, can discover your inworld associations.

The introduction of SLStats.com has caused privacy advocates to complain about potential issues such as stalking, and RL employers to draw false conclusions from the suspect data (Mistral, 2006a; 2006b). As a result of this outcry, the functionality of the website has been downgraded. Linden Lab has not reacted or taken action with respect to the SLStats watch/site (Mistral, 2006b).

The SLStats watch and website illustrate where the real privacy issues in SL lie: (third party) data aggregation and the possible use of these data for data mining. Just like in the real world and the Internet it is not so much your nosy neighbour but rather 'superiors' such as parents, teachers, employers and governments, and profiling and data mining by business and government who pose serious threats to your privacy. The threat may at present be limited, but scripted applications, such as the SLStats watch show that they are possible. In this respect Linden Lab is not really helping to keep personal information contained within Second Life. Linden is implementing a new search feature which even facilitates this data flow:

"Be aware that the new search results will be available to the public, once it's released, anyone with a web browser can view them from the Second Life website. The search results may also be picked up by other external search engines such as Yahoo and Google, although we are not explicitly asking search engines to crawl them at this time. It's important to remember that this information is not tied to your real life identity and is the same information that anybody could see with a free Second Life account."[5]

The information that can be found using the new search features was indeed already available to Residents, but this statement neglects a subtle issue. You must register to become a Resident, which involves entering into a contract. In its Terms of Service (ToS) the contract contains privacy protection provisions to which the Residents are contractually bound. This regulates behaviour within Second Life and gives the users' legal means to complain and seek redress. When the same information becomes available outside Second Life, the protection offered by the ToS becomes useless. Non-SL users are not bound to terms in the SL ToS when they search for information using Internet search engines. This means that inworld privacy breaches, even by people with a free SL account, can be addressed on the basis of the Terms of Service, whereas protection is absent on the Internet at large.[6]

Governing the Metaverse

This brings us to regulation in Second Life. Regulation can generally take the form of a combination of four modalities (Lessig, 1999): social norms, law, market and architecture. In this chapter we confine ourselves to law and architecture because these are the most prominent instruments for regulation in SL.

Regulation by means of the architecture is regulation by computer software, or 'code' (Lessig, 1999). Software (in this case the SL client) enables the user to perform certain actions, prohibit certain actions and does not implement features or functions that might be implemented had the developers made different choices. In other words, what users can do is determined to a large extent by what the software allows them to do. For instance, irrespective of the question whether monitoring of conversations by bugs is permissible by any (legal) standard, Linden can make the act of creating bugs or attaching them to objects possible or impossible. The range of control by changing the software or the parameters within the software and hence on user behaviour is significant (e.g., Grimmelmann, 2005). Teleporting, creating skyboxes, recording conversation, stalking avatars, are all controlled by the (implicit) rules embedded in the software.

Linden Law

A second source of regulation is law. It consists of the regulatory framework within which the developers and Second Life as a service operate, and the regulatory framework that Linden enacts for its customers. The former category is complex. Firstly, Linden Lab, being a US corporate entity, has to comply with US law. Secondly, because Second Life runs on a distributed network of servers stationed in multiple countries and attracts users in many countries, also foreign regulation, such as the EU Data Protection Regulation (e.g., 95/46/EU) has to be observed. We will concentrate however on the regulatory framework that Linden has enacted for its customers, on what is coined as the "Linden Law": the Terms of Service and the Community Standards. These documents codify the social norms (as Linden sees them) into written rules. The participants in Second Life enter into a contract with Linden Lab when they register for the game. This legally binds both Linden and the user to the provisions in Linden Law. Linden Law therefore provides Linden Lab with an instrument to regulate the behaviour of the players in Second Life. Linden Law can be changed at any time, and in fact occasionally does. For instance, voice was introduced in 2007 and this may have fundamental effects on the way commercial and social bonds are formed in the game (Aiken, 2008). The following therefore necessarily only describes the state of the regulatory framework in SL at a specific moment in time, January 2008.

Enforcement of the rules outlined in 'Linden Law' is handled in two ways, both ultimately involving code. When rules are (implicitly) embedded in code, such as in the case of a hypothetical ban on bugs, the enforcement will be automatic; the software will simply prevent the user to perform the impermissible behaviour. In the case where rules in the Terms of Service or Community Standards are at play, punishment also involves code. The three most important forms of punishment in Second Life are warnings, suspension (temporary or permanently) and banishment to "the Corn Field", a moonlit environment consisting of rows of corn, two television sets, an aging tractor and a one-way teleport terminal allowing no escape.[7] When suspended, the user can log in but is immediately teleported to the Corn Field and is unable to leave for the duration of the punishment.

Privacy Regulation

The primary privacy framework consists of the Community Standards and the Terms of Service. The Community Standards sets out six kinds of undesirable behaviour, the Big Six, that may result in suspension, or even expulsion from the game. Rule 4 of the Community Standards addresses privacy in the form of a data protection clause as one of the Big Six:

"4. Disclosure
Residents are entitled to a reasonable level of privacy with regard to their Second Lives. Sharing personal information about a fellow Resident --including gender, religion, age, marital status, race, sexual preference, and real-world location beyond what is provided by the Resident in the First Life page of their Resident profile is a violation of that Resident's privacy. Remotely monitoring conversations, posting conversation logs, or sharing conversation logs without consent are all prohibited in Second Life and on the Second Life Forums."

Residents can file abuse reports using a form available within the Second Life application. Each abuse report will be investigated by the Community Affairs Committee, run by the Linden team. According to (Linden, 2006b), the Abuse Team investigates each abuse report using screenshots, chat logs (meaning that Linden stores conversations) and other tools to make sure that the claim is valid. Based on this evidence, the Abuse Team will determine whether an offence has been committed and, if so, it will take action against the wrongdoer. The reporter will be notified and the suspension will be reported publicly (without providing details with respect to reporter and wrongdoer) on the Police Blotter page[8] on the Second Life website.

For serious misconduct, defined as warranting a two-week suspension, a *Review for Ban* procedure will automatically be triggered (Linden, 2006a). The Linden staff review the offender's entire disciplinary history to determine whether a permanent expulsion is in order and seeks the advice of the Resident Review Panel on the anonymised case at hand. The Resident Review Panel consists of 25 active Residents, chosen anonymously and at random from the entire Second Life population.

The Community Standards are part of the Terms of Service. The ToS provide an abstract privacy provision which falls under the blanket clause for (im)proper conduct within SL which is provided by Article 4.1, which reads:

"4.1 You agree to abide by certain rules of conduct, including the Community Standards and other rules prohibiting illegal and other practices that Linden Lab deems harmful."

The scope of 'other rules' is not specified and could include much more than what is defined in Article 4.1's sub-articles, most notably sub-article iv, which states:

"you agree that you shall not: ... (iv) take any action or upload, post, e-mail or otherwise transmit Content as determined by Linden Lab at its sole discretion that is harmful, threatening, abusive, harassing, causes tort, defamatory, vulgar, obscene, libellous, invasive of another's privacy, hateful, or racially, ethnically or otherwise objectionable;"

This provision, unlike CS rule 4 which defines a complaints based offence, defines behaviour that can be addressed by Linden at any time, even without prior complaint by a Resident. Furthermore, Linden, by virtue of 'as determined by Linden Lab at its sole discretion', provides itself with unlimited powers to define behaviour as offensive.

There are also other provisions relating to privacy. For instance, the practices of private detectives might be illegal because they appear to breach Article 5.1 sub ii of the Terms of Service, which states:

"[You shall not] *impersonate any person or entity, including, but not limited to, a Linden employee, or falsely state or otherwise misrepresent your affiliation with a person or entity."*

The target of covert operations will usually be unaware of who the agent is and what their true affiliation is (i.e., I am not here to befriend you, I am here to try and trap you) (Samian, 2005). Such conduct could be considered impersonation as included in ToS article 5.1 sub ii. As said, if this conduct is illegal, the perpetrator can be suspended by Linden Lab.

Residents can be 'prosecuted' by the Lindens for offences defined in the Terms of Service and the Community Standards. The options for punishment are defined in article 2.1 ToS, which states that:

"Linden Lab may suspend or terminate your account at any time, without refund or obligation to you. Linden Lab has the right at any time for any reason or no reason to suspend or terminate your Account, terminate this Agreement, and/or refuse any and all current or future use of the Service without notice or liability to you."

This provision is very broad because it states that the Lindens do not have to provide proper cause for any suspension or termination of an account. This opens the door to arbitrary decisions without accountability, which from a governance perspective is undesirable. Which brings us to the topic of governance in Second Life.

Governance in Second Life

On paper, the Terms of Service and the procedures designed by Linden incorporate much room for them to act on their own discretion. They are open to suggestions, but consider making decisions about the rules and enforcement their call. Since Second Life is their product, this does not seem unreasonable. If users don't like the terms and conditions of the game, they are free to leave. In practice it is not that simple. SL users create real value in SL and build social capital in the game. This makes leaving the game different to just going from one supermarket to the next to buy a loaf of bread. We will return to this issue later, but first we need to explore Linden's position.

From the outset of Second Life's existence, Linden Lab,"…has portrayed itself as a common carrier and platform rather than as administrator or government, leaving dispute resolution to its residents and avoiding the creation of formal dispute resolution policy" (Mayer-Schönberger and Crowley, 2006). Despite the considerable powers it has attributed to itself in the Terms of Service, Linden has kept its interventions to minimum and at least passably fair (LGSG, 2007a). This leads to an interesting paradox, because when Linden Lab do interfere, they do so as 'benevolent dictators', doing what is best for the community, without democratic participation or assurance of transparency (Mayer-Schönberger and Crowley, 2006). Linden combines extreme laissez faire (non intervention whenever possible) with dictatorship.

There are two related questions that can be raised concerning this model of governance. First, is 'non interventionist benevolent dictatorship' a proper form of governance for an online virtual community and second, what is a suitable form of governance for Second Life from the perspective of a right to privacy?

Regarding the appropriateness of the governance model, the Lindens can build on experience in other online communities. All online communities struggle with governance issues. LambdaMOO is a famous and documented example that (accidently) has experimented with different models (Curtis, 2002). When faced with players moving around objects without their "owner's" permission in 1992, Pavel Curtis, the game's initiator drafted LambdaMOO's 'law' to make the game's rules explicit. Soon after, enforcement of the rules was attributed to a small group of system administrators (the Wizards) in the Architecture Review Board (ARB) who started acting as police, judges and executioners. The ARB was met with suspicion by the gamers: 'How was it formed? Who chose those particular people and why? How do they make their decisions? What is said in the Star Chamber? Why can't we go in there? It wasn't (at least at first) that anyone knew of anything bad actually happening around the ARB; its very existence, and the way it was created, were enough to worry some players.' (Curtis, 2002). Because of the ARB's high burden, Curtis decided to change the governance and the ARB no longer made 'social decisions'. LambdaMOO turned into a rough place where '[t]he level of inter-player strife and harassment rose and rose, slowly but inexorably'. This led to yet another kind of governance, a self-governance system by means of ballots. However, because '…the voting population could never agree on anything of real substance', not many petitions reached ballot stage and this model also seemed to fail. Curtis (2002) concludes '[d]eep in its very structure, LambdaMOO depends on the wizards and on the owner of its machine. These are not and cannot be purely technical considerations. Social policy permeates nearly every aspect of LambdaMOO's operations, and only the wizards can carry out those operations'.

The conclusion that can be drawn from the LambdaMOO experience seems to be that some form of central authority is required to enact and enforce rules in an online environment.

Linden enacts the rules in Second Life, but it is reluctant to enforce them. Linden does not want to interfere as a matter of principle, but Linden's enforcement on a global scale also poses practical problems. It would require considerable resources and expertise because there are many Residents (officially over 7 million) and a broad range of possible issues: not only pertaining to the Community Standard's big Six, but also criminally oriented offences ('theft', (ID) fraud, slander) and civil disputes, such as labour and employment disputes and intellectual property related cases.

Both Linden's non interference and Linden's interference lacking transparency and accountability have met critique within Second Life[9] and therefore, it does not seem to be very sustainable in the longer run and many Residents feel something needs to change. As Aiken (2008) puts it: Second Life is at crossroads: Linden can take full responsibility for the powers it exercises and create a nuanced system of norms, it can empower users to enforce norms or a combination of both.

Linden has acknowledged the governance issues[10] and has opted for instituting a form of local governance. Control will be devolved to local regions, the islands (estates), allowing their owners to enact and enforce their own set of rules and standards (Linden, 2006d). Linden will still handle "problems that threaten the stability of our technical, economic and social structures" and they will police on these matters. Linden, therefore, envisions a federal system of governance with Linden acting as the central 'government' with certain powers and the estates having considerable powers. How this power balance will exactly work out is still unclear and it will depend on the interplay between Linden and the local governments.

The first steps towards this federal model were taken early in 2007. An "Estate Level Abuse program" was introduced that allows estate owners to receive and resolve their own abuse reports in the method in which they best see fit.[11]

An interesting initiative to develop local governance comes from the Local Governance Study Group (2007a, 2007b). The LGSG has made a proposal for a 'bill of rights'/constitution (2007b) that outlines how 'governments/states' ought to be created, their (potential) powers, how they can levy taxes, possible offices of state, the possibility of holding elections, etc. The tools do not prescribe a particular type of governance, but leave this open to the founders, but do prescribe what each government should make public in order for visiting Residents to know what they're dealing with. Governments should have a name, flag or symbol, national anthem, indicate government type (monarchy, democracy), constitution, details about land and citizens and details about decision making and set out the rules of the land. According to the Tools, any parcel of land should be allied to one specific government or no government and clearly mark this.

A system of local governance could make rule enactment and enforcement more effective and could also increase the legitimacy of government. It allows for different kinds of estates to be created suiting the different needs of the participants:

"a large corporation buying a series of islands as a showcase for its products or services might want a system whereby misbehaviour on its lands can be punished by banishment without it having to do any of the hard work, but where it retains ultimate control; a commercial landlord might want a full-fledged system of civil law, including contract and covenant enforcement to entice serious businesses and consumers at once; a group of aspiring businesspeople and artisans wishing to start their own community and share resources might want a democratically elected local council; and an individual who wants an island for creating whimsical artistic follies might want no government at all." (LGSG 2007a)

Privacy in a Federal Second Life

Finally, let us take a brief look at the second question regarding governance: from the perspective of a right to privacy which governance model is desirable? As we have seen informational privacy has been addressed to some extent in Linden Law. Linden Law mainly addresses the individual dimension of privacy. The individual can submit abuse reports when their privacy has been breached by other Residents. Linden does address small-scale issues brought to their attention through the abuse reports, and their number seems to be fairly small anyway. They have not addressed larger issues either, such as the virtual detective agencies and the SLStats watch/site nor do they take an active role to protect Residents' privacy.

As previously stated, privacy issues exist both inworld and in the spill over effects between SL and RL. Inworld, the main issue is that individual players need to be able to define their own personal sphere. They should be able to control their identity and what they reveal thereof to other Residents in different contexts. SL should respect this and not implement mechanisms that undermine individual control. Furthermore, there should be clear rules describing the rights of the avatars in this respect. If breached, Residents should have means to seek remedies, obtain compensation for damages and offenders need to be punished. More important, however, seem to be privacy issues resulting from the spill over (bidirectional) between Second Life and the Real World because this affects the individual's real life. This requires even stronger measures on the architectural level and on the level of (legal) institutions and enforcement. Because these issues not only affect the individual, but also the (virtual) society, the responsibility to act lies with Linden. The social dimension of privacy, however is hardly developed in Second Life—the architecture of the game does not really value privacy—and all communication in Second Life is monitored. Linden has a God perspective on the environment and its Residents and can use this for every purpose it seems fit.

The current model of benevolent dictatorship is inadequate from the perspective of a right to privacy. Will local governance fare any better?

This will partially depend on the precise relation between the central level (Linden Law enacted and enforced by Linden Lab) and the private estates (local law enacted and enforced by local governments). Different models can be envisioned, just like in the real world. Linden Law could trump local law, just like federal law trumps certain state laws in the US. But one could also imagine Linden Law confined to restricted areas, much like the EU regulation is confined to common market domains, but refrains from substantive criminal law.

What will be the role of the current Community Standards? Would these provide the lowest common denominator or the maximum achievable (possibly not even applicable in all estates)? Given the current privacy climate on the Internet where corporations, by and large, treat customer data as assets, we would not be surprised to see a race to the bottom regarding privacy protection if local privacy regulation is left to the private estates. In this respect, it is important to know who will run the new 'governments' (in the LGSGs terms). Will commercial landlords put up lower privacy standards than citizen run 'governments'? My guess would be yes, but we will have to wait and see.

With respect to promoting and protecting privacy as a social value, LambdaMOO's main lesson, that social policy has to come from the top (Curtis, 2002), seems apt. In this light we would welcome Linden adopting the role of the global society's moral consciousness by providing a reasonable overall level of privacy protection in Linden Law which is binding to Second Life as a whole.

CONCLUSION

This chapter has illustrated some of the privacy aspects of Second Life. Privacy may, at first sight, seem to be unimportant because Second Life is, after all, 'just a game'. We have endeavoured to argue to that Second Life is more than a game. It is a synthetic world and a social microcosmos that can play an important role in individuals' social interaction. It supplements other modes of ICT-mediated interaction but seems to draw its users more into this experience. The permeability of the inworld-real world barrier makes the environment both an interesting area for the study of human behaviour and it urges us to take privacy seriously in relation to Second Life.

Second Life does not seem to favour privacy much on the architectural level and therefore special attention has to be paid to other modes of regulation. The environment is designed to support information sharing and collecting data about other Residents. Linden Labs as 'governor' of the game also does not seem to value privacy beyond the lip service paid in the ToS. The ToS and CS contain privacy provisions, but their enforcement is rather lax. Linden's resources are limited and Linden does not want to interfere in the game as a matter of principle. This may partially explain their passiveness towards privacy issues. An alternative explanation may be that the governance structure of the game is too immature; a non surprising conclusion that is even acknowledged by Linden Lab.

A change in governance structure has been set in motion. Local governance may contribute to a more mature governance structure and may offer means for Resident involvement in governance (democracy?) and for more serious governance instruments and institutions, such as police and a justice system. The Lindens can learn a great deal from real world theories and experiments with different forms of government, governance, and policy. Fundamental protection of rights such as privacy has to be endorsed by society at large and by the rulers that be. Linden Labs will have to play a role here not only by setting standards in Linden Law, but also by implementing necessary code.

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KEY TERMS

Information(al) Privacy: Being in a position to determine for [oneself], when, how, and to what extent information about [oneself] is communicated to others.

Audience Segregation: The ability to present different performances (in relation to presentation of self) to different audiences in order to maintain different relationships.

Governance: The use of institutions, structures of authority and even collaboration to allocate resources and coordinate or control activity in society or the economy.

Modalities of Regulation: Regulation can be accomplished by different regulatory instruments. Lessig distinguishes between: law, (social) norms, architecture and market. Architecture in cyberspace relates to the hardware and software that make cyberspace what it is, constitute a set of constraints on how you can behave. (L. Lessig, Code and other laws of cyberspace, 1999)

Linden Law: The Terms of Service and the Community Standards that govern the relation between Linden Lab and Second Life user, and therefore the behaviour of users within Second Life. Linden Law is contract law.

ENDNOTES

1 This chapter is based on Leenes (2008).

2 http://www.usatoday.com/printedition/money/20070205/secondlife_cover.art.htm

3 See for instance the interview in Reason, February 2005, with the author, http://www.reason.com/news/show/36481.html

4 http://secondlife.com/whatis/economy_stats.php states that there are 13.853.205 as of 1

June 2008, in the 7 days preceding this date, 458,171 Residents had logged into the virtual world.

[5] http://blog.secondlife.com/2007/10/19/new-search-currently-under-development/

[6] This does not mean that there is no privacy protection at all on the Internet. Within the EU, the Data Protection Directive 95/46/EC and its implementation in the member states, for instance offers protection against illegitimate processing of personal data, but the in-world privacy protection and instruments are much more direct and also more enforceable (see below).

[7] http://www.secretlair.com/index.php?/clickableculture/entry/hidden_virtual_world_prison_revealed/

[8] http://secondlife.com/community/blotter.php

[9] E.g., (Mistral, 2006a), or see issues of the sensationalist inworld newspaper AvaStar, http://www.the-avastar.com/slife/jsp/microsite/pages/index.jsp)

[10] See for instance, http://secondlife.reuters.com/stories/2007/01/26/interview-with-linden-lab-chairman-mitch-kapor-in-davos/

[11] http://blog.secondlife.com/2007/04/20/introducing-estate-level-governance/

Chapter X
Leadership of Integrated Teams in Virtual Environments

David Tuffley
Griffith University, Australia

ABSTRACT

This chapter introduces a process reference model of leadership for integrated teams operating in virtual environments. Geographically dispersed integrated project teams collaborating in virtual environments face many challenges in successfully completing projects, particularly if the teams are non-homogenous. These challenges have driven the development of more powerful and efficient collaborative technologies, that enable participants to better communicate. The need to support and develop leadership in the online setting is one of these challenges, representing a socio-technical gap between how integrated virtual teams use leadership and how technology supports it. The leadership model proposed here will be useful both to individuals desiring to lead in such online settings and those wishing to develop online systems that support leadership.

Leadership is the art of getting someone else to do something you want done because he wants to do it.

—Dwight D. Eisenhower (1988).

INTRODUCTION

Of the hundreds of quotes about leadership from all walks of life, this well-known one from Eisenhower seems to exhibit best, though perhaps not explain, the enduring enigma that is leadership. A manager may use authority to achieve compliance, but a leader finds a way to make the person want to do it.

Leadership has been observed and studied for countless generations, yet interestingly little consensus exists as to what true leadership is. Intense and on-going controversy exists between psychologists, sociologists, historians, political scientists and management researchers on this point (Yukl, 1994). No universally accepted definition of leadership has yet been developed.

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After thousands of empirical studies performed on leadership over the previous 75 years, no clear and unequivocal understanding has emerged as to how we can distinguish leaders from non-leaders (Bennis and Nanus, 1985).

Conventional wisdom maintains that leadership is an innate ability that natural leaders are born with, and which cannot be effectively learned. Another school of thought, typified by Peter Drucker (1996) and Warren G. Bennis (1994), maintains that leadership can indeed be learned; that in effect, leaders are made rather than born. This is an underlying assumption of this project,

Meanwhile, in the world of software development we have seen a growing commitment to defining the way to do the job as a process, as typified by Humphrey (2002). This systematization approach is reflected more broadly by W. Edwards Deming who is famously quoted as saying "If you can't describe what you are doing as a process, you don't know what you're doing." (2000). If we accept the basic proposition that leadership can be learned rather than only be received through inheritance, then it is logical to suggest that leadership can be described as a process, as suggested by Deming (2000).

BACKGROUND

The past 50 years have seen an ongoing proliferation of the global enterprise, organisations that transcend national borders and extend across the globe. This trend has led to the advent of distributed work environments and the formation of multi-disciplinary virtual teams (teams that operate across different time and physical space) to perform many projects across industries. And yet expertise in the coordination of virtual teams is emerging as a critical area of need for research.

The rise of the virtual project has driven the development of more powerful and efficient collaborative technologies that facilitate meetings. This technology includes information sharing, messaging and discussion forums, audio and video conferencing, as well as knowledge portals, business directories, webcams and other manifestations of groupware.

The efficiency of these collaborative technologies notwithstanding, the building of functional social networks in virtual environments can be challenging, particularly on an international scale.

In this context, the socio-technical gap can be described as being between the collaborative technologies and our ability to use them effectively.

One approach to the treatment of this socio-technical gap is to recognize that everything that occurs in a project is ultimately the responsibility of the project manager. Yet the term 'management' leaves out a vital ingredient; how to motivate diverse team members to want to perform to a high standard and achieve the project aims? It is leadership that is required. We therefore ask the question, what are the human factors involved with leading successful virtual teams? As technologists, we might have the technology that allows virtual teaming, but without a good understanding of the human factors involved with teamwork, and in particular the challenges of leading multi-disciplinary teams in a virtual environment, our efforts to operate globally will likely achieve only limited success.

The process reference model has a practical aim; to inform the practice of project managers of integrated teams in virtual environments to give them the means to achieve better project outcomes. It distinguishes leaders from managers in the sense that leaders know how to motivate people to perform, whereas managers direct people's activities and resort to coercive force when necessary. Managers can learn leadership skills, and these can be used for the benefit of all concerned.

Virtual Teams

Distinguishing Virtual Teams from Conventional Teams

Bell and Kozlowski (2002) quoting a widely cited earlier study by Townsend et al (1998) define virtual teams as:

Groups of geographically and/or organizationally dispersed co-workers that are assembled using a combination of telecommunications and information technologies to accomplish and organizational task.

Virtual teams can therefore be distinguished from conventional teams in two fundamental ways; their spatial proximity and the communications technologies employed. When contrasting Townsend et al's (1998) definition of virtual teams with that of conventional teams (Humphrey, 2000), we see that the Humphrey definition offers a good general purpose view of what a team is, that a team consists of:

1. At least two people, who
2. Are working towards a common goal/objective/mission, where
3. Each person has been assigned specific roles or functions to perform, and where
4. Completion of the mission requires some form of dependency among group members.

It might therefore be reasonable to combine these definitions in order to achieve an operation definition of a virtual team, as follows:

1. At least two mutually interdependent people, who
2. Are geographically dispersed, and who
3. Are working towards a common goal/objective/mission, where
4. Each person is assigned specific roles or functions to perform, and where
5. Communication is facilitated by a combination of telecommunications and information technologies to work towards the completion of the project/mission.

Leadership of Virtual Teams

The classical period of ancient Greece produced concepts and modalities that have become the foundation of western civilization. In relation to leadership studies the philosopher Plato (427-347 BC) in his renowned dialogue *The Republic* outlined certain enduring leadership principles that Western administrative thinking has based itself upon (Takala, 1998):

Until "kings were philosophers or philosophers were kings" there will be injustice in the world. (Plato)

Plato captures something of the essence of leadership in this quotation; power must be tempered with wisdom. If wisdom can be learned through reflection on experience, then perhaps leadership is a skill that can be learned and perhaps described in general terms as a process.

Summary of Empirical Studies of Leadership in Virtual Teams

Dube and Pare (2004) surveyed virtual team characteristics published in empirical studies. Misiolek (2006) used this as a basis for further investigation into leadership aspects of virtual teams. The combination of these two sources plus additional investigation results is given in the table below. It summarizes what is a very broad sweep of theoretical perspectives developed over time in these empirical studies. It is useful as an overview.

Using Design Research to Develop a Process Reference Model for Leadership of Integrated Virtual Teams

In a general sense, Design Research focuses on the development and the evaluation of the performance of (designed) artefacts with the explicit intention of improving the functional performance of the artefact. In this broad sense, a leadership process reference model is one kind of artefact whose creation is facilitated by the design research approach for the purpose of closing the socio-technical gap.

Design research is typically applied to categories of artefact including (but not limited to) algorithms, human/computer interfaces, design methodologies (including process models) and languages. Its application is most notable in the Engineering and Computer Science disciplines, though is not restricted to these and can be found in many disciplines and fields (Vaishnavi and Kuechler,2004/5). Such renowned research institutions as MIT's Media Lab, Stanford's Centre for Design Research, Carnegie-Mellon's Software Engineering Institute, Xerox's PARC and Brunel's Organization and System Design Centre use the Design Research approach (Vaishnavi and Kuechler,2004/5).

Vaishnavi and Kuechler (2004/5), quoting earlier work by Takeda et al. (1990) analyze the reasoning that occurs during the design cycle and illustrates it in the way seen below (Reasoning in the Design Cycle).

The design research process illustrated in the Design Cycle model above begins with an awareness of a problem that the researcher seeks to solve or otherwise improve performance of. The problem in this project is the apparent need for some kind of reference model to facilitate virtual team leadership.

Suggestions for improvement are abductively derived (inference to the best explanation) from the existing knowledge base, in this case the literature on teams and leadership is comprehensively reviewed and a tentative process reference model is developed according to the prescribed standard (ISO/IEC 15504 part 5) for doing so.

In the Development stage the draft Process Reference Model is tested and Evaluated to determine it's validity and serviceability, particularly in relation to its ability to be the basis for a Process Assessment Model.

Table 1. Characteristics of empirical studies of leadership in virtual teams (adapted from Misiolek, 2006; Dube & Pare, 2004)

Authors	Main research method	Theoretical perspective
Balthazard et al. (2004)	Lab experiment	Shared leadership; leadership style; transformational and transactional leadership
Cogburn et al., (2002)	Quasi-experimental field study	Behavioural; two-factor theory
Connaughton & Daly (2004)	Interviews	Implicitly behavioural
Hoyt & Blascovich (2003)	Lab experiment	Transformational and transactional leadership
Kayworth & Leidner (2002)	Field experiment	Behavioural; behavioural complexity theory; trust
Pauleen (2003)	Case study	General theoretical discussion
Pauleen (2004)	Interviews & 2 10-week action learning sessions + grounded theory analysis	General theoretical discussion with focus on relationship-building and trust
Piccoli & Ives (2000); Piccoli et al. (2004)	Field experiment	Team control structure; self-managing teams
Sarker et al. (2002); Nicholson et al. (2002)	Field experiment	Emergent leadership; propose new theoretical model incorporating culture, communication, technical ability, trust, gender, performance, and client location
Sudweeks & Simoff (2005)	2 case studies	Behavioural; implied two-factor theory; emergent leadership
Tyran et al. (2003)	Field experiment	Behavioural; two-factor theory; emergent leadership
Weisband (2002)	Field experiment	Behavioural; two-factor theory; group awareness
Yoo & Alavi (2004)	Field experiment + grounded theory analysis of transcripts of team interactions	Behavioural; two-factor theory; emergent leadership

Development, Evaluation and further Suggestion are re-iterated through multiple cycles in which the draft Process Reference Model is tested in various different organizations and contexts.

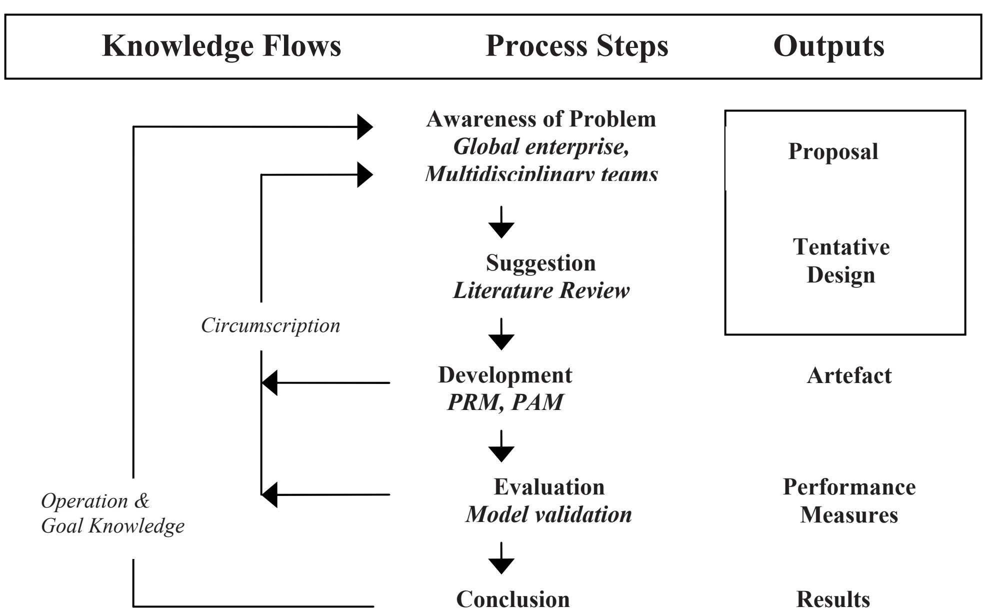
Circumscription feeds information back into the awareness stage that could only be derived through the specific act of process reference model construction.

Process Reference Model for Leadership of Integrated Virtual Teams

The process reference model is derived from a Design Research project (as described in previous section). The project was informed by a broadly-based review of the literature relating to leadership, covering the literature of software engineering, organizational psychology and management. The process reference model focuses on the human factors that a leader must embody and practice when operating integrated virtual teams. The model is segmented into three sections; generic leadership principles (applicable to any team), factors specific to integrated (multi-disciplinary) teams, and factors specific to virtual teams, as seen below.

1. **Generic Leadership Skills**. A generic set of leadership skills/qualities that will apply in both face-to-face and virtual team environments. This generic set is identified and distilled from the wealth of leadership research over time.
2. **Specific examples of practices for integrated teams.** The integrated teaming goals and practices of the relevant literature constitute leadership criteria by default in the sense that someone has to give effect to them, and that will be the responsibility of the leader.
3. **Specific Virtual Environment Challenges for Leaders**. The virtual teaming challenges outlined by Bell & Kozlowski will be met by an effective leader. These factors have been hypothesized by Bell & Kozlowski (2002) as being specific factors influencing the success of virtual team leaders.

Figure 1. Adaptation of general methodology of design research for this project (Vaishnavi and Kuechler, 2004/5, Takeda et al 1990)



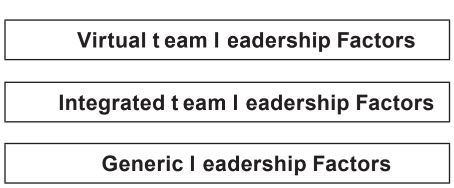
Discussion of how these specific virtual environment challenges are dealt with is included in this section. It is not provided for the integrated teams section or generic leadership sections due to space limitations. The discussion is preceded in each instance by the phrase "In practice," and is displayed in italic font. The information is derived from interviews with project managers from four different multinational organizations operating virtual teams and may prove of interest to a socio-technical audience.

Generic Leadership Personality Factors

The generic leadership factors have been derived from a wide ranging literature review, too numerous to mention here. The most significant contributions have been from Bennis, Beiderman and Nanus (various dates), Peter Drucker (1996), Capozzoli (1998), Cusick (1997), Taninecz (1996), Potts and Catledge (1996).

1. **Create Shared Vision**. Ability to perceive a guiding principle/idea that captures the imagination of members to create a shared vision and inspire them to realize that vision. The shared vision is a clear and unambiguous expression of an envisioned future. It is the basis for a common understanding among stakeholders of the aspirations and governing ideals of the team in the context of that desired outcome.
2. **Communicate shared vision to create optimism**. Ability to communicate this shared vision to create optimism in members. This communication can take many forms in day-to-day practice but conveys an expectation of high standards. An aspect of charisma. Inspirational motivation, optimism, individualized consideration and contingent reward all appear to optimize team performance by creative a positive affective climate.
3. **Display Integrity/good character**. Ability to act with integrity and honesty, to act consistently over time in pursuit of the shared vision, regardless of set-backs. It is a form of principle-focused leadership that creates a climate in which team members can rely on a leader to act according to guiding principle rather than exigent circumstances. Involves doing the "right thing" when it is easier not to under the circumstances.
4. **Create Trust**. Ability to generate and sustain trust. Trust can be defined as confidence in someone or something. In terms of project groups we can make a distinction between bilateral trust between individual group members (one-to-one trust) and general trust (one-to-all) in the project group.
5. **Action-oriented**. Inclined towards action, risk-taking, curiosity. Action-oriented leaders are able to overcome the inertia and disincentives that reside in situations that others might succumb to. Action-orientation is particularly relevant in goal-frustrating situations when others might give up.
6. **Accepts responsibility**. Accepts ultimate responsibility for events even if others appear blameworthy. Requires the courage to accept the truth/reality of a situation. Requires the courage to accept the truth/reality of a situation, even when it is unpleasant. Effective leaders accept that the circumstances in which they find themselves are largely the result of their own previous actions. They do not blame others (Macaluso, 2003).
7. **Individualized consideration**. Deep concern for the well-being of individual members. Team members recognize that the leaders to some extent know them as an individual. The antithesis of this is a team member who feels that the leader regards them as expendable, as "cannon fodder".

Figure 2. Process reference model architecture; high-level functional view



8. **Original thinking**. Stimulates members to think in original ways, emphasizing the triumph of reason over irrationality, and challenging established ways of thinking. Original (creative) thinking can lead to solutions that elude conventional thinking. Persistent problems often require new ways of thinking. Original thinkers are not so influenced by the opinions of those that say "it cannot be done", they are more likely to think "we haven't thought of a solution yet". It is to be free from the restraints of tradition - the "wisdom of the ages" that can sometimes be a straightjacket for the mind.
9. **Resilience**. Ability to maintain an enthusiasm for goal realization, regardless of set-backs. Leaders are more likely to develop resilience when their guiding vision (that they have communicated effectively to the group) is sufficiently strong to supersede the alternative situation that has been imposed on them, and which threatens the realization of the goal. It is having the integrity of character to remain true to the original goal in the face of adversity.
10. **Conceptual ability**. Ability to conceptualize abstractly in a broad sense. In more narrow sense, has ability to understand technical issues at least at the conceptual level. Abstract conceptualization allows a leader to mentally manipulate abstractions in problem-solving, efficiency-enhancing ways. This ability is related to the ability to create a unifying vision for the project, which can be seen as a higher level abstract conceptualization skill.
11. **Empathy**. Ability to empathize, to see the world through other people's eyes. Empathy is distinct from sympathy. Sympathy involves becoming emotionally attached to people and outcomes, whereas empathy is dispassionate, non-judgmental. An analogy from the medical domain is that of a doctor using empathy to accurately understand a patient's condition/situation. The doctor cannot sympathise with the patient, unless they are to risk becoming overwhelmed by the suffering they encounter in the course of a day.
12. **Judgment**. Ability to exercise good judgment. Good judgment is a fundamental ability that informs almost all of a leader's activities. It is the foundation of appropriate action. Good judgment is conditional upon a rational, objective mind-set in which people, objects and events are viewed realistically for what they are in any particular set of circumstances, rather than relying on stereotypes and prescribed understandings to guide action.
13. **Self-worth & competence**. Ability to make members feel valued, competent and effective in their role, so to avoid feelings of frustration, disillusionment, anger and betrayal. A key aspect of encouraging a sense of self-worth and competence in group members is to avoid over-regulation. By nature people do not react well to over-regulation. The human species has evolved in a chaotic environment where conditions vary from one day to the next and survival depends on swift adaptation to change.
14. **Rewards desirable performance**. Team behavior that works towards realization of goal (shared vision) is rewarded. In behavioural psychology terms, this implies positive reinforcement for desirable behaviour. A common mistake is to take desirable performance for granted, effectively ignoring it, while taking action to punish when undesirable performance occurs. While necessary to do the latter on occasion, it must be remembered that the leader's attention is a reward in itself and adopting a reward for desirable performance approach shows significant benefits.
15. **Management by exception (passive)**. Adopt a laissez-faire attitude until non-compliance of standards has occurred. The "reward desirable performance" process notwithstanding, under some circumstances, it is appropriate to operate on a management by exception basis. This laissez-faire, passive approach is appropriate when a member is expected to act independently, with a degree of autonomy. The member might be a sub-contractor who

maintains a professional approach to his/her work and can be relied upon to perform professionally and to a high standard.

Integrated Team Leadership Factors

The Capability Maturity Model (Integration) (CMMI) is a software engineering process model developed over several decades by Carnegie-Mellon University's Software Engineering Institute. The CMMI's Integrated Product and Process Development (IPPD) addition contains detailed material in relation to integrated teaming without mentioning much about leadership specifically. And yet, when the nature and scope of this material is examined, it becomes apparent that much of this IPPD material describes de facto leadership practices in the sense that they are activities that must be performed. In the normal course of events, it is the leader that is responsible for making sure these activities are performed.

It should be remembered that the CMMI-IPPD was derived from the IPD-CMM (Integrated Product Development Capability Maturity Model) developed by Suzanne Garcia (1997) of the Software Engineering Institute in the 1990's. IPD-CMM itself derived from Concurrent Engineering from the 1980's, which can trace its origins all the way back to the late 19th Century in the United States. The point of relating this chronology is to indicate the strength and practical value of CMMI-IPPD, being the accumulated wisdom of several generations of engineers undertaking projects of an often distributed nature.

What follows is an adaptation of the goals and practices from CMMI-IPPD to have a leadership-orientation.

1. Establish the project's work environment by creating an environment in which all virtual team members use (preferably broadband) two-way communications media. Team members must be in a position to communicate with each other in ways that approximate normal face-to-face interactions. This implies that voice-only telephone and email are insufficient for this purpose. Video telephones and/or web-cam based audio-visual channels that deliver frame-rates that replicate natural movement and speech would be desirable.
2. Establish the project's shared vision by understanding and communicating to team members the mission, goals, expectations and constraints of the project in a way that creates a sense of common purpose and enthusiasm. In terms of integrated teams, the following factors should be considered:
   - external stakeholder expectations and requirements
   - the aspirations and expectations of the project leader, team leaders, and team members
   - the project's objectives
   - the conditions and outcomes the project will create
   - interfaces the project needs to maintain
   - the visions created by interfacing groups
   - the constraints imposed by outside authorities (e.g., environmental regulations)
   - project operation while working to achieve its objectives (both principles and behaviors)
3. Establish the integrated team structure by considering the nature and scope of the project to arrive at an appropriate team structure (dynamic, adaptable to emergent circumstances). Factors influencing appropriate team structure include product requirements, cost, schedule, risk, resource projections, business processes, the project's defined process, and organizational guidelines are evaluated to establish the basis for defining integrated teams and their responsibilities, authorities, and interrelationships.
4. Allocate requirements to integrated teams by assigning requirements, responsibilities, tasks, and interfaces to teams in the integrated team structure. This allocation of requirements to integrated teams is done before any teams

are formed to verify that the integrated team structure is workable and covers all the necessary requirements, responsibilities, authorities, tasks, and interfaces. Once the structure is confirmed, integrated team sponsors are chosen to establish the individual teams in the structure.

5. Establish integrated teams within the larger team structure (team leaders and members assigned, team charter established, resources allocated). Integrated teams within the integrated team structure are established by the team sponsors. This process encompasses choosing team leaders and team members, and establishing the team charter for each integrated team based on the allocation of requirements. It also involves providing the resources required to accomplish the tasks assigned to the team.
6. Ensure collaboration among interfacing teams by creating an environment of collaboration, informed by the shared vision, facilitated by communications technology and brought together by the leader with the help of interface control working groups. The success of an integrated team-based project is a function of how effectively and successfully the integrated teams collaborate with one another to achieve project objectives. This collaboration may be accomplished using interface control working groups.
7. Establish empowerment mechanisms that allow team leaders and members to recognize clear channels of responsibility and authority. These mechanisms shall avoid situations where people assume too much or too little authority and when it is unclear who should make decisions.
8. Establish rules and guidelines for integrated teams by maintaining a clearly defined set of criteria for structuring and forming integrated teams. Operating rules and guidelines for the integrated teams define and control how teams interact to accomplish objectives. These rules and guidelines also promote the effective leveraging of the teams' efforts, high performance, and productivity. Integrated team members must understand the standards for work and participate according to those standards.
9. Balance team and home organization responsibilities by having clear guidelines for how members can balance their team and home organization responsibilities. A "home organization" is the part to which team members are assigned when they are not on an integrated team. A home organization may be called a "functional organization," "home base," "home office," or "direct organization." Home organizations are often responsible for the career growth of their members (e.g., performance appraisals and training to maintain functional and discipline expertise).

Leadership Challenges in Virtual Environments

The leadership challenges for leaders of virtual teams are described in some detail, and includes preliminary findings from the validation exercise in which project managers of complex virtual teams from four different multinational organizations that operate integrated virtual teams are asked what they do in relation to a particular team process, and what if any artefacts exist to provide objective evidence of process performance.

1. **Recruit required expertise for virtual team.** Ability to recruit suitably structured and resourced virtual teams to realize complex project outcomes. Virtual teams are usually comprised of geographically dispersed members, allowing for a broad base of potential expertise to be drawn upon when assembling a virtual team. This is particularly true when the task to be performed is a complex one.
   In practice, international organizations have HRM resources indicating availability of suitably skilled people. Where required skills are not available internally, such organizations often have sub-contracting arrangements with external recruitment agencies. Informal

networks also may be accessed. Increasingly, networking sites like FaceBook and LinkedIn are being used as revealed by anecdotal discussion with interviewees.

2. **Provide synchronous, information-rich channel(s) of communication.** Ability to devise synchronous, richly-textured communications media to enable virtual teams to communicate as if face-to-face. Technological mediation is essential to bridge the gap created by geographical distance, in order to create a substitute for face-to-face communication between team members. Such mediation must be synchronous and richly-textured in the sense of being able to replicate the richness of face-to-face communication to an acceptable degree. Email and telephone is not sufficiently detailed with communicational nuance. Videoconferencing with a frame-rate of more than 15 frames per second (fps) would be a minimum.
   In practice, video-conferencing and net meetings are used to facilitate real-time meetings. Recognition that there is still no substitute for face-to-face meetings, revealing the short-comings of exiting virtual meeting arrangements. Project managers say they begin projects with face-to-face "getting to know you" meetings that are repeated perhaps every six months, supplemented by the currently available virtual meeting technology.
3. **Devolve leadership functions to team.** Previous point notwithstanding, ability to devise structures and routines that provides alternatives to and substitutes for face-to-face contact. The leader overcomes the difficulties of performing key leadership functions when not able to communicate face-to-face by creating technologically mediated structures and routines that substitute for face-to-face contact. In this way, leadership functions are distributed to the virtual team that is then able to become more self-managing as a result of this devolution of leadership functions.
   In practice, self-managing teams and the formalized delegation of assignments and roles are used by the project managers interviewed. Recognition that the "micro-management" approach of the past is maladaptive in the current environment, at least in many instances.
4. **Perform complex tasks in real-time.** Ability to devise suitable ways for virtual teams to operate in real-time (related to point 2 above). Complex tasks become very difficult to perform when intensive, reciprocal interaction between virtual team members is required. The time-lag between action and response becomes impractical. Simpler tasks may be feasible to perform in distributed time where the workflow arrangements become less dynamic and more sequential.
   In practice, there is recognition and agreement that complex tasks are best performed in real-time at least to the extent allowed by circumstance and technological support. Project schedules and deadlines were cited as pressing reasons to perform most tasks in real-time.
5. **Manage team boundaries.** Ability to devise operating procedures that are conducive to stable relationships resulting in less-permeable team boundaries. Managing team boundaries in a condition which allows complex tasks to be performed by integrated teams requires that the boundaries be in a condition that allows defined operating procedures and stable relationships to be maintained. This implies that the boundaries are less malleable over the course of the project lifecycle. Simpler tasks may be more tolerant where people move into and out of the team and where explicit operating procedures are less critical.
   In practice, team boundaries are "managed by creating a broad vision" (in one case). By this is meant that the leader creates the guiding vision or "big picture" and by assigning clear roles and gaining commitment to the vision, team boundaries are likely to manage themselves. This process occurs as a consequence of the guiding vision.

6. **Establish and maintain stable team membership.** Ability to devise ways of promoting stable team membership, particularly in relation to complex projects. Complex tasks require more stable team membership to enable the virtual team to achieve the projects objective(s). Less complex tasks may be more tolerant to dynamic team membership.
   In practice, stability of team membership is promoted through the manager finding ways to make team-members feel valued, appreciated. Beyond this, having clearly defined roles, which implies team-members having authority to make decisions relevant to their role, also promotes stable team membership.
7. **Define roles and perform tasks synchronously.** Ability to devise clearly defined singular roles, particularly in relation to complex projects. While virtual team members may on occasion perform multiple roles, it becomes increasingly important that roles are clearly defined when the task complexity increases, and the work is done synchronously. Rigid role definition becomes less important when the tasks are simpler, particularly when the tasks can be performed asynchronously.
   In practice, complex tasks require clearly defined roles, as previously discussed. One manager observes that not all roles need to be defined, only the key roles. This is part of the "manage by creating a broad vision" approach discussed above in which autonomy of team members is promoted by allowing some latitude for how tasks will be performed.
8. **Establish performance management functions to compensate for temporal distribution.** Ability to devise proactive performance management functions, AND be good at using technology to provide members with team development experiences. Where temporal distribution degrades the quality of the information that a leader normally uses to carry out performance management, compensatory measures should be established that (a) allow team members to effectively manage their own performance, and (b) have an anticipatory element that helps team members to avoid potential problems and adapt to changing environmental conditions.
   In practice, performance management is achieved by self-managing teams who have a common understanding and agreement as to what will be done by when and by who.
9. **Establish team development practices, facilitated by rich-texture communications technology, in response to real-time requirement.** Ability to devise effective member self regulation mechanisms, AND be able to manage the greater difficulty of implementing these across multiple boundaries. Team development activities that promote coherence are likely to be more important when the virtual team operates in real-time. Virtual team leaders need to be adept at identifying appropriate technology to facilitate the necessary degree of team coherence to achieve success.
   In practice, neither project managers had any specific input on this process beyond a general statement about looking for what is working well and reinforcing this in the future. Where richly-textured ICT is freely available to virtual teams, team-development practices are likely to evolve over time in response to the specific ongoing needs. In other words, it is an evolutionary process that requires the presence of the ICT substrate.
10. **Establish effective self-regulation functions across multiple boundaries.** Ability to devise critically important team development opportunities, particularly in relation to developing positive relationships in a complex project environment with a discrete life cycle. Where virtual teams cross multiple boundaries (in terms of culture, organization and specific job functions) it is important for leaders to carefully assess the nature of these boundaries and to determine how best to tailor performance management for individual team members given the nature of the differences.
    In practice, self-managing teams achieve the

establishment of self-regulation functions to some extent through having global and local policies that provide a guide to action for team members acting at both levels of operation. Policies do not, it is conceded, go far enough in the creation of team development opportunities, particularly those that foster the development of positive relationships. Richly-textured ICT available on demand may serve to spontaneously provide such opportunities.

11. **Establish unique team culture where team spans multiple boundaries.** Ability to devise multiple roles for members in ways that avoid role ambiguity and conflict. Teams that span diverse functional, organizational and/or cultural boundaries will have poor cohesion unless the leader works to establish a common culture that is a blend of each member's individual culture. From this basis of common culture, team cohesion can be established and cultivated in a way that develops mutual respect, trust and reciprocity (mutual obligation).

    In practice, the explicit creation of a blended team culture spanning diverse functional and ethnic backgrounds is not being performed by the project manager interviewed, however it is speculated that this activity would be facilitated by frequent face-to-face and richly-textured virtual meetings. But contact with each other is not sufficient, there needs to be a compelling reason, even a sense of danger, or mission to galvanize team members to breaking down the walls of their reserve long enough to bring about a newly blended culture.

12. **Establish operating procedures to allow members to regulate their own performance.** Ability to devise ways of managing team members with multiple roles, particularly in relation to complex projects. In the same way as team members who have known each other for some time find it easier to work together, so too does a leader find it easier to lead when he/she has been doing so for some time and is familiar with the team members. In this situation, the leader is able to establish goals, structures and norms that help to regulate performance. Deviation from these can generally be recognized. On the other hand, with shorter-term, discrete lifecycle projects, it is more difficult to establish these regulating mechanisms since they tend to take time to develop. It is important for the leader to create these mechanisms early in the lifecycle rather than wait for them to develop.

13. In practice, virtual teams in which members have multiple and/or complex roles have a clear need for a set of guiding principles that constitute a guide to action in any given situation. This is achieved through the cultivation of self-managing teams. When a team member thinks for him/herself and have clearly defined deliverables, they devise their own micro-level operating procedures that are necessarily consistent with the macro-level procedures as defined by the project manager.

A Socio-Technical Environment Perspective

An alternative and perhaps a more evolved way to view the process reference model is to take an environmental (in contrast to the functional) perspective, as seen below. Leadership factors apply to the following five environments; Individual, Project, Organizational, Socio-cultural, and International. The environments are nested concentrically, as seen in the figure below.

Leadership factors from the Process Reference Model can be re-assigned from a functional level to an environmental level, and additional factors may possibly be recognized in this more evolved architecture. This alternative view may offer greater flexibility in how the Process Reference Model is understood and applied, particularly from a socio-technical perspective in the sense that it explores the dynamics of the relationship between people and technology in the conduct of IT development projects. It connects the project team (a socio-technical

Figure 3. Process reference model architecture; environmental view

system in itself) with the larger complexities of the organization in which it functions, the socio-cultural environment and ultimately the internationalized global environment in which the technology is often to be used.

CONCLUSION

Effective leadership of virtual teams in tomorrow's world will be facilitated by increasingly rich communications media enabling people to collaborate as though they were in the same physical location. Broadband communications technologies (such as next generation wireless and fiber optics) coupled with the declining real-cost of computing power promises to create virtual environments rich enough with subtle detail to make it seem as if we are physically present with others. The commercial potential for the development of such technologies is high, ensuring a vibrant and competitive market for such products. Rising fuel prices, declining oil stocks and greenhouse gas-causing global warming will all drive the development of technologies that enable virtual work, educational and recreational environments. The development of these technologies is not just a commercial opportunity; it is a response to the fundamental human need to communicate and create social networks. This instinctive need lies deep in human nature and will likely drive the further development of high-performance virtual environments far into the future.

The development of high-performance virtual environments notwithstanding, the qualities of a good leader remain constant, whether they operate in co-located space or in virtual space. The challenge for the leaders of tomorrow will be extended beyond the possession of generic leadership skills to the ability to negotiate successfully with these emerging technologies and create successful leadership practices. Such qualities are arguably an extension of the same qualities displayed by effective leaders throughout history. Indeed, the human capacity to create a functional common understanding when engaged in group endeavors is a defining aspect of the human species. It is arguably responsible for our phenomenal success as a species.

The process reference model described in this chapter is aimed at identifying and classifying these necessary skills into the three broad categories of generic, virtual and integrated team leadership skills. The process reference model is presented in the standard process reference model format used in the software process improvement domain of software engineering (for example ISO/IEC 15504 or SPICE and the Capability Maturity Model Integration) to maximize the ease with which the leadership model can be implemented by groups already using these established process reference models to support their projects.

The process reference model represents an overlapping of the socio-technical and software engineering domains. This latter is oriented towards the technical process and could benefit from an improved understanding of the human factors involved in technology development that is afforded by the socio-technical approach.

In an evolutionary sense, we are at a significant threshold. We are making the transition from operating in a physical environment only, to operating in a hybrid physical-virtual environment, with the trend towards increasingly virtual environments. Over millions of years, we humans have evolved the ability to live in a wide range of physical environments. We have adapted to conditions from the Equator to the Poles, and now beyond into space. It is our unsurpassed tool-making abilities that have enabled this expansion, and our technology is yet another tool at our disposal. But learning to live happy, healthy, effective lives in this hybrid reality may be a greater challenge than just inventing the technology. The leadership process reference model presented in this chapter is designed to both help produce the kinds of technologically-savvy leaders needed for a brave new online world, and also provide a basis for technical designs that support leadership.

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KEY TERMS

CMMI® Capability Maturity Model Integration as developed by SEI, see below)

Co-Located Team. The members are located in the same physical location, as opposed to "virtual".

IPPD. Integrated Product and Process Development (a CMMI body of knowledge)

Integrated Team. A group of people with complementary skills who collaborate to deliver specified work products. An integrated team may be either co-located or distributed. Contrast Virtual Team (below).

Process Reference Model (PRM). In accordance with ISO/IEC 15504:2006, a definitive set of descriptions of process entities that will later be assessed and so measured. PRMs provide an agreed terminology for process assessment.

SEI. Software Engineering Institute, Carnegie-Mellon University, Pittsburgh, U.S.A.

Virtual Team. Group of geographically and/or organizationally dispersed co-workers that are assembled using a combination of telecommunications and information technologies to accomplish and organizational task.

Chapter XI
Recontextualising Technology in Appropriation Processes

Monique Janneck
University of Hamburg, Germany

ABSTRACT

For a technology use to be successful, the circumstance of its introduction into a use context—or recontextualization—is crucial. The users of a technical artifact play an active role in this process: They appropriate the technology, that is, they explore a new technology and choose how to integrate (or not integrate) it into their practices and (work) routines. This chapter discusses a variety of factors that influence technology artifact appropriation. It illustrates the process of recontextualizing technological artifacts, and common pitfalls associated with it, as well as the protagonists doing the appropriation. For empirical illustration, case studies from different use contexts are presented, including some "lessons learned" drawn from them. Concluding, further research perspectives and challenges are discussed.

Life is what happens to you while you're busy making other plans.

—John Lennon

INTRODUCTION

Imagine the following scenario: *XNET is a virtual organization consisting of several individual and small-to-medium-sized enterprises in the consulting business. To strengthen their market position, the business partners venture for joint acquisition of customers and projects. Since the individual partners reside and work distributed geographically, they decide to establish a knowledge management system and intranet to enhance communication and information flow. After examining several options, a widely used off-the-shelf software product is chosen, which nevertheless allows for customization. A task force is installed that produces checklists, guidelines, and proposals for use. They also offer*

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individual support and regularly monitor use. As the intranet turns out to be barely used, another software product is chosen and installed with quite some effort but equally low success, causing quite a bit of frustration. Finally, as part of a research project, a third groupware system is developed according to the network's needs, but, usage reports remain disappointing. There are almost no contributions besides those posted by a few active network members, trying to foster use. The other members seem to mostly ignore the system, preferring communication via e-mail or face-to-face—just like they did before the new software was introduced.

This scenario has not been made up; it was adapted from a research project on technology development and use for virtual organizations (Janneck & Finck 2006a, b, Janneck, Finck & Obendorf 2006, Finck & Janneck 2008). It is a common experience that new technology—especially information technology—is not used as expected, less than expected, or even not used at all (cf. Huysman et al. 2003, Ciborra 1996, Orlikowski 1996, Bossen & Dalsgaard 2005). This is often a frustrating experience: Apart from not achieving the intended benefits, possibly pricy investments are lost.

To ensure usability and suitability for the use context, state-of-the-art software engineering approaches stress the importance of involving users in the design process, e.g. participatory design (PD) or prototyping methods. Nevertheless, software engineering methods and research focus mostly on the phase before new information technology is put to regular use, which has been termed *decontextualization* phase (Krause, Rolf, Christ & Simon 2006, Simon, Janneck & Gumm 2006, Sesink 2003). However, for successful software support, the circumstances of its introduction into a use context and the development of use practices are equally crucial—a process analogously understood as *recontextualization* (Krause et al. 2006, Simon et al. 2006, Sesink 2003).

The recontextualization phase is accompanied by user activities known as *technology appropriation* (cf. Orlikowski, Yates, Okamura & Fujimoto 1995): Appropriation is "the process by which people adopt and adapt technology, fitting them into their working practices" (Dourish 2003). Thus, technology appropriation is an active endeavor of users who explore new technologies and choose how to integrate them into their lives. Appropriation might change technology (use): People might decide to use it differently than intended by the developers (maybe inventing highly creative ways of "misuse"), or not to use it at all. They might also decide to alter the technology itself, for example by changing the preset configuration of functions or modes of display—an activity known as *tailoring* (cf. Pipek 2005).

Appropriation can be an individual as well as a cooperative activity, with groups of users discussing and negotiating terms of usage. For groupware use in cooperative working and learning scenarios, collaborative appropriation has been described as an important success factor (cf. Huysman et al. 2003, Pipek 2005).

Appropriation is closely tied to organizational change (cf. Wulf & Rohde 1995, Orlikowski & Hofman 1997, Balka & Wagner 2006): Introducing new technology to organizations always brings about changes in work practices, and often also in organizational structures and roles. Mastering such changes is often mediated by appropriation activities: On the one hand, implications of technology use might not become apparent until people actually start using it. On the other hand, providing support for the use of new technology can help to increase acceptance for changes accompanied with it.

In the following sections, several theoretical perspectives on appropriation will be explored, illustrating the *process* of *recontextualizing* technological artifacts as well as the *protagonists* doing appropriation work.

For empirical grounding, two case studies will be presented to illustrate the process and protagonists of technology appropriation in two different settings.

A further section discusses some 'lessons learned' that can be drawn from the case studies and implications for sociotechnical systems design.

Concluding, further research perspectives and challenges are discussed.

Empirical Cases

The following empirical cases are used throughout the chapter to illustrate the theoretical approaches with practical examples.

Case A is taken from research on computer support in educational settings, describing the use of a community system in college courses (e.g. Pape, Janneck & Klein 2005, Pape, Bleek, Jackewitz & Janneck 2002, Janneck 2007). Case B illustrates the introduction of a groupware platform in a self-organized vocational network (Janneck & Finck 2006a, b, Janneck et al. 2006). Case A especially exemplifies typical appropriation phenomena; case B focuses on the activities of mediators. In-depth descriptions of results can be obtained from the literature cited.

Examples from the empirical cases are set in *italics* in the following sections.

Case A: Software use in Educational Settings

As part of research on computer supported collaborative learning, the introduction and use of educational software in college courses (across a variety of different courses, didactical designs, and fields of study) was investigated over several years, using a triangulation approach combining quantitative and qualitative methods like interviews, questionnaires, and log file analysis (e.g. Pape et al. 2005, Janneck 2007).

Furthermore, the usage of a web-based student platform, serving as a medium of communication, information sharing, and support for about 500 student members, was investigated over several years, including an in-depth interview study. This platform was not a part of the university's official e-learning infrastructure, but was initiated, established, and administered by the students themselves (Rohde, Reinecke, Pape & Janneck 2004).

The research results presented in the following sections were identified as crucial factors of software use in educational settings. Yet, they also exemplify common phenomena of technology appropriation that can likewise be observed in other contexts of use.

Case B: Collaboration Support in a Vocational Network

As part of a software development project, the introduction and use of collaboration support within a vocational network was investigated over several years (Janneck & Finck 2006a, b, Janneck et al. 2006, Finck & Janneck 2008). As in case A, research methodology involved qualitative methods like interviews and observations as well as a questionnaire study. The software development project followed a participatory design approach, involving users intensively in all development phases (Janneck et al. 2006).

The network in question had been founded as a pool of freelance IT and management consultants to exchange experiences, knowledge, and work results, offering its approximately 20 members a variety of services such as vocational training and exchanging business opportunities. The network is completely self-organised without formal hierarchies or roles, thus relying on its members' involvement and commitment. Financial resources are scarce. Software support is deemed necessary to keep the network members in touch, to handle customer projects, and for central storage of documents.

In the past, several project management systems had been tested within the network before the research group got involved. However, with each of them, the usage turned out to be unsatisfactorily low. The network members blamed this on the respective software, which they regarded as unsuitable for their tasks. Therefore, a new groupware system was developed to suit the network's needs. Even though the necessity of software support was unquestioned within the network, technology appropriation turned out to be difficult, and again, the new system was barely used except by a small group of core members.

In the following sections, case B will be used to illustrate crucial factors of appropriation success—or failure.

The Process: Recontextual IS - ing Technological Artefacts

The process of bringing technology into use has been termed *recontextualization* in opposition to the *decontextualization* that takes place when human and organizational actions and practices are formalized and 'translated' into algorithms computers can execute (e.g. Krause et al. 2006, Simon et al. 2006, Sesink 2003). Sesink (2003) and Crutzen (2001) also use the terms "deconstruction" and "reconstruction" (or even "destruction" and "construction") to make clear that building technological support for human actions does not merely add to existing practices, but rather "destroys" them and replaces them with something new. May the consequences be positive or negative: In any case, computer-supported activities will not be the same as they were without technological support, and they may have an impact on other practices or structures that cannot be foreseen.

In their work on interdependencies between information technology development and use, Rolf and colleagues (Krause et al., 2006, Simon et al., 2006) argue that the challenge of software development is not only to write correct code, but also to integrate new technology into its social and organizational context (cf. the debate initiated by Dijkstra (Denning, 1989)). However, in practice technology development usually focuses on the decontextualization phase. Even state-of-the-art software engineering methods emphasizing the importance of prototyping, cyclical development, and the involvement of users in the design process (e.g. Floyd 1993) seldom provide precise methods for introducing new technology within a (work) context and moderating its use and the change of other (work) practices in the medium term, nor do they address possible recontextualization problems during technology development (cf. Gumm & Janneck 2007).

During the recontextualization phase, a variety of conflicts may emerge (Krause et al., 2006). They can be attributed to several common factors:

Restrictions due to formalization. Formalizing human action for software support often goes along with increased standardization. While this might help to make work processes more efficient and transparent, it might also decrease flexibility that is needed to cover irregular and unpredicted exceptions (cf. Rolf 2008). To describe the limits of formalization, Rolf and colleagues speak of so-called *interim* and *mandatory formalization gaps* (Krause et al. 2006, Simon et al. 2006): The interim formalization gap describes routines that might possibly be automated, but have not been yet for economical or technical reasons. The mandatory gap, however, describes activities that cannot be processed without a high degree of flexibility and should be automated very carefully or not at all.

For example, in case B, network members were required to provide standardized profiles of their professional experience and qualification on the platform. However, quite a few members had substantial problems relating the standardized input fields to their individual CV and expertise. As a result, a number of profiles were useless or missing altogether. Even though some standardization in data input is useful in terms of comparability and also to ease data recording and retrieval, allowing for some variability would probably have increased data quality and comprehensiveness in this case.

Objecti. cation of (hidden) structures. Formalizing existing practices as part of technology development processes can upset contexts and actors by shedding light on (organizational) structures, processes, relations, and hierarchies that were kept in the dark before. The resulting conflicts are not due to the technology itself, but the technology helps to uncover them (cf. Finck & Janneck 2008).

In the vocational network investigated in case B, informal hierarchies within the seemingly flat network organization became apparent when the groupware system was introduced and hierarchical access rights had to be assigned to its members. This caused substantial upheaval concerning roles and power distribution.

Emerging new structures. However, new technology does not only serve to objectify existing structures, it also almost inevitably leads to the establishment of new structures and routines (cf. Finck & Janneck 2008). As a result, people might have to change their habits and (work) processes or experience a change of position or reputation, with some stakeholders benefiting and others experiencing drawbacks.
In case B, handling documents electronically raised new issues of privacy and commission charges for the re-use of materials that might be of economical value. This issue had not been virulent before, because paper-based or even handwritten documents were perceived as to hard to copy to actually re-use them.

Recontextualization in a different context. Especially regarding standard or off-the-shelf software, decontextualization and recontextualization do not take place exactly in the same context: The software is implemented for an abstract or idealized use purpose that may vary greatly from its actual use. Therefore, it is often difficult for users to understand the underlying design principles of the software and relate them to their interests and tasks.
In case A, the software in question was designed to support self-dependent learning and collaboration on an equal footing, therefore refraining from predefining structures and complex access rights. In practice, both students and teachers often had different expectations: Students expected to have less access rights and regularly missed the opportunities the software provided for them. Teachers were anxious of the freedom students had (but seldom acted out).

Fear of change. Apart from concrete changes actually associated with it, the introduction of new technology—like most organizational changes—might arouse a variety of fears. Be they justified or unjustified, in any case they will interfere with technology appropriation and the organizational development that comes along with it.
In case B, several network members who were less computer literate feared that use of an electronic communication tool would put them at a disadvantage concerning their position within the network. Our research showed that this was actually the case: Network members tended to judge fellow members by their computer skills.

Technology appropriation is an important part of the recontextualization phase: It is a *recontextualization activity* carried out by the actual users of a system and several other stakeholders within an organization. In the following sections, the *protagonists* of appropriation work and their activities will be explored.

The Protagonists: Doing Appropriation Work

Protagonists of appropriation are, above all, the actual users of a system that is introduced within their (working) context. They need to get to know the system, grow accustomed to it, experience its strengths and drawbacks, and integrate it into existing practices and routines. In doing so, different people use different strategies. Studies on technology appropriation and support have identified the following appropriation activities (cf. Gantt & Nardi 1992, Mackay 1990, Pipek 2005, Grossmann et al. 2004, Bossen & Dalsgaard 2005):

Tailoring or customization. Especially software systems usually offer possibilities to adapt the system configuration to individual needs, reaching from e.g. simple color or other display configurations to choices of functionality or even changing the system in end-user programming activities. However, tailoring activities are highly dependent on the users' technical skills and interests.
The software used in case A offered only limited possibilities for tailoring, which were available mostly to teachers. In this context, even those limited and straightforward tailoring mechanisms were rarely made use of. The vast majority of teachers used the standard configuration. This illustrates the need for thoughtful default settings.

Using existing templates. When confronted with new programs, users often try to use existing templates or macros (for example for spreadsheets or word processing) or "borrowing" templates from more experienced users. Likewise, new technology might be "adapted" to existing work practices by ignoring new functions not compatible with them.
In case A, this became especially obvious. Since software use in educational contexts takes place in rather short cycles of semesters and terms, the software needs to be usable right away—there hardly is any time for introductory training courses to support technology appropriation. Therefore, users—teachers as well as students—gladly adopted existing templates from their colleagues or fellow students. While this facilitated technology appropriation in the beginning, it somewhat seemed to stifle creativity at later phases of use.

Establishing new practices and structures. On the opposite, users also might seize the opportunity to change existing routines and structures.
In case B, the introduction of technology lead to the emergence of new technology-related roles within the network, such as administrators and moderators. Furthermore, using technology enabled network members to enforce certain rules more strictly, e.g. granting access to (electronic) documents only to those fulfilling certain access criteria.

Learning by doing or by observation. Many users seem to dislike manuals when they get to know new software and prefer a 'trial and error' approach. Likewise, formal training is often less appreciated than continuous support, e.g. by colleagues that serve as models for system use.
In case A, most student users behaved very passively (a common phenomenon in virtual collaboration known as lurking, cf. Preece 2000) and had difficulties establishing routines of use. Technology appropriation was much facilitated by a few experienced (student) users demonstrating possible ways of use and serving as role models.

Creative misuse. Especially information technology often allows for various use purposes, enabling users to establish new and possibly unintended ways of use.
In case A, we observed rather frequent 'misuses' of the software functions. E.g., subgroups were established to protect certain documents, or teachers used discussion threads to pre-order and categorize documents (something that could not be done with the regular document folders that allowed flexible sorting and display rules for all users). Even though the software was not used as intended, creative misuse was typically a sign of vivid and successful use practices.

Negotiating use. It is often necessary for users to discuss and agree on certain ways of technology use. This is especially true for collaborative settings or communication technology, but may also apply to the use of individual software, e.g. when it comes to formatting issues or file names.
In case A, users—both students and teachers—complained less about technical or usability problems, but more about the low level of participation and missing incentives and opportunities for use. This emphasizes the importance of use conventions and also sense-making for technology appropriation: Users need to recognize the additional benefit as motivation to adopt system use.

Boycott. Users disliking new technology often react simply by ignoring it or putting a minimal effort into use.
This became especially apparent in case B, where network members cooperated on a voluntary basis and had little extrinsic motivation to use a system not useful to them. Several groupware systems established by network mediators were basically not used at all.

The examples presented above show that appropriation is often a collaborative activity, even if the technology involved is not decidedly for collective use (cf. Mackay 1990, Pipek 2005). Consequently, relations between users and the roles they take on play an important role for technology appropriation. Actors influencing technology use in an organization have been characterized as *technological cham-*

pions who make unsolicited efforts to introduce new technologies and ideas, often out of personal motivation, *expert users* who are highly skilled, serving as models or supplying e.g. usage rules, templates or macros for other users, or *translators* who provide support for others when they experience problems (Scheepers 1999, Gantt & Nardi 1992, Mackay 1990).

In contrast to these more informal roles, there are also 'official', organizationally imbedded and sanctioned roles, e.g. support staff, administrators, or local developers, who serve as so-called *mediators* of technology appropriation.

Mediating Technology Use

According to Orlikowski et al. (1995), technology appropriation should ideally be explicitly moderated in a process they term *technology-use mediation*.

Drawn from a study in a large manufacturing company, Orlikowski et al. (1995) describe technology-use mediation as a "deliberate, ongoing, and organizationally sanctioned" intervention, which is carried out by specific members of the organization they call *mediators*. Orlikowski et al. (1995) identify four activities of mediators:

- **Establishment** of the technology both technically (e.g. setting up hardware, installing software, registering user accounts) and socially (e.g. proposing usage goals and customs).
- **Reinforcement** of the system use once it is established (e.g. offering ongoing support and guidance, helping to integrate the new technology into existing routines and workflows).
- **Adjustment** or refinement of certain aspects of the system usage (e.g. technical alterations or a change in usage rules) in response to problems or challenges.
- **Episodic Change:** Major modifications of both the underlying technical system and/or usage customs and norms may be necessary to address organizational changes or different users' needs. Episodic changes need to be prepared and legitimized carefully to ensure that the majority of users will support them.

These activities can be related to the three types of *technological change* in organizations identified by Orlikowski & Hofman (1997): *Anticipated*, *emergent*, and *opportunity-based* changes.

Establishing technology is usually an anticipated change that was planned and prepared in advance, even though in some cases technology use might emerge from a smaller 'inner circle' and spread to wider parts of the organization. Adjusting technology use is also a reaction to emergent, spontaneous changes. Episodic changes tend to be opportunity-based responses to developments or events that were not originally anticipated but are nevertheless introduced in a purposeful manner. Reinforcement does not represent change, but is directed at stabilizing the existent patterns of use.

Bansler & Havn (2003) broaden the concept of technology-use mediation by emphasizing that it is an active process of *sense-making*: Initially, mediators do not necessarily have a clear notion or even vision of what the respective technology may offer them and how they would like it to be used, but have to construct their understanding in a process of enactment of different practices and interpreting their experiences: "the essence of the mediator's job is to make sense of the technology—and this sense-making is an active process where the mediator simultaneously enacts the technology and an environment where it fits in" (Bansler & Havn 2003, 140). Thus, technology-use mediation highly depends upon the personality, values and responsibilities of the mediators: it is "grounded in identity construction" (Bansler & Havn 2003, 142). As a result, two mediators may develop totally different views and strategies of technology use even though they work in the same organization using the same tools.

Technology-use mediators need to be accepted as such, as case B shows, which will be explored in depth:

In case B, a small group of core members, mostly highly experienced in the use of ICT, adopted informal mediator roles. Besides using the platform often and actively themselves, they also acted as ad-

ministrators, offered user support, provided content and tried to stimulate use. In terms of Orlikowski et al. (1995), their activities can be clustered as follows:

- ***Establishment:*** *The mediators themselves, who were also involved in the selection process, initiated the technology use. Furthermore, they set up and hosted the platform. They invited the other members to register for a user account or even set one up for them. Their activities were welcomed by most of the other network members, but failed to initiate active use on their part.*
- ***Reinforcement:*** *The mediators also acted as administrators and tried to moderate and support use. They tried to stimulate use by posting relevant information and structuring it according to the different topics of interest to the community. For example, the network members were encouraged to post their vocational profiles on the platform, and links to different job exchanges were provided. The moderators also tried to establish interaction and incentives for use. For example, certain announcements were no longer distributed by e-mail but only available on the platform.*
- ***Adjustment:*** *Adjustments of the existing platform or refinements of certain aspects of usage barely took place. Instead, several changes of technology were initiated (see below).*
- ***Episodic Change:*** *Episodic changes in this case were solely changes of technology: Several commercial and Open Source groupware systems were used within the network within only a few years. Use difficulties were 'cured' by introducing new technology—without much success, however.*

In this case study, technology appropriation was mainly driven by a few people and did not reach the rest of the network. They acted as mediators, but unlike the mediators described by Orlikowski et al. (1995) their activities were not organizationally sanctioned and failed to induce commitment among the other members—possibly because they made few efforts to discuss and negotiate technology use. Technology use failed because the majority of network members never related the new technology to their individual and common work practices. Mediators failed to 'make sense' of the technology.

Technology Appropriation as Identity Construction

Janneck & Finck (2006a, b) take the notion of identity in technology appropriation even further: In their work on online communities, they found that processes of identity-building among community members play a major role in respect to their technology adoption and use. To analyze these processes, they draw on *Social Identity Theory* (Tajfel 1978).

In social psychological research, social identity is a well-known concept of explaining individual experiences and behavior in relation to membership in social groups, mainly regarding intergroup relations, conflict, and discrimination.

The theory of Social Identity (Tajfel 1978) assumes that an individual's self-concept and feeling of identity is closely related to his or her memberships in different social groups. Since individuals strive to uphold a positive self-concept (Tajfel & Turner 1986) they also tend to evaluate social groups that they belong to (the so-called 'ingroups') positively while devaluating or even discriminating 'outgroups'. This is even true for so-called 'minimal groups' whose members do not know each other and which are randomly put together for experimental purposes (Tajfel 1978).

Therefore individuals tend to conceptualize themselves as a 'group' if they perceive little differences between group members and many differences compared to other people not belonging to their group. Shared norms, beliefs, attitudes, tasks and goals are important conditions for the development of social identity and group coherence.

Based on empirical observations, Janneck & Finck (2006a, b) show that the development of a common identity among members is a crucial agent of appropriation and mediation of technology-use: Members identifying with the group also showed a positive attitude towards the joint technology use. Vice versa, using a common platform not accessible by non-members lead to a heightened sense of community and common identity within the group (see also Rohde et al. 2004).

In the vocational network investigated in case B as well as in the student community investigated in case A, members identifying strongly with the community evaluated the technology more favorably and also showed higher activity levels. Active users also tend to be at the core of the community and thus get involved in decision-making processes such as choosing the technology that will be used. Active involvement in community matters is an important source of identification with the community, while passive users had only a vague notion of why and how to use the community platform. Vice versa, members with a clear vision of the communities' development and goals readily contributed to it, whereas others remained reluctant.

As predicted by Social Identity Theory, establishing distinct community boundaries seems to strengthen members' sense of identity: Passing these boundaries creates a salient situation for self-categorization as a group member. In both communities efforts to have well-defined system boundaries could be observed. In case A, administrators strictly controlled and limited access to the system to students of their own faculty, thus excluding teachers and students from other disciplines. This limitation of membership was described as a means to increase the sense of identity among the members of the community. Likewise as predicted by theory, there was evidence for devaluation of outgroup members (in the shape of derogatory remarks), in this case students of Computer Science who share part of the curriculum with students of Information Systems but are not allowed as members of the student platform.

However, these mechanisms might also lead to subgroup division and thus have negative effects on group cohesion at large. In both cases, especially active users were seen as 'subgroups' that were closed to the rest of the community members. Since the active members also embodied technology provision, some community members displayed negative attitudes towards the technology as a consequence of their negative reaction to the existence of the 'power user' subgroup.

Lessons Learned: Crucial Factors of Technology Appropriation and Implications for Sociotechnical System Design

Literature describing processes of appropriation and technology-use mediation mainly focuses on the introduction of software systems in traditional organizations, authorities, or government agencies (e.g. Orlikowski et al. 1995, Scheepers 1999, Pipek 2005). The case studies presented here to exemplify processes of technology appropriation come from different use contexts with unique challenges.

In educational settings, system usage is mostly limited to a time frame of a few months (i.e., one term/semester), barely leaving time for initial training. Even if the same technology—e.g. a learning management system—is used throughout the educational institution, different teachers will have different expectations, teaching styles, and didactical concepts that also affect technology use. Thus, technology appropriation needs to take place fast if the technology is to support teaching effectively.

The vocational network observed in case study B is unique because it lacks the hierarchical structure of traditional organizations. It is based on voluntary membership, with none of the members possessing any exceptional decision-making powers. Therefore, technology appropriation needs to be driven solely by the commitment and intrinsic motivation of the network members, whereas software use in traditional organizations (and also in educational settings) is probably at least partly involuntary, i.e., it is often mandatory to use certain types of technology or follow certain procedures or workflows.

In spite of the differences, both case studies emphasize the importance of negotiating technology use for successful appropriation. In case A, discussing and establishing common rules and conventions of use was associated with greater user satisfaction and more frequent use. In case B, members were not willing to invest time and effort in technology use without expecting tangible benefits from it. Such benefits, however, could only be achieved when all members agreed on a certain way of use, e.g. posting relevant information only in the groupware forum and not via e-mail.

Negotiating technology use is a central task of mediators. In educational settings, just like in traditional organizations, there are usually officially appointed or recognized roles associated with technology-use mediation, e.g. teachers, tutors, administrators, technical support staff etc. In self-organized settings like the network presented in case B, mediation is more an unsolicited effort of individual community members with a special interest in technology. In contrast to traditional organizations, they cannot rely on extrinsic factors such as organizational sanctions or benefits. Whether they succeed in promoting technology use seems to be closely related to the concept of sense-making (Bansler & Havn 2003): Instead of relying on the authority and legitimization of an officially recognized role, they have to rely on the power of their own ideas, visions, and personality. Their activities, however, closely resemble those of organizational mediators identified by Orlikowski et al. (1995).

Thus, looking at technology appropriation in those unique settings magnifies concisely the key challenge that is present in most processes of technology appropriation, regardless of the context: To actively make sense of a technical artifact and the changes that its recontextualization brings about, ideally supported by people with the personal or role authority to mediate the process.

Even though technology appropriation takes place in the recontextualization phase, it should already be considered in the decontextualization phase when technology is developed—something that is seldom accounted for in practice (cf. March, Jacobs & Salvador 2005). Even though participatory design and requirements engineering approaches (e.g. Kotonya & Sommerville 1998, Floyd 1993) provide plenty of concepts and methods on how to analyze the respective use context and involve (future) users in the process, the focus is still on the design of a technological artifact—and hence the decontextualization phase—and less on the adoption and use of technology.

Gumm & Janneck (2007) make an attempt to bridge the gap by proposing requirements engineering concepts that try to foreshadow possible challenges and conflicts during software recontextualization. They frame a number of questions for software developers to ask themselves during the development process, which can roughly be grouped in six areas:

- **Planned and unplanned changes:** what activities and structures will or might be changed through technology?
- **Values and guidelines:** what (implicit) values, principles, and ideas do guide the stakeholders' actions?
- **Key players and role models:** are present and/or future technology-use mediators involved in the development process?
- **Power and politics:** how does the new technology impact power structures? Who might benefit from these changes, who might not?
- **Formalization gaps and flexibility:** were the limitations of formalization considered? What degree of customization and flexibility is necessary?
- **Paths of technology use:** what lessons can be learned from the way technology has been used and introduced in the past?

Methods to address these issues include traditional participatory design techniques such as scenarios, future workshops, or sociotechnical walkthrough (Carroll, Rosson, Chin & Koenemann 1998, Bødker 2000, Herrmann, Kunau, Loser & Menold 2004) as well as less common or newly developed methods, such as analyses of technology use paths or micro-political structures (Gumm & Janneck 2007). Considering the complexity of technology development and appropriation processes and the variety of factors influencing them, a triangulation approach combining different measures seems appropriate. In any case, it should be an effort of joint technological and organizational development.

CONCLUSION

We started this chapter with a scenario illustrating that simply supplying technology does not automatically lead to its—let alone satisfactory—use: For successful technological support the circumstances of its introduction into a use context are crucial. This was understood as a process of *recontextualizing* technical artifacts that represent algorithmically formalized practice, thus not merely supporting (as it is often worded), but inherently changing human actions. The users of a technical artifact play an active role in this process: They *appropriate* technology.

This chapter discussed a variety of factors influencing technology appropriation: The *process* of recontextualization, and possible conflicts associated with it, as well as the *protagonists* in technology appropriation were described. Typical appropriation activities of both regular users and so-called *mediators*, i.e. organizationally sanctioned role-players initiating and supporting technology use, were highlighted. Processes of sense-making and identity-construction related to technology use were explained.

These approaches were illustrated by means of two empirical cases of technology appropriation in practice. In contrast to the bulk of research on technology appropriation, focusing mostly on traditional organizations, case A highlighted software use in educational settings, while case B illustrated the introduction of a groupware system in a self-organized, non-hierarchical vocational network. Results showed that technology appropriation in these contexts was subject to similar phenomena and challenges as they have been described within traditional organizations (cf. Orlikowski et al. 1995): Users need to make sense of the technology regarding their work routines and tasks, ideally supported by mediators who serve as role models, provide support, and help to negotiate and establish rules of use. As case B showed, intrinsic motivation for technology use is crucial—organizational pressure or sanctions can make up for some of it, but do not suffice, as became clear from case A.

Technology appropriation is commonly a group phenomenon, since actions supported by technology are usually part of a greater (organizational) workflow and affect others, even if the technology in question is not decidedly for collaborative use. Consequently, research on technology appropriation has soon turned to include group processes (cf. Mackay 1990, Gantt & Nardi 1992, Orlikowski et al. 1995). Personal factors influencing technology appropriation—e.g. attitudes, attribution styles, personality—have been less in the focus of researchers (maybe because research on technology appropriation has been done more in the field of information systems than in psychology). This is an interesting prospect for future interdisciplinary research.

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KEY TERMS

Technology appropriation: The process of adopting and adapting technology by users or groups of users to integrate it into their lives, practices, and (work) routines.

Decontextualization: Formalizing human and organizational actions and practices and transforming them into algorithms computers can execute as part of software or generally technology development.

Recontexualization: The process of bringing technology and the formalized practices associated with it back into the use context. Technology appropriation is understood as important part of recontextualization.

Technology-use mediation: The process of moderating technology appropriation.

Technology-use mediator: Organizationally sanctioned role supporting technology appropriation.

Social Identity Theory: Social psychological concept assuming that an individual's self-concept and feeling of identity is closely related to memberships in different social groups.

Participatory Design: Software Engineering approach seeking active involvement of users in the design process.

Chapter XII
Explaining Participation in Online Communities

Petter Bae Brandtzæg
SINTEF and University of Oslo, Norway

Jan Heim
SINTEF, Norway

ABSTRACT

The last few years have seen a substantial growth in online communities such as MySpace and Facebook. In order to survive and increase in size, online community systems must enhance social interaction and participation. This chapter analyzes participation in new online communities, using a combination of the socio-technical perspective and the human-computer interaction perspective. In 2007, both qualitative and quantitative data was collected from questionnaires from five sample groups in Norway—four popular online communities and one national sample of Internet users. The results show that online communities attract like-minded people, but vary in terms of different user types. Most visitors have a clear social purpose, but the level of participation differs with respect to user types and community characteristics. Participation in terms of user-generated content (UGC) differs greatly, depending on the medium used. Most users do not contribute audio-visual UGC, and text is still the main UGC. Possible future research and socio-technical design implications are discussed.

Participation is everything

—Involve (http://www.involve.org.uk/, 2005)

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INTRODUCTION

By combining the socio-technical perspective with the human-computer interaction perceptive (HCI), the aim of this chapter is to broaden our understanding of how non-professional users participate in online communities. In particular, this chapter will try to close the socio-technical gap (e.g. Ackerman, 2000) by addressing both the community level and the user perspective—thus identifying social user requirements and how these can improve participation in online communities. This will be done by analyzing and discussing empirical data about community usage within several Norwegian online communities. (Access to and the uses of online communities are high in Norway compared to other countries in Western Europe, and are therefore a particularly interesting area when investigating community usage). Finally, this chapter suggests some socio-technical design principles of this analysis.

The background of this chapter is the growing body of research that demonstrates an exponential increase in online communities and user-generated content (UGC) (Brandtzaeg & Heim, 2007; Li et al., 2007; Bishop, 2007; Horrigan, 2007; Wunsch-Vincent & Vickery, 2006). Unfortunately, this research fails to account for *why* and *how* users participate or engage in social networking settings and UGC. However, this is critical knowledge, since online communities are increasingly becoming an established part of the Internet and have changed the nature of online user participation (Bishop, 2007).

Several Internet services have been designed to draw upon voluntary active participation among non-professional users in terms of both UGC production and social interaction. The core condition of all online communities is the active participation of community members. However, at present, the general ambition about user participation, creation and sharing of UGC in online communities is far from being fulfilled, while only a few users actually are participating actively (Bishop, 2007; Geerts et al., 2007). Several online communities pays little attention to the complexity of community interaction and the need to support and guide it. This may explain why many online communities are more or less ghost towns (Preece & Maloney-Krichmar 2003). A number of studies (e.g Nonnecke & Preece, 2000; Nielsen, 2006) indicate that, in most **online communities**, there exists a "90-9-1 rule" for levels of participation, where 90 percent are defined as "lurkers", 9 percent are occasional contributors of **UGC**, and only 1 percent are active contributors. Kollock and Smith (1996) describe lurkers as free-riders, i.e., non-contributing, resource-taking members. This is also referred to as the "free rider problem".

Therefore, this chapter aims to understand who the typical participants are, why and how they participate, and what types of participants that exist in terms of different user types characterized with their particular usage pattern inside the community. This coherent approach will determine what level of participation different user types or user groups are ready for, and how designers should adapt to a diverse population of users. Nevertheless, rapid changes in users' habits and technological advances are continuously reshaping the new media landscape (Brandtzæg, 2007), and the situation regarding user needs and "participation" in online communities poses some important design challenges:

- To support the move from a text-based to a more complex multimedia environment. New online communities can, in fact, be described as a micro-Internet, an "all-in-one-place solution" that features a convergence of diverse Web 2.0 functions and services, such as blogging, chat, wiki, e-mail, video, book marking and photo. A synthesize of different Web 2.0 technologies with the community is a typical trend of several of the communities we are studying in this chapter, but also holds for more well-known communities such as Facebook and MySpace. A huge challenge is that most users cannot cope with this complexity associated with a combination of Web 2.0 technologies, and most users can't create and share multimedia **UGC** as easily as they can manipulate text and photos (Brandtzæg, 2007).

- To understand the shift from online communities controlled mainly by professional users, to online communities controlled by a non-homogeneous mass of non-professional users with different tastes, needs, and degrees of participation. "The user population has changed to include people of all ages, different cultures, educational backgrounds, experiences and technical skills" (Preece & Maloney-Kirchmar, 2003 pp. 602).

The combination of a fragmented user population and diverse features and opportunities inside the communities is indicative of a situation where users participate in different ways. Therefore, the present chapter focuses on how to characterize non-professional users of online communities, and especially on distinguishing between significant patterns of community usage. The main challenge is to understand the increasingly differentiated group of non-professional users, and how we can support their needs as users in order to create more engaged communities with an increased level of user participation.

In regards to a socio-technical perspective, a crucial dilemma is the technical goal of a of a stable, interoperable information infrastructure and the view of online communities as evolving, open, socially constructed. This may end up in a contrast between communities as clear technical entities, and the fact that the technical system should support unclear social interaction in the everyday life of human beings. Danah Boyd (2005) demonstrated thoroughly that social software developers don't understand human-human interaction**.** Boyd states, "As technologists, we often frame technological use rather than build technology based on users' practices and needs" (2005, p. 1). In other words, design implications for social systems should actively involve the needs of a diverse user population (e.g. Geerts et al., 2007; Obrist et al., 2008), in order to successfully develop online communities with active participants (Brandtzæg & Heim, 2008).

Approaching Online Communities

A common way to define online communities is suggested by Jenny Preece (2000), who defines an online community as a group of people who interact in a virtual environment. However, in this chapter we will limit ourselves to clearly focus on *person-oriented communities*. Modern online communities with social networking features may be viewed as social organizations in a technological setting, where different types of applications are in use by a broad range of non-professional users (see Obrist et al., 2008). These communities have a purpose, are supported by technology, and are guided by norms and policies (Preece, 2000). As discussed above, they also differ in their levels of participation.

At present, there is no accepted or universal definition of the term "online community" (Preece, 2000). On a general level, online communities can be divided into five different categories (see also Brandtzæg & Heim, 2008):

- **Person-oriented communities:** Communities where social interactions between individuals are in focus. Examples are MySpace, Facebook, Friendster, Bebo, Orkut, Windows Live Space, and Hi5.
- **Professional communities:** Communities that focus on business networking. Examples are LinkedIn and itLinkz.
- **Media-oriented communities:** Communities that focus on the distribution and consumption of user-generated multi-media content, such as video, music or photos. Examples are YouTube and Flickr.
- **Virtual-world communities:** Communities that are essentially a 3-D virtual world, built and owned by their residents (the users). A typical example is SecondLife and World of Warcraft.
- **Mobile communities:** Communities that make it possible to have direct and indirect contact with community friends and allows

users to make updates on the move. Typical example is Twitter.

In this study, we are in particularly focusing on category number one—person-oriented communities with social networking features. Online communities should therefore be understood a sub-category of socio-technical systems, and might be related to both consumer technologies and organizational technologies.

Currently, the socio-technical perspective tends to have a single level approach with a focus on the group or organization, while HCI focuses on the single user (Dillon, 2000). Thus, these two approaches, if used in combination, can offer richer insight into online community design and implementation. The present chapter does this by making use of both approaches—investigating both users' needs and differences related to certain aspects of online community usage (user types), and looking at differences between online community characteristics (community types).

To investigate a more diverse user population with fragmented tastes, this study draws upon earlier research which identifies typical user types reflecting different patterns of media usage (e.g. Horrigan, 2007; Heim & Brandtzæg, 2007). According to this body of research, the importance of demographic traits may have less explanatory power than previously thought. An alternative approach is to simply correlate demographics with amount and types of use and by this define some typical user types to see how participation varies among different groups. Consequently, this approach accounts for the fact that users of online communities are engaged in different activities inside the communities, but in more or less systematic patterns, to achieve a higher level goal.

It should be noted that our aim is not to identify categories of online communities, but rather to identify typical categories of community users depending of their level of participation reflected by a typical usage pattern. Our aim is to identify types of participation in terms of profiling user behaviors and user preferences (including contributions of UGC) that are related to specific user characteristics in the general online community population. Such characterizations of the typical non-professional users is missing, and is much needed for our understanding of how different people approach online communities, and what they want to achieve when they log onto them. However, this will not limit our understanding and previous analyses of how different types of user profiles are more or less involved in different types of online communities.

Data Material

The data material supporting the conclusions and design implications is taken from at study that took place in March 2007 over a four-week period. A total of five samples, totaling 5733 respondents, were examined; 3328 were women, and 2405 were men.

The investigation was carried out in two stages: 1) with four different online communities, Biip, HamarUngdom, Nettby and Underskog, in Norway and 2) with one representative sample of Internet users in Norway.

The four online communities were chosen because they are among the most popular and well-known in Norway. In addition, they reflect some interesting differences (e.g size and/or focus) that make it possible to look more closely at the meaning of differentiated types of communities from a group level. Furthermore, the online communities investigated have application features that enable users to contribute various types of UGC, such as video, text pictures, and audio. They are typically defined as social networking communities, or as person-oriented communities, which was crucial since this study investigates levels of user participation.

Table 1 describes the origins of the four communities the number of members, and types of UGC that each allows.

A total of 5233 persons responded to the survey in the four online communities, from each community as follows:

- Biip.no (N = 2778)
- Nettby.no (N = 512)
- Underskog.no (N = 335)
- Hamarungdom.no (N = 1598)

The second data collection procedure was designed to obtain *a representative response* to our research questions. This was done by collecting data from an Internet panel of 500 users that was nationally representative of Norwegian Internet users in regard to gender, geographical location, and age (15-74 years). The national sample is referred to as "Rep. Sample" in the figures and tables in this chapter.

Measures

We used an online questionnaire that contained both open and fixed-response questions. The questions that were identical in all the surveys included five broad categories of measurements, described in more detail in a separate study by Brandtzaeg & Heim (2007).

First, to learn more about the users of online communities, we used the following two types of measurements: 1) Demographics, such as residence, gender, age, and education. 2) Attitudes about Internet use, partly adapted from our previous research on categorization of different user types (Heim & Brandtzæg, 2007), and partly inspired by research by Tsai et al., who classified adolescents' perceptions of the Internet into categories (Tsai, Lin, & Tsai, 2001).

Secondly, in order to investigate both user types and motivational issues, we investigated time spent using online community/communities, frequency of UGC contribution, types of UGC (text, pictures, audio, video) contribution, and which online communities people visit, and how often.

In addition, we included the following open questions:

- *Please tell about your most important reason for using the community.*
- *Why have you stopped using or are less active in other communities?*
- *Under what conditions would you consider contributing more films/videos?*
- *Do you have any suggestions for improving online communities in supporting you to contribute more actively with films/videos?*

Questions 3 and 4 only applied to people interested in UGC contributions.

The community surveys included one instrument that was not included in the "Rep. Sample." The participants were asked, "What are your reasons for visiting this community today?" This was followed

Table 1. The four online communities used in this study

Site	Origin	Members	Description	UGC
Biip.no	2005 June	280,000, (March 2007)	One of the most popular teenager communities in Norway. Mostly for socializing and sharing of pictures, music and videos.	Picture, audio, text, video
Hamar-Ungdom.no	2002 August	190,000, (March 2007)	Initially a local online community targeting youth in a small town in Norway called Hamar. However, the community has become very popular and grown outside its original borders. Mainly socializing and discussions.	Picture, audio, text
Nettby.no	2006 September	320,000 (March 2007)	A large community connected to Norway largest online newspaper that attracts a broader part of the population. Popular for discussion and interests groups, as well as socializing.	Picture, audio, video, text
Underskog.no	2005 November	10,000, (March 2007)	Originally a user generated cultural calendar for Oslo. Very academic and cultural oriented, but also for socializing and discussions. This is an invitation-only community.	Picture, audio, video, text

by 14 alternative answers, mainly related to different features and activities within the community. We formulated a follow-up question about the most important reason/goal for their community visit that day, giving the respondents the opportunity to select just one alternative.

Analysis

Most analyses were descriptive. A k-means cluster analysis (using SPSS 14) was applied to identify typical usage patterns and user preferences (including different activities of UGC) connected to particular user characteristics in the general online community population.

Participation: Who, How and Why

This section is divided in to three main areas of inquiry regarding three levels of participation in online communities; 1) *who* are participating in these communities 2) *how* do they participate?, and 3) *why* do they participate?

Who?

Age, Gender, Education and Residence

The members of each online community were homogeneous with respect to age. Community users tended to be younger than the general population. Mean age was from 16 to 29 years in the community samples, while 41 years was the mean age in the "Rep. Sample."

The members of online communities in more detail:

- **Biip**: Adolescents, with a mean age of 16 years, mostly in their final year at comprehensive school, and far more females (62 percent) than males (38 percent). Members have no specific type of residence and live all over the country.
- **HamarUngdom**: Adolescents with a mean age of 17 years, mostly in high school, somewhat more females (53 percent) than males (47 percent). A majority from rural areas.
- **Nettby**: Mostly young adults with a mean age of 23 years, more females (58 percent) than to males (42 percent). They have no special type of residence, with members living all over the country. About one third of the members were pupils/students.
- **Underskog**: Adults with a mean age of 29 years, with a high educational level. Most members live in the Oslo area. Somewhat more males (55 percent) compared to females (45 percent).

Attitude Towards Technology

We found that frequent community users had a more positive attitude towards technology as a means for both entertainment and communication than the general Internet population. As shown in Table 2, both entertainment (3) and communication (4 and 5) are significantly correlated with community usage.

Similar to the results of other research (Horrigan, 2007; Li, 2007), our study found that it is mainly younger people who use online communities. However, in communities with a clear objective (such as Underskog) and less anonymity (e.g. Underskog, Nettby), the users tend to be older. Further measures the improve security and usability will probably make online community opportunities more equal across generations, and should also increase the social participation among elderly citizens.

Another central finding of our study is that girls (13-17 years old) are in the majority in several of the communities. This is interesting, since the relationship between gender and ICT use has been a research issue for many years, and the dominance of boys and young men in this area has been a social concern (Brandtzæg et al., 2005). The social interaction within these community applications may explain the high involvement of girls (Kaare et al.,2007).

Furthermore, our research shows that the more frequently one visits online communities, the more likely it is that the technology will be perceived as a means of communication and entertainment. In a recent study analyzing Eurostat data from 2005, Heim and Brandtzæg (2007) found that the group of typical "entertainment users" varies from one country to another, from 5 percent to 15 percent of the total population, but it is mainly younger people who are associated with this pattern of media usage.

How?

Community members are very frequent visitors; more than 85 percent visit their community daily or several times a week. According to our data, 30 percent of the general Internet population in Norway visits a community daily or several times a week (Rep Sample).

Furthermore, community members tended to visit several communities. A majority of community members visited four or more communities several times a month or more. Approximately 10-20 percent of the community members in Biip, Nettby, Underskog and HamarUngdom visit four or more communities daily.

Level of UGC Contribution

As Figure 1, below, shows, 40 percent of the "Rep. Sample" contributed user generated text several days a week or daily. In the other samples, this differed according to which community the users belonged. In Nettby, 50 percent contributed text several days a week or daily.

Only 5 percent of the "Rep. Sample" contributed pictures several days a week or daily, while 15 percent in Nettby and Biip did so. Movie and audio contributions were even less frequent, and were more or less absent, with only about 2 percent of users doing this several days a week or daily.

We asked all participants to rate the importance in contribution of different types of UGC by the following questions: "How important are the following when you want to contribute and be active in online communities?" (see alternatives in Figure 2).

As Figure 2 shows, people were more interested in watching other people's videos than in sharing their own. Contributions of text and pictures were viewed as very important, while opportunities for downloading and sharing sound/music and video/film were evaluated as a less important activity.

It seems, from our results, that community members are dedicated to "online communities" as such, but not to one single community. Although almost all users are online almost every day, they are not loyal to any particular community. A majority of online members visit two or more communities each day, and in the course of a month, a majority will have visited four or more. Users also switch frequently from one community to another. This due to a variety of reasons: harassment, evaporation of the charm of novelty, lack of interest, or lack of

Table 2. Relationship between community engagement and attitude towards technology (N = 500)

Attitude towards technology	**Spearman's rho with number of online communities visited several times a month or more**
1. It is very important to me to have a well-equipped, quality PC.	-0.034
2. I am dependent on Internet to get several practical tasks done.	-0.011
3. My PC and the Internet are very good sources for entertainment for me.	0.319**
4. To me, Internet is an important way to keep in touch with other people.	0.223*
5. The mobile phone is very important to me to keep in touch with family and friends.	0.088*

* *Correlation is significant at the 0.01 level (2-tailed).*

** *Correlation is significant at the 0.05 level (2-tailed).*

friends in the community (see Brandtzæg and Heim, 2008), to name a few.

New technology enables non-professional users to produce digital photos, sound, and video. YouTube and Flickr are examples of successful websites that have incorporated such technologies into online communities. However, it seems that today, most users of online communities are not quite ready to use the multi-media opportunities available to them. We have seen that submitting video or audio files are rather unusual activities. Submitting photos, on the other hand, is something that is done every now and then by most users. It seems that uploading a digital picture is a low-threshold activity, while producing sound and video is more demanding. The most frequent participation activity is to contribute with text and pictures (see Figure 2).

As mentioned in the introduction, user participation in online communities such as Wikipedia follows a 90-9-1 rule; 1 percent contributes regularly, 9 percent contribute from time to time, while 90 percent are "lurkers." In our study, almost everybody

Figure 1. Level of UGC contributions among community users

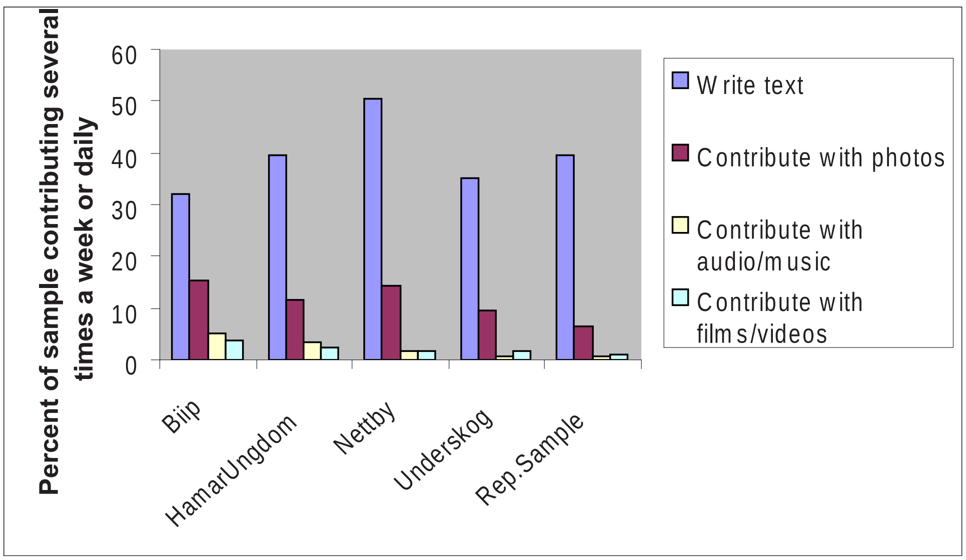
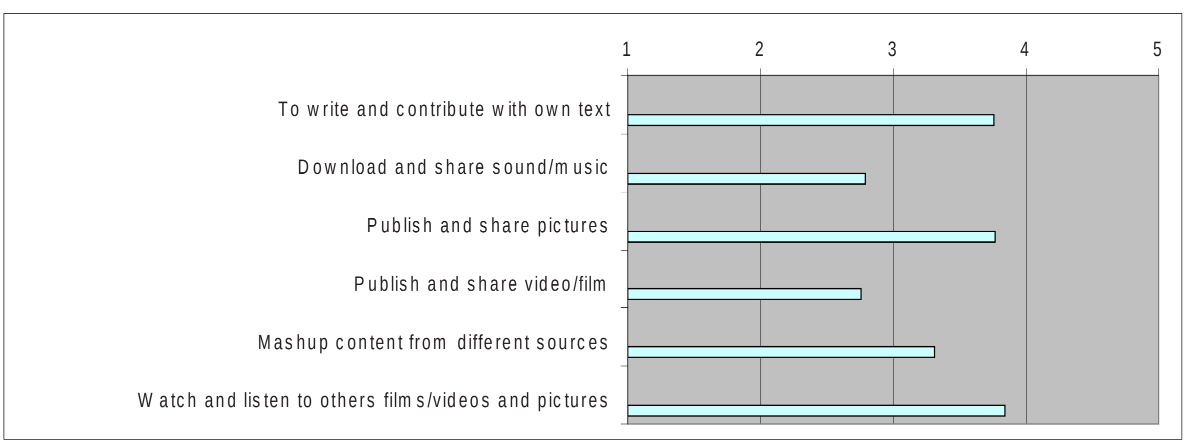


Figure 2. How users view different types of UGC contribution in regards to importance



contributed now and then to the community space; however, not with impressive videos or encyclopedia articles, but with textual comments, observations, and amateur photos. Thus, in the terminology of, for example, Jacob Nielsen, our estimate of the "non-lurkers" (the 9 percent and 1 percent groups) is twice as high as Nielsen's. This could be due to the fact that our study was targeting typical social networking communities with low thresholds for contribution, while Nielsen's was based on high profile sites such as Wikipedia. However, when we examine the community where video sharing is technically supported (Underskog), we see that as many as 7 percent say that the purpose of their visit is to upload a video, and that 25 percent contribute once a month or more. So, by this definition, only 75 percent are "lurkers," (even when we are talking about A/V-content) compared to Nielsen's 90 percent.

An explanation is that the high-profile UGC sites, like YouTube and Wikipedia, are a new means of creation and sharing of media, but the basic consumption paradigm is still to broadcast—from few to many. This is contrary to what we see in the smaller online communities where social networking as a prime focus (as examined in this chapter), where social exchange is the focus and content is produced by few—and consumed by few. However, the "few" in the different communities aggregates to a vast amount of "many." This is, however, in line with earlier research showing that lurking levels are higher in some communities than others, and that lurking may vary in relation to other community variables such as size of the community, frequency of posting, and number of single messages (e.g. Nonnecke, Preece and Andrews, 2004). As suggested by Olson: "the larger the group, the less it will further its common interests" (Olson 1965: 36). There might be a number of reasons why active participation may be more difficult as group size increases. According to Dawes (1980), will the costs of an individual's decision to free-ride or lurk be less in larger group where users are spread over a greater number of people (Dawes 1980). An individual may also be less motivated to participate or contribute if his or her actions do not affect others in a noticeable way (Kollock & Smith, 1996).

Why?

In addition, by using cluster analysis, we found five clusters, or user types, that mirror different reasons and deeper level motivations for attending an online community. These patterns were defined by 14 variables measuring the reasons why participants visited the community at the time of participation in the survey. 1) "See if somebody has tried to contact me," 2) "Write letters or messages" and 3) "Contact others" were the three most common reasons to visit a community site.

Furthermore, in order to examine user types in terms of patterns of usage inside communities in more detail, we extracted some typical responses, to exemplify these patterns of community usage and members' interest in and motivations for contributing video material inside the community.

Figure 3 describes the distribution and characteristics within the five user types, based on usage patterns and activities in online communities:

1. Sporadics

This user type (19 percent) refers to users who give few reasons for visiting the community. These users are not very involved in activities, but rather visit the community sporadically to check their status from time to time. These users are spread equally over the four communities and age groups and equal about 10 to 20 percent of all participants. They tend to be males.

A typical "sporadic" user is August, who is 16 years old and lives in Oslo. He has been a member of Biib for one and a half years. His main reason for being a member is to send free SMS (Short Messaging Service on the cell-phone). He has about seven persons in his profile, but has only been in contact with one other person during the past week. August joined the community for reasons other than the community itself; for him, it is a place to receive free SMS. But he does not deny that he also enjoys comments from others in the community. He doubts that he will contribute videos because he is not using the Internet for content production; he is just not interested in contributing.

2. Time-killers

These users (27 percent) are the largest user group. They are engaged in several activities, but only to a small degree. They are, in addition, more "lurkers" than "contributors," since they hardly contribute any UGC. The types of users represented by this usage pattern are spread equally over the four communities (20 to 30 percent), and in terms of age and gender.

A typical "time-killer" is June, a 16 year old from a small town. She has been a member of "HamarUngdom" for about three years, but is starting to lose interest. She thinks that technology is important for practical reasons (instrumentality) and for entertainment, and less so for keeping in touch with others. She has not been socializing with anybody in the community this week. She has about 20 persons in her profile.

Her reason for not contributing videos is her lack of trust in the community and the lack of personal video content that she wants to share. She is less active in the community because the people there are not the same age as she is anymore.

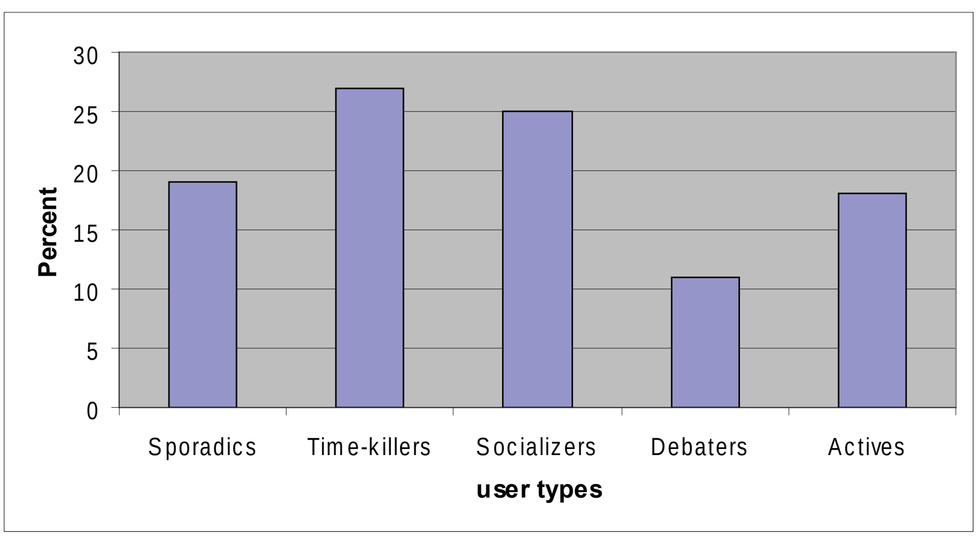
3. Socializers

These users (25 percent) are the next biggest user type and are characterized by mainly using online communities for communication or "small talk" with others. The main reason for visiting the community is to socialize with others. This pattern is typical of teenage girls at Biip, and practically absent among the Underskog members.

A typical "socializer" is Mari, who is 14 years old and lives a medium-sized town. She is an eager member of Biip, and has been a member for almost a year. The Internet is very important to her. She uses the community to keep in touch with friends, and she also likes to make connections with new people. This week she has been in touch with five people, and she has about 30 contacts in her profile. She publishes pictures now and then, and she likes watching videos.

Mari says that the Internet and PC technology are important to her, but she has never tried to upload or share videos herself, although she likes to watch videos from others. Uploading and sharing pictures are no problem. Mari has been members

Figure 3. User types in online communities



of other communities as well, but her reason for no longer participating in these was mainly related to usability issues.

4. Debaters

These users (11 percent) are characterized by being highly involved in discussions, reading, and writing contributions in general. The debating pattern is unequally distributed among the communities—very frequent in Underskog, practically absent in Biip. Somewhat older users and more males tend to engage in debating activities.

A typical debating user is Odd, who is 42 years old and lives in Oslo. He has been a member of Underskog for more than a year. He has a high degree of education and likes to discuss and express himself in writing. He is dependent on the Internet in order to carry out practical tasks, and uses the Internet mainly for instrumental reasons, and considers video contribution to be too time-consuming. He also regards his community as being more text and picture-related than video-focused. He uses communities to keep updated on cultural events and new publications, as well as for social contacts.

5. Actives

This user type (18 percent) describes users that engage in all kinds of participation activities within the community, including UGC production. This pattern is unequally distributed among communities, being most frequent in Nettby and HamarUngdom.

A typical active user is Julia, who is 15 years old and lives in the countryside. She has been a member of the HamarUngdom community for more than three years, and is still very active. During the past week, she had been in contact with 20 persons—almost everybody in her profile. She does many things when she is logged on, but nothing related to events or to publishing music or videos. Julia uses communities mainly for the purpose of social interaction; she primarily communicates with friends in her profile. She does not contribute videos and cites usability/design issues as the reason.

The different online community user types reflect huge differences in patterns of community usage, as well as preferences and reasons for attending a community. However, the social factor seems to be the most important motivation for participating in online communities. The Actives engage in more or less all activities inside the community, the Debaters interact with others for the purpose of discussion, the Socializers primarily use the community for communication and "small talk" activities, and the Sporadics are, as all other users, "socially curious" while they sporadically check to see if somebody has contacted them. The Time-killers might be the only user group that is somewhat asocial.

However, all the user types reflect different high-level motivations for participation and social interaction. Two main types of motivation for social participation in online communities stand out. One type is related to informal chatting, and a second to more serious debate and discussion. Although both genders and most age groups are represented in both modalities, younger girls are more typically "socializers," while older boys and men are typically "debaters". These modalities have been around on the Internet for many years, supported by informal e-mailing and chat channels like IRC and MSN on the one hand, and bulletin boards, discussion groups, and blogs on the other. Recently, these two types of interaction have been merging into a single type of application: the online community. This also underscores the fact that we see a convergence between different types of applications, such as mail, blog, chat, and homepage, into one integrated service; the online community. The four communities in this study vary with respect to these two modalities, highlighting the fact that community characteristics are of importance for participation. The importance of community size has also been suggested by others (Butler, 2001; Waterson, 2006; Nonnecke, Preece, and Andrews, 2004).

In our study, we see that the user typology vary somewhat between the individual communities. The Socializers are more frequent in the Biip community, which has younger members, while Underskog is more often represented by Debaters. Underskog has more highly educated users and a higher mean age than the other communities. This is an invite-only community that is very culturally and academically oriented. The two other communities seem to have a mix of different user types. This might be explained by the fact that these communities are more open and have more diverse user populations. For example, Nettby is a community that is associated with the largest online newspaper in Norway and recruits a wide spectrum of users through this connection.

Socio-Technical Design Implications

This chapter focused on who uses, and participates in, online communities and UGC, and how and why they do so. The goal was to explain participation in online communities from a socio-technical perspective, combined with a HCI perspective, and to elaborate on some design implications for online communities.

Our research shows that the social requirements or the level of sociability, as well as entertainment factors, seem to be the most important needs driving people to participate in communities. Consequently, these factors should be considered in any design. In addition, on a community level, smaller social networking communities with person-orientation seem to motivate users to contribute more UGC, than occurs in large media sharing sites such as YouTube. However, there is still a lack of knowledge regarding how people can be encouraged to contribute audio/visual (A/V) UGC and how to encourage older people to participate in online communities. Most people do not contribute A/V content, so the implementation of easy-to-use publishing tools for A/V-content will be one of the main challenges for online communities in the future. However, small and person-oriented communities with a focus on few-to-few communication can attract lurkers to contribute, since the percentage of lurkers is decreasing in these types of environment.

In the future, the freedom to choose new media applications that directly apply to users' interest and lifestyles will be much greater than today, so future community applications must be more attractive than the other options. We have also seen, both in this study and others (e.g. Brandtzæg and Heim, 2008) that members of online communities are not faithful; the majority switch between as many as four different communities. Therefore, the technical requirements should be dynamic and should follow the development of the users' needs. It must be recognized that these needs and motives may follow some trends that are subject to cultural, technological and social changes. However, some "basic needs," such as the need for social interaction and support, will stay stable over time. Nonetheless, how these "stable" needs are satisfied, and through what types of channels or communication modus, may change over time and between generations.

However, a socio-technical strategy to increase participation must base its requirements on "basic needs". Also previous attempts to understand why community members participate or do not participate has suggested that individuals are needs-driven (e.g. Bishop, 2007). In this work, there are several candidates for the kind of "basic needs" that community-technology should support in their design principles:

- **Communication:** Support sociability (e.g. Preece, 2000) in all kinds of sharing activities, collaboration and communication between people. Focus in particular on social presence, co-experience and interaction between like-minded people, including attributes as trust and belonging, and a strong sense of community.
- **Entertainment:** Support the desire people have to listen to music and consume cultural entertainment in general.
- **Information:** Support the desire people have to consume and contribute with news both locally and globally. Develop tools supporting local-oriented information and make it possible for the users to personalize local-oriented

information retrieval. In general, make it easy to perform tasks with information-oriented goals.

- **Control and usability:** Support people to master complicated technology (ease-of-use), and control over the social network. Make it easy to contribute with UGC (a key is to focus on usability related to video and audio) and make it accessible to others.
- **Learning and education:** Support people in their ability to share insight and know-how to gain learning and educational experiences.
- **Efficacy:** support people in making their daily life more efficient. Extensive research literature has shown how important a sense of efficacy is a basic need (e.g. Bandura 1997).
- **Creativity:** Support people in producing and presenting material that one can be proud of. Develop small and person-oriented environments, with a focus on few-to-few content sharing. Rules governing the use of collective goods should also match local needs and conditions

We are convinced that the rapid growth of both user generated content and online communities is due to the fact that they meet one or more of these user needs. We see that prestigious and big user generated applications such as YouTube, Flickr and Wikipedia to varying degrees support the needs of self realization, information, and entertainment, whilst the smaller user generated communities in this study primarily support social needs. The Underskog community (described in this chapter) may be a hybrid, and now Facebook (70 million users in May 2008) is an example of a big site supporting social exchange. We have further seen that members of the "social" communities are interested in technology as a means for entertainment, obviously not as producers, but as consumers or "lurkers."

CONCLUSION

One of the main challenges facing research in the socio-technical domain is the rapid changes that are taking place in both technological development and user demands. Our results suggest that the development of future design of online communities should focus on social and entertainment aspects, to enhance participation as well as "basic needs." Secondly, it must be taken into account that the growing ranks of non-professional users have neither the desire nor the skills to go into the technical details necessary to produce audio-visual content. Successful applications should make low demands of users, both in terms of the content's "artistic" level and the skills needed to submit it. Finally, even "lurkers" contribute when online communities are designed into small and person-oriented environments, with a focus on few-to-few content sharing, rather that one-to-many content sharing.

With rapid changes in user behavior, the specification of user requirements for future applications will prove to be a challenging chase, and require a combined socio-technical approach and HCI, user-centric approach. This should clearly address user needs and user types (individual level), in terms of high-level motivation in relation to different types of online communities (group level).

ACKNOWLEDGMENT

The research leading to these results has received funding from the CITIZEN MEDIA project (038312) in the European Community's Sixth Framework Programme (FP6-2005-IST), and the RECORD-project, supported by the Research Council of Norway and the VERDIKT-program. We would also like to thanks the users that participated in the study. Finally, many thanks to our colleagues at SINTEF ICT—Asbjørn Følstad, Amela Karahasanović, and Jan Håvard Skjetne—for supporting our work.

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KEY TERMS

Lurker: Is one who mainly consume others information online community, but does not participate actively with own user generated content. Lurkers are often referred to as free riders.

Non-Professional Users: Internet users that are amateurs or not professional in producing content. Not engaged in a profession in producing media content.

Online Communities: A group of people interacting via communication technologies in a virtual environment rather than face to face, for social, professional, educational or other purposes. These communities have a purpose, are supported by technology, and are guided by norms and policies.

Person-Oriented Communities: Communities where social interactions between individuals are in focus. Examples are MySpace, Facebook, Friendster, Bebo, Orkut, Windows Live Space, and Hi5. See also Social networking sites

Sociability: Communities with good sociability have social policies that support the community's purpose and are understandable, socially acceptable and practicable.

Social Networking: The process of connecting individuals via friends, relatives, and acquaintances—a person's social network.

Social Networking Sites: A Web site whereby individuals describe themselves in a personal profile, reveal themselves through participation in communities, and form networks of interactions by declaring one another to be 'friends'. See also Person-oriented communities

User-Generated Content: The production of content by the general public rather than by paid professionals and experts in the field. Mostly available on the Web via blogs, online communities and wikis, user-generated content refers to material such as the daily news, encyclopedias and other references, movie and product reviews as well as articles on any subject, all of which have been traditionally written by editors, journalists and academics in the past. Also called "peer production."

User Types/User Typology: User types can be described as user profiles associated with different categories of user groups. Each user type is characterized with a particular usage pattern reflecting a certain type of user participation inside the online community. The user types are also reflecting different kinds of user skills, user preferences or motivations. The goal in defining user types is to understand how different users behave when using the community.

Chapter XIII
Cyber Security and Anti-Social Networking

Malcolm Shore
Canterbury University, New Zealand

ABSTRACT

This chapter is about the way in which computer hackers invoke social networking paradigms to support and encourage their activities. It reviews the evolution of hacking as a form of social networking, from its roots in Bulletin Board systems to the current attacks on Second Life, and considers the motivation for hacking. Ajzen's Theory of Planned Behavior and Beveren's Flow Theory model are, when considered together, found to explain many of the observed characteristics of early hacker activity. The place of social networks in motivating hacking is explored, and some observations are made in relation to hacking and the Second Life environment. A number of control variables are identified which can be used to reduce the likelihood of people engaging in the hacking activity. Addressing the social network factors which motivate hacking provides an important early step in addressing cybercrime.

Laws are like cobwebs, which may catch flies but let wasps and hornets break through

—Jonathan Swift, *A Critical Essay Upon the Faculties of Mind*

INTRODUCTION

This chapter looks at how the many types of social networks and socio-technical systems can be used to enable and support the activity of computer hacking. A hacker was once the name given to a person who was able to rapidly and reliably change computer software to achieve new functionality, often using sophisticated coding techniques which were not generally known or used. Over time, however, the term became used to describe the more restricted group of people who exploit software vulnerabilities to gain unauthorized access to computers. Hackers have a strong networking culture—antisocial net-

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working if you like, with online groups, magazines, and conferences characterizing their interactions and peer recognition rewarding their skills.

However, as with any computer system, socio-technical systems are at risk of attack from hackers. Understanding antisocial networking and the motivation that drives hackers is an important step in reducing the levels of disruption in socio-technical, and other, systems.

Computer Hackers and Bulletin Boards

Computer hackers are usually associated with the Internet, but hacking originated well before the Internet become popular. Early computer hackers attacked systems by accessing them through dial in modems. By the 1980s, phone and computer hackers had organized themselves into strong social networks in the form of hacker groups, one of the best known being the US-based Legion of Doom (LoD). LoD started out as a group of phone hackers, breaking into the operational systems used by telecommunications companies. However, it soon began to attract the more general computer hackers and eventually became notorious for its computer hacking. While much of this was focused on demonstrating their expertise, some hackers did use these skills to commit crimes.

At this time, computer hackers used dial-in bulletin boards to provide a means of sharing information on target vulnerabilities and exploits, and these boards were catalysts for the emergence of the early hacker social networks. Law enforcement agencies were poorly equipped to deal with this emerging field of anti-social computer activity, but some agencies did respond by establishing incognito bulletin boards. One example was the Underground Tunnel bulletin board created in 1985 in Austin, Texas by Sgt Robert Ainsley. Law enforcement boards were typically used as sting operations to catch hackers posting dial-in access codes and pirated software and to collect information that could be used to gain access to other hacker bulletin boards.

The early computer hackers tended to be bright college students with an average age of about 14, self-taught computer users with access to microcomputers and modems (Maxfield, 1990). These youngsters hacked for fun, but the leaders of the hacking groups were often older and sought financial gain from pirated software or using stolen credit card information.

Internet Crime

With the growth of the Internet, bulletin boards have been replaced with 'Warez' web sites. These sites operate in much the same way as the earlier bulletin boards but have a much wider audience thanks to the global nature of the Internet. There has been a corresponding increase in the opportunities for individuals and groups to access systems without authorization in order to cause disruption, damage systems, and commit crime. Examples of internet crimes include the $10,000,000 robbery from Citibank in 1994 and denial of service attacks on popular sites such as CNN and eBay (Slatalla, 2004).

There is a difference of opinion regarding the seriousness of hacking. Yar (2005) notes a convergence of thinking which aligns with traditional concepts of juvenile offending and offenders, and hacking has in many cases glamorized in the media. However, such views mask what has become a widespread and serious problem. PriceWaterhouseCoopers, in a multi-industry study of 897 companies from 19 Asian countries, revealed that 63% of respondents had suffered a security breach or attack over the previous twelve months (PriceWaterhouseCoopers, 2003) and it is not uncommon for home computers to suffer 50 attempted hacks or port scans a day (Furnell, 2004). This activity has far reaching effects on the national economies of developed nations, as it discourages the growth and widespread acceptance of eCommerce, eGovernment and eSociety. Further, a US Official involved with Critical Infrastructure Protection (Vatis, 2001) considers hacking to be a serious issue for the future reliability of cyberspace and cannot be ignored as just youthful exuberance:

'Although..[hackers].. may be seen as merely delivering nuisance attacks, the potential for critical systems to be knocked offline… remains'.

It is unlikely that new technology and software will exhibit any greater security than it has in the past. A more successful approach to reducing the threat may be to explore the reasons why hacking takes place so as to develop strategies for reducing the motivation for such activities and the supporting (anti-)social networks (Rose et al, 1999).

Motivation

What Motivates Hackers?

The root motivation for hacking is difficult to define, and many explanations for why hackers break into or attack computers have been proposed. Underpinning them all is the assumption that the hacker is a rational being, and that his or her behavior can be explained in some form of logic.

An early attempt to develop a profile of hackers involved interviewing 100 hackers (Taylor, 1999). The results of this survey indicated that the hacker is predominantly a young middle-class white male (14-25) who is a loner and exhibits confidence only when online or discussing computer systems and tends to be an underachiever in school. Many of the subjects consider hacking to be an addictive, thrill-seeking activity. Similarly, Wentworth suggests a profile in which a hacker is typically middle-class Caucasian aged 12-28, a loner with obsessive traits, and an underachiever at school (Wentworth, 2002). She suggests that such hackers are motivated to gain control of a portion of their life, dislike their real world persona, and seek recognition from the media. Parker interviewed over 200 hackers but cautions against attempting to generate a single hacker profile, finding there is diversity amongst computer hackers: 'Every time you think you have a profile nailed down, the next interview blows it all away' (Parker, 1998). Himanen has suggested that there is intrinsic motivation in the entertainment value and intellectual challenge of entering computer networks (Himanen, 2001). Hacking a system provides a level of interest in what might be found as well as providing the thrill that comes from the danger of being caught (Van Beveren, 2001). Just operating in the virtual world itself is also appealing to those individuals who find in it an alternative to the demands and complexities of human relationships (Forester and Morrison, 1994) and an escape from the reality of life. Quittner reports that, because of the difficulty many computer hackers experience interacting with the real world, psychologists assign a deep sense of inferiority to their psyche which can be alleviated by the sense of power and control gained by disobeying the rules or inflicting damage (Quittner, 2004). Interestingly, there has been little mention of escapism as a motivation.

Not all hacking is seen as anti-social, and in fact the manifesto adopted by early hackers (Blankenship 1966) states the reason for hacking as learning. Times, however, have changed. Leeston and Coyne (2006) report that 36% of hackers they surveyed hack so to help improve computer systems, 34% to solve puzzles, and 5% to make the world a better place—although they also report that hackers enjoy misleading researchers about their motivation. They also report that, according to Schell and Dodge (2002), 11% of hackers are malevolent. The motivation for developing hacking skills may come from the perspective of white hat system penetration testing (Lakhani and Wolf, 2003). Hackers can contribute to open source software testing to find flaws which can then be fixed to prevent malicious attacks resulting in real damage. Slightly less convincing is the argument that hacking is necessary to counter a totalitarian government by finding out what information is held and making it publicly available (Forester and Morrison, 1994), and some hackers purport just to believe in the ideal of free access to all information (Voiskounsky et al, 2000). Taylor (1999), however, notes that self-attributed motivations by hackers are typically after-the-fact self-justifications.

Social networks play a significant part in hacking. Hacking can instill a sense of belonging by achieving the recognition of peers; it thrives in a cyber-community of hackers which congratulates members on successful infiltrations and, in some cases, rates success on the extent of damage or defacement achieved. Fame as a hacker becomes highly desirable within this counter-culture, exacerbated by mass media sensationalism and condemnation of hacking attacks. Even those in the industry send a confusing message, as some businesses hold hacker challenges, and some even consider it acceptable to hire past or current hackers as security consultants (Schultz, 2002). Leeston and Coyne (2006) suggest that some hackers are motivated by the value of the fame achieved, and another group for financial gain—cyber criminals. They also note that, in the former case, legislative controls do little to discourage hackers. Sorenson (2003) provides a broad review of the hacker culture, with a focus on the social subculture of hacking.

The virtual nature of electronic systems also plays a part in hacking. The impact of a hacking attack can often seem unreal and is therefore easier to ignore by the hacker. A lack of empathy, usually associated with the concept of ethical flexibility, is compounded by the impersonal nature and almost game-like qualities of cyberspace (Shaw et al, 1998).

Some psychologists believe there is a subconscious tendency in hackers towards either criminal or harmful behavior, the actual cause of which is hard to define (Van Beveren, 2001). This behavior may be revenge for imagined or real slights, and may target a specific company, a particular country, or society itself (Forester and Morrison, 1994). There can also be tangible rewards for the unethical, such as the financial and other returns that might result from theft of credit-card numbers (Ananova, 2004), (Constanzo, 2003), changing university records (Farrel, 2002), or in some cases stealing identities (Synovate, 2003).

Psychological Theories of Motivation

There are a number of mainstream psychological theories of motivation for actions in general. Ajzen's Theory of Planned Behavior (Ajzen, 1991) suggests that there are three determinants of intention: attitude to behavior, subjective norms, and perceived behavioral control, and that these all have implications for performing a behavior. The Theory of Planned Behavior can be used in a variety of contexts to not only explain and predict behavior patterns, but also to devise strategies for changing behavior. It has been successfully used to explain the motivation for computer crime (Folz et al, 2002) and to conclude that peer pressure is a major driver. From this, it has been suggested that efforts to reduce misuse should focus on reducing the effect of social networks, i.e. reducing peer support and encouragement for the activities. However, given the closed groups in which hackers tend to operate, changing the subjective norms of a hacker community may be a significantly difficult undertaking.

There is another less well known psychological theory which has its origins in psychologists' desire to understand what causes the intense involvement in an activity for which the motivation cannot be explained by traditional psychological or survival theories. Csikszentmihalyi (1993) proposed the concept of a flow experience which could be used to explain children's play, education, and happiness or subjective well-being, and to aid occupational studies to try and investigate the enjoyment some people found in their work. This concept has been applied in psychotherapy for those exhibiting deviant behavior (Csikszentmihalyi and Csikszentmihalyi, 1988) and studies have also been carried out in the field of education (Chan and Ahern, 1999; Parr et al, 1998). Flow theory has been used to explain certain compulsive phenomena in the use of online environments (Csikszentmihalyi, 1990; Novak and Hoffman, 1998; Takatalo, 2002). John Van Beveren (2001) has proposed that the development of a computer hacker should be considered in the context of flow theory.

Flow Theory

The Flow Experience is a state of consciousness that is intrinsically motivated and for which the energy invested in the experience is not for genetic or cultural survival, but rather the enjoyment and inner harmony attained in the experience itself, which reaffirms a sense of self (Csikszentmihalyi, 1993). Future rewards or advantages provide little motivation, and the specific state experienced is sought simply because it is so desirable. Although any activity may engender a state of flow, it typically occurs in those which are clearly structured.

There are two common characteristics of activities which provide an individual with the opportunity for flow.

- The first is that the activity is sufficiently absorbing to remove all irrelevant thoughts which might divert the thought process from the task at hand. This merging of awareness with the action at hand leaves no room for the intrusion of everyday worries and preoccupation.
- The second is that it provides a balance between challenge and skill. The challenge, meaning simply an opportunity for action, must be sufficient that the task not be boring, but not so much that it is beyond the participant's ability. Individuals experiencing flow all report feeling a sense of control over the challenge, and that by applying their skill and concentration they are capable of assuring a favorable outcome.

Two additional characteristics have also been suggested: curiosity and intrinsic interest (Shernoff et al, 2003). Curiosity drives the individual to pursue the activity and can be linked with a sense of satisfaction or accomplishment once the task is completed or the knowledge attained. Intrinsic interest in an activity provides the basis for further involvement purely to experience the activity again. This is closely aligned with curiosity. The autotelic nature of an experience, that is, the desire to perform it for its own sake rather than for any external rewards, is crucial to experiencing flow.

Because flow depends on a balance of challenge and ability, to sustain it there has to be an ongoing growth in the complexity of the activity and in the ability of the person to perform it. The intrinsically rewarding nature of the flow experience leads to replication of the experience; this leads to growth in the individual's skill, which then allows the individual to seek out more complex activities to maintain the balance required to repeat the flow experience. These characteristics make flow theory a good tool to use in understanding the hacking experience.

Van Beveren considers the three major psychological theories of crime—psychoanalytic theory, learning theory, and control theory—as possible ways to explain hacking, but reports that they 'do not seem to account for the behavior of hackers'. He notes that some of the conventional explanations are 'similar to the antecedents for construction of flow', and then proposes Flow Theory as a better explanation for the development of hacking skills. He suggests a model of hacker development which involves beginners (script kiddies) progressing on the basis of their flow experience to either cyberpunks who are hackers behaving in generally vandalistic ways or penetration testers, hackers who use their skills to help identify weaknesses and hence secure systems. Van Beveren puts forward six propositions of this model: that toolkits which are available to script kiddies must be successful; that the development of skills is dependent upon the tools and challenges in the online environment; where sufficient challenges and tools exist to develop skills, flow will occur; that a script kiddie becomes a cyberpunk or penetration tester through the development of skills; experiencing flow rapidly increases the motivation to find new challenges; and that criminal tendencies would pull the script kiddie towards the cyberpunk rather than penetration tester.

Flow theory can explain the fascination with penetrating computer networks and systems experienced by some individuals. In the activity itself, the two preconditions of absorption and a balance of challenges and ability can be found. The challenges faced by computer hackers, and the skills they require, vary enormously as their knowledge of available tools, understanding of how networks and network devices work, and ability to program or develop scripts increases. The challenges inherent in computer hacking are likewise variable, as the levels of security on different networks and between systems vary, as does the level of difficulty within even the same task, such as breaking different password or encryption schemes.

The emotions reported by computer hackers are similar to those reported by individuals experiencing flow, and some of the traditional explanations for hacking can be adapted to fit under the flow model. This would see the intrinsic motivation that comes from the entertainment value in hacking, described above, account for the enjoyment factor necessary as part of the flow model. Likewise, curiosity has conventionally been put forward as an explanation for the attraction of hacking, and is indeed one of the components of the flow experience. Curiosity is fulfilled by the inherent nature of hacking, in that it intrudes into and spies on other systems and computers. The required focus of attention in computer users was shown in studies (Webster, 1988) in which users reported being mesmerized by the computer. It is easy to imagine that, as computers are limited to a single screen with limited output and input, the field of concentration is easily narrowed to focus on the virtual environment. Hackers also experience a degree of control over their activity, knowing that their intrusion has the potential for success, dependent on the successful application of their skills to the activity.

Addressing the Problem

Traditional Solutions to Hacking

Many countries have enacted computer legislation which provides penalties for a wide range of computer-related crimes, including hacking. Legislation, however, has not been a total success. Subsequent to the adoption of initial computer crime legislation in the US, it had been argued that the lack of severe punishment contributes to the hacker problem; until November 2003, prosecutors in the United States of America had to show that computer criminals caused at least $5,000 in actual losses to secure a conviction. In the UK, computer crime legislation does not apply to the significant number of hackers who are juveniles; in a study of hackers detected by British Telecom, the average age was 21, with the youngest being 14 years old (Hoath and Mulhall, 1998). With over 2000 system intrusions reported in the CSI-FBI survey over a twelve month period (Gordan et al, 2004) it appears that legislation even with expanded penalties has limited effect. Partly this is due to the difficulty in pursuing and prosecuting trans-jurisdictional crimes, but also partly due to the limited extent to which consequences play a part in the juvenile and teenager's frame of reference. Kevin Mitnick is reported to have argued that expanded penalties will be very unlikely to deter hackers as the remoteness of the virtual world and the hacker's belief in his own skill ensure the hacker will be in denial of being caught (Krebs, 2003). This idea seems to be gaining traction, with Yar (2005) suggesting that punitive strategies for the law enforcement response to hacking are giving way to rehabilitation as for other addictive behavior. In a more general vein, it has been suggested that understanding what drives hackers to infiltrate and explore computer systems can assist in developing preventative measures to the burgeoning problem of hacking, and crime prevention should be used to complement prosecution (Canadian Safety Council, 2004).

In a discussion paper for the UK Government, the issues related to changing behaviors through personal responsibility are discussed (Halpern et al, 2004). They note that over the last ten years there has been a growing public concern about various anti-social behaviors, and that behaviorally based intervention is more cost-effective than intervening in the consequences of incidents. Of interest are their reports that parental intervention at an early stage can be effective, and the use of formal warnings in the form of Acceptable Behavior Contract result in a marked improvement in behaviors. These contracts are made between an individual and an authority (parental or official) and are designed to ensure the individual acknowledges their antisocial behavior and the effect that it has on others. One common problem with government intervention, however, is that it often assumes behaviors typical of the 'rational man', but Halpern notes that this may not always be a valid assumption, especially when peer pressure exists. They suggest considering, rather than the rational man, the ecological man which defines the man in terms of individual, interpersonal (e.g. peers), and community contexts. While they indicate a range of theories and discuss various approaches, they also note that the field is relatively underdeveloped. Nevertheless, with flow theory providing an insight into the motivational basis for hacker development, and the Theory of Planned Behavior and the ecological rational man providing an insight into control variables, it is possible to develop a novel strategy to address hacking.

Security in the cyber environment is currently being addressed through an increasing level of cyber policing. Many countries now have computer crime legislation and operate eCrime units which comprise not only computer forensics teams but also a proactive Internet policing service. Computer Emergency Response and/or Critical Infrastructure Protection schemes often include a 24 x 7 watch service which alerts police to potential cybercrime. In the US, the cyber-watch service is proactively watching for indicators of impending attacks (Hale, 2003); the Indian CERT includes 'attacker profiling' as one of its functions, and India has opened cyber crime police stations including the e-Police Station in Bangalore which was formally notified in 2001; Viet Nam has recently established a cyber police force which is pro-actively working with ISPs and Internet Cafes with a focus on political use of the Internet, as has Tunisia; Egyptian Police have reportedly carried out Internet entrapment to identify and arrest homosexuals; China is active in prosecuting cyber crime and pursuing cyber dissidents (Richardson, 2004); and Japan has recently prosecuted a lecturer for developing and distributing anonymous FTP software that can be used to abet cyber crime (VWUJ, 2004). The extent to which countries are committing to cyber policing is in some cases staggering. China, for example, is said to have over 50,000 cyber police manning the 'Golden Shield' project, a special firewall development focused on monitoring internet traffic for crimes, including political dissent.

One particular cyber crime has gained sufficient notoriety to justify proactive cyber policing and international cyber cooperation. The Scottish Evening News on 29 June 2004 reported that cyber police in the UK, United States, and Australia patrol chat rooms seeking out child pornographers, and the Canadian RCMP is involved in a similar initiative. The success of chatroom patrols suggests that proactive policing could emerge as an increasingly effective countermeasure in the cyber environment, and a priority area for such action arguably would be monitoring the development and exchange of hacking tools through chatrooms, hacking warez sites, and from known hacking-oriented servers. Taking the initiative and patrolling the hacker environment could reduce the availability of tools, discourage access to them by would-be hackers, and identify at an early stage users of such tools.

Virtual Worlds as Future Social Networks

While Virtual Worlds have been discussed and trialed for some time, it is only recently that they have started to emerge as a major new social networking environment. Unsurprisingly, its emergence has been quickly followed by new ways of hacking and committing computer crime. One Virtual World, Second Life, has now gone beyond the point of critical mass at which it is sustainable, and with over 11 million residents it is likely to be a dominant environment into the future.

Second Life is in many ways the ultimate social network, in which a person can participate through their avatar in a world of social interactions in which many of the boundaries of normal life can be removed. It is also an environment where real world norms are suspended: in Second Life, avatars can fly; distance is removed through the ability to teleport; and there are no laws or law enforcement systems other than peer reporting to the system administrators. Islands can be designated as places where avatars can attack other avatars, and being killed means little more than having to log in again.

In its limited existence so far, Second Life has found the problems facing Internet commerce to be just as much a problem in the Virtual World. In early 2007 Second Life was the target of phishing attacks, and in July 2007, Second Life's World Stock Exchange was hacked and over 3 million Linden dollars funds taken. The Second Life databases were hacked in September 2007 and account details and encrypted password and payment files taken. A hacker cracked one of the standard banking software systems in November 2007 and stole funds from the L&L Bank trust (Second Life Herald, 2007), and in December 2007, a vulnerability in Quicktime was exploited within Second Life to covertly take money from avatars who watched streaming video (Second Life Blog, 2007).

The use of Second Life as a platform to launch attacks on real world servers is an area of future concern. The communications facilities exist to issue packets from Second Life into the real world, either to control external malicious servers (known as bots) or to directly attack target systems. It is likely that the range of communications capabilities and hence attack vectors will increase as the Second Life system develops. The ease by which restricted access hacker social networks can be developed within Second Life and the level of anonymity that can be achieved is likely to encourage this as a major, if not the dominant, source of future hacking attacks. The response to this threat will need to involve active participation by law enforcement in much the same way as bulletin boards, chat rooms, and warez sites have and are being monitored. However, law enforcement agencies will face a great number of legal and judicial challenges as they seek to trace offenders through Second Life.

Combating Hacking Through Their Social Networks

Most countries have taken the legislative approach to combating hacking, the US since 1984. This has not proved to be a complete answer to deterring hacking. Nevertheless, New Zealand in 2004 enacted powers to prosecute for the distribution or possession of malicious software, and this allows prosecution not only of the offender for committing a crime, but also the supplier of such software on the basis of aiding and abetting a crime.

Flow theory highlights the fact that a prerequisite for the development of hacking skills is the ease in which would-be hackers can enter the community and gain access to the malicious software tools needed to start the flow experience, and their effectiveness. Access to these tools is an important control variable—without tools there would be no flow experience for many script kiddies, and teenagers would quickly turn their attention to other more benign cyber activities such as online computer gaming.

The approach being taken in the UK and the US of encouraging parental controls at an early stage to reduce peer pressure, formal education later to reinforce acceptable behaviors, and cyber policing as a pre-crime deterrent, is designed to substantially reduce the incidence of antisocial computer activity.

Taken together, these various themes can be integrated to achieve a wide-covering and coherent strategy for combating hacking:

- **Parental Control.** This is a positive factor that can influence the proclivity to commit computer crime. 'Responsibilities of Cyber-citizenship' is now one of the parental talks that are encouraged in the US (Reno, 2000; Stansell-Gamm, 2003) in order to teach children about the antisocial and eventually criminal nature of hacking activities. Parental education and the encouragement of parental control over Internet use will in time also help reduce the incidence of hacking.
- **Computer Ethics Training.** Peer pressure is probably the hardest variable to control, and is a major factor in many other forms of temptation through the teenage years. Traditional methods of addressing the issues of

peer pressure can be applied through not only parental control as above, but also through education channels and preventative policing programmes focused on hackers social networks. There has been some concern voiced that students in computer science are being taught the technological skill to create havoc without learning the ethics to ensure their skills are utilized only in a benevolent fashion (King and King, 2000), and this has resulted in an increasing adoption of computer ethics training as part of computer science courses.

- **Cyber Police Patrols.** Cyber police patrols focused on identifying early signs of aberrant behavior, including malicious tool exchange, in advance of an offense being committed could achieve a significant reduction in downstream investigation and prosecution costs. The use of formal warnings and establishing acceptable behavior contracts would be an effective control in many cases. As was seen through the law enforcement response to bulletin boards, active patrolling of the cyber environment is a major deterrent to hackers.
- **Legislation.** There will always be those for which parental control and ethics training does not work, and legislative controls will be needed as a final deterrent.

Conclusions and Future Research

This chapter reviewed the various reasons put forward as motivations to hack, and also looked at various strategies for combating hacking. The resulting synthesis is a comprehensive strategy to discourage youngsters from starting hacking and to minimize the flow factors which would encourage script kiddies to progress to become more serious malicious hackers. However, the deployment of this strategy is only feasible at a national level and so validation is difficult. Further research is needed to identify whether the introduction of formal parental control regimes has made any difference to the incidence of hacking. Further research is also needed to determine the most effective means of carrying out cyber patrols and the protocols for response in the event of detecting a potential problem. Formal research is also needed to determine the role of escapism in motivating youngsters to hack.

This chapter also presents some issues related to hacking and the emergence of virtual worlds. Some questions that need to be answered are: Are hackers currently using virtual worlds as social networking and warez sites? How anonymous are virtual worlds, especially where the server technology is distributed? What are the forensic traces necessary to identify hacking activity from or through a virtual world? This is an area of increasing research significance which needs to be more seriously addressed, as there is considerable potential for further research.

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KEYWORDS

Cyber Police Patrols: Law enforcement staff browsing the internet in order to detect and prevent cyber crime.

Hacking: The act of remotely accessing a computer server or network without authorization.

Flow Theory: A psychological theory which addresses compulsive behavior caused through a positive feedback loop.

Social Networks: Relationships between people with a common interest and a need to intercommunicate.

Second Life: A virtual world which enables a wide range of activities and experiences.

Chapter XIV
Emerging Cybercrime Variants in the Socio-Technical Space

Wilson Huang
Valdosta State University, USA

Shun-Yung Kevin Wang
Florida State University, USA

ABSTRACT

This chapter examines the gaps that arise between reactive social control systems and proactive technology systems. The authors further link these gaps to cybercrime patterns and growth, by a theoretical framework that depicts the role that cybercrime plays in different gaps. This further suggests a typology of cybercrime, based on instrumental vs. expressive differences between offenses. Recent and emerging criminal activities and formal and informal control responses are reviewed and evaluated to illustrate this cybercrime framework and typology. The result is proactive strategies that can help prevent cybercrime from occurring in the disjoints between social and technical systems.

The world has become too dynamic, complex and diversified, too cross-linked by the global immediacies of modern communication, for stability of thought or dependability of behaviour to be successful.

—Timothy Leary (1920-1996).

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INTRODUCTION

The advent of the Internet has undoubtedly revolutionized the way we work, communicate, entertain, learn, and think in the physical world. The Internet and its associated technology have created numerous, unprecedented forms of human interaction in a new, virtually constructed space, known as **cyberspace**. This social cyber milieu is invisible and intangible**,** but like oxygen, we know it exists in the human community (Rho, 2007). Relying on the Internet's interconnected computer networks, users can practically transmit information to one or countless recipients any time of the day or night over continents without physical constraints. This unbounded ability to communicate has created virtually limitless opportunities for innovators, resulting in new ways of human relations and interactions expressed in a variety of forms.

Yet like most innovations which have a tendency to crime (Merton, 1968), the Internet holds potential for misuse and abuse of information in human interactions. Crimes committed on or through the Internet, so-called **cybercrime**, are common and indeed soaring (Cisco, 2007). A survey of computer security officials discovered that about half of responding companies experienced increased numbers of security incidents between 2004 and 2006 (Computer Security Institute, 2007). The survey further showed that as the incidents of cybercrime increased, the financial losses caused by these crimes escalated as well. These facts attest to the rising severity of crime resulting from the social system's inability to match the rapidly progressing technical system. How is this mismatch between the social and technical systems formed? How has cybercrime grown and expanded in this gap between the two systems? Finding answers to these questions is an important step in combating cybercrime and in some way helping to achieve a balance between the social and technical systems.

This chapter attempts to examine the evolution and growth of cybercrime in the gaps existing in the socio technical space. The chapter starts with a conceptualization of cybercrime and the creation of a classification scheme. The classification explains the role that information plays in variations of cybercrime. Next, a framework is introduced to depict how types of cybercrime have evolved in the socio-technical space. Recent cybercriminal activities are evaluated to illustrate the framework. Social responses in terms of formal and informal controls are also examined to assess their effectiveness in cybercrime mitigation. The main purpose of the analyses is to identify strategies which can better control crimes already active on the information superhighway and prevent the emergence of new variants of cybercrime.

Defining Cybercrime

The term cybercrime can be defined in a variety of ways depending on the perspective from which research is taken. The prefix "cyber" in Greek refers to navigation (Pangaro, 1991). Literally, cyber techniques are an art of steersmanship (Guilbaud, 1959). The cybernetics literature has built the foundation for the notion of a cyber system (Parsegian, 1972). In this cybernetic frame of reference, complex systems of technology, sociology, biology, psychology, communication, and many other fields can be combined to explain interconnectedness of human and machine. Cybercrime, as a member of the interrelated network, is thus confounded with numerous elements in the social and technical systems.

From a sociological point of view, cybercrime is not different from other types of crime. (Emanuelsson-Korsell & Söderman, 2001). Both are crimes of opportunity committed by a motivated offender against a suitable target under an unguarded condition (Cohen & Felson, 1979). However, cybercrime is also a technology offense. As Brenner (2007:386) stated, it is "the use of computer technology to commit crime." Because of the continuous breakthroughs in Internet technology, cybercrime can evolve into a new generation of criminal acts unseen and inexperienced. In this chapter, we take into account the socio technical aspects of cybercrime, and define it as a law violation involving abuse or misuse of information explicitly on or through the Internet. The specific function that information plays in a cybercrime can determine the nature and type of the illegal act. For instance, a 1994 report published by the U.S. Department of Justice included the following three categories of **digital crimes**: information as contraband, information as an instrumentality, and information as evidence (Casey, 2004). In this classification, a cybercrime is investigated based on the presence or absence of contraband information (e.g., an encryption software), information means (e.g., virus codes), and records of information (e.g., Internet access logs). A study by Emanuelsson-Korsell & Söderman (2001) focused on five types of information-technology crimes: computer viruses, unlawful access to computer systems, manipulation of data, theft of information, and fraud. Criteria relating to abused data or financial gains were employed to classify these crimes. Similarly, Moitra's study (2004) of cybercrime taxonomy categorized crimes and victims by type of harm—either physical or information related. Each of the two types of harm can further be categorized as individual, such as spamming, or essentially organizational such as defacement of a corporate webpage. Moitra also provided a classification for cyber criminals according to their motivations. These include material and symbolic gains; examples are money, thrills, reputation and ideology.

Cybercrime, nonetheless, does not exist in the cyberspace. But information does. In the virtual ecosystem, information is infused to facilitate each and every aspect of digital interchanges. Information is passed around in all directions for human expression and interrelation. This infusion can be propagated for psychological gratification, monetary gain, or other fruits of crime (Casey, 2004) such as illegal software. The content of the information in a crime therefore reveals the motivation of the offender and type of targets to which the information is delivered. Given that cybercrime is substantiated by the information embodied, it is imperative to consider the target and potential gains of such information in the construction of a cybercrime typology.

Table 1 displays a taxonomy for a dichotomy of instrumental and expressive cybercrime. The classification logic is similar to the categorization initially adopted by Chambliss (1967) in his analysis of effects of differential sanctions on instrumental and expressive crimes. According to Chambliss, crime for gain is "instrumental to the attainment of some other goal" (1967:708), and expressive crime is committed because "the act was satisfying in and of itself" (1967:718). Likewise, **instrumental cybercrime** is committed primarily for material gain; the goal is to maximize the profit with minimum effort. Gains may vary from the acquisition of money, merchandise, and data, to non-tangible items like services and confidential information. **Expressive cybercrime**, on the other hand, focuses on human relations rather than profit. These crimes maybe committed for fascination, friendship, revenge, or other interpersonal reasons such as pleasure. Expressive cybercrime may also be related to political ideology, environmentalism, or passion for social justice. Both categories of cybercrime can be further broken down into either individual or organizational types, depending on the target being victimized. Individual cybercrime is more likely to occur than its organizational counterpart because of the larger potential pool of Internet users and their weaker resources for protection. The four cybercrime categories are classified generally according to the basis of potential gains obtained from the crime, and the victim type.

Cybercrime in Different Gaps

As Internet technology and innovation continue to progress with high demand from the general public, cybercrime evolves quickly with new information absorbed during the progression. This evolution is evident by the recent adjudication of cases by the U. S. Department of Justice (2007) and from studies by computer companies (Cisco, 2007; Symantec, 2007). While cybercrime is growing at high speed, responses of the criminal justice and legal systems are ordinary and passive. The essence of social and legal responses is mainly reactive, regardless of the nature or seriousness of cybercrime variants. In contrast, the technological system is a proactive

Table 1. Cybercrime classification and examples

Target of the misused information	Instrumental Cybercrime	Expressive Cybercrime
Individual	Crimeware Identity theft	Child exploitation Online stalking
Organization	Denial of service attack Corporate espionage	Warfare terrorism Website defacement

one driven by initiation, competition, and expertise of innovators. Once a technological product is invented and manufactured, social control agents then respond to the technological innovations by applications on crime prevention and criminal justice administration. This lag is inherent between social responses and innovative technologies.

In addition to the response difference between the reactive and proactive systems challenging cybercrime mitigation, the freedom of personal space on the Internet poses another hazard to social control. The proximity and scope that traditionally have restricted offenders to local crimes with single victims have broadened to international arenas where the number of victims is at liberty (Jones, 2007). The general axiom of offender-to-victim relation of a physical crime has also changed in cybercrime (Schlegel & Cohen, 2007). Personal acquaintance and socio-economic similarity between offenders and victims, which traditionally have been factors in crime, do not apply to cybercrime. These revolutionary features associated with the cyber technology have not only produced new crimes but also propel these emerging crimes at a rapid rate. This discrepancy between the proactive/fast Internet technology and the reactive/slow social system in the virtual space has created a cyber gap which breeds crime. The triple-A Engine of accessibility, affordability, and anonymity of the Internet (Cooper, 2002) may have been advantageous to offenders rather than the police in this cyber gap.

Figure 1 depicts the cybercrime gaps that form between and along the social and technical systems. The Figure is based on a theoretical framework initially developed by Ackerman (2000), Whitworth and de Moor (2003), and Whitworth (2006). The socio-technical gap in their studies of online community refers to a mismatch between what the social system is supposed to do and what the technology can support. They maintained that individuals in the social system have utilized the web of computer networks for interaction, expression, communication, expectation, and other needs. In their views, the needs of society have not been met because of the deficiencies in technology capabilities.

In the framework of cybercrime as diagrammed in Figure 1, we maintain a similar assumption that agents of the social system manage and propel elements in the technical system. However, the Figure implies that the technical system represents not only the computer hardware, software and their associated technology, but also the virtual space defined by the interrelated networks of machines. The socio-technical gap in this cybercrime framework is a lagging condition of the social control system correspondent with a less-supportive technology. This lack of technological support has resulted in such a gap where nonconformities and outlaws have increased too fast to be kept under control by the social response system. As indicated by the horizontal lag, the disproportional growth is conditioned on the developmental speeds of the social and technical systems.

Another margin of space shown in the Figure is the upright, virtual distance called the **cybergap** located between the social and technical systems. This gap signifies the inherit discrepancy existing between the physical and virtual environments. Like the socio-technical gap, nonconformists can exploit this cybergap, victimizing individuals and organizations over the Internet for either gratification or instrumental reasons. The Figure suggests that crime variants in the cybergap are distributed according to the nature and kind of **human computer interactions**. The degree of variations will increase with both the importance of human relationships in the social system and the diversity of invented products in the technical system. The popularity and dominance of either system in the cybergap to some degree determine the share of the cybercrime distributions.

As Figure 1 suggests, expressive cybercrime will take over more space in the cybergap when human relations in the social system are intensified. Imagining an information warfare between two countries, website defacements could be a highly common tactic used by either side. By the same token, a greater proportion in the cybergap will lean toward instrumental cybercrime when the technology system is more prominent than the social system. For example, the popularity of peer-to-peer (P2P) file sharing platforms has led to overwhelming illegal downloads of copyrighted products in our generation. This global prevalence is infused mainly through technology instead of meaningful human interactions. The current cybergap is obviously dominated by violations committed for instrumental gain rather than human expression.

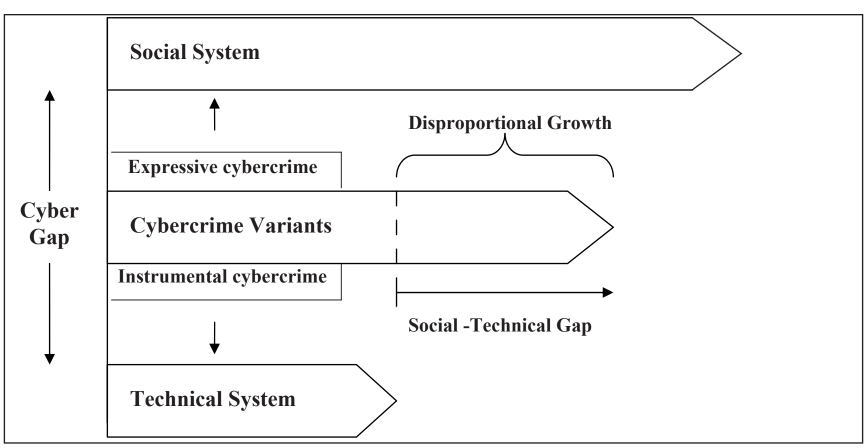
Emerging and Growing Cybercrime Variants

The following examples illustrate in more detail the role of social and technological interconnections in defining the modern variants of cybercrime. Two examples of instrumental crime—crimeware, identity theft—and one for crime of expression—child exploitation—are examined. These crimes have been forecasted to be more threatening in the near future (Taylor, Caeti, Loper, Fritsch & Liederbach, 2006).

Crimeware

The uninvited interference codes that enter a computer system have evolved over time by methods of intrusion and motivation. In their first generation, unwanted codes are penetrated into a user's computer by means of disks, email attachments, graphs, and downloads. These malicious codes turn into viruses, worms, trojans, and time bombs attacking the computer's memory and storage, leading to the breakdown of computers, servers and even the entire network. Since the mid-1990s, when more Windows-based programs became available, we have witnessed screen pop-ups generated by adware and spyware as we have surfed on the Internet. These unwelcome pop-up ads represent a transition from hidden codes to visible advertisements, and from not-for-profit hacking to commercialization for profit. In response to the vast presence of these unwelcome advertisements, computer hardware and software have been developed to enhance the protection of computers from unauthorized intrusion. The appearance of unwanted materials on screen has reduced significantly due to these protection devices. But as the security environment improves,

Figure 1. A cybercrime framework of social and technical systems



the technology that controls access to the computer and Internet become more sophisticated. Wireless connection coupled with the P2P file sharing networks, in particular, provide abundant windows of opportunity for criminals to invade and control someone's computer from a distance.

In recent years, we have observed a new round of transformation in which **malware** is able to take possession of an infected computer and use it to perform illegal activities. The computer security industry has warned that this new type of attack, performed by "botnets," is one of the top threats to Internet security (Cisco, 2007; Symantec, 2007). Short for robot, a bot is a computer program used to gain unauthorized access to vulnerable computers through P2P sharing channels or trojans. Botnet refers to a network of compromised computers called "zombies" configured to launch attacks from command-and-control servers operated by remote hackers. A botnet can infect millions of computers via the formation of the army of zombies. Botnet herders can also use the unnoticed codes to track signals of keystrokes entered on the infected computers, scan credit card numbers and owner names, uncover account names and passwords, and steal other confidential information. Furthermore, botnet owners can use the zombie computers to launch spamming or initiate denial of service attacks on behalf of others, harvest email addresses, and engage in many other schemes including wiretapping and defrauding banks. Recent "botware" products have begun to create zombies through channels used by MySpace and MSN Messenger (Vaas, 2007). Considering the potentially large number of users of these services, the attacks can be more extensive as bot intrusion techniques advance.

The evolution of malware from virus to botnet suggests that the exploited information by criminals is moving toward more control and greater gains. The real driving force of the movement is profit. Viruses, worms, trojans, and many malicious codes have been commercialized for sale; spyware and adware are popular tools for marketing products. In this profit-driven process, both technology and socially defined gains have mutually created new variants of crimeware**.**

Identity Theft

An introduction of how we identify individuals in the civilized world is necessary before analyzing changing features of identity theft. Crume (2000) and Foster (2005) have discussed three general principles commonly used to determine or verify the identity of an individual. The first principle is that the individual must *know* something, such as his or her ID and password in order to access information. This method has been broadly applied to secure email accounts and other types of personalized services, such as online banking and financing. The second is that the individual must physically *have* something, such as a key, a piece of a document or a smart card. Holding a passport to go through customs is an example. The third is that the person must *be*—biologically—who they are claiming to be. In this method verifying a person's identity involves the use of biologic characteristics such as fingerprints, iris, odor, voice, and hand geometry. The third method may be the most secure method of the three, but it is also probably the most expensive because of the advanced technology required and the relatively large space needed to store identity information. Two or more of these principles can be adopted simultaneously to better protect personal information and belongings. The ATM card is an example of the combination of the first two identification principles — a user needs to present an ATM card (*have* something) and type in a password (*know* something). This dual combination can increase the level of protection of personal access (Crume, 2000).

Today, the majority of online activities only use the first layer (*know* something) to verify a user's identity. Hence, obtaining information about an individual—including but not limited to a user name and password, government-issued identification numbers, bank account numbers and credit card numbers—has become the only requirement for potential identity thieves to access others' personal information and pretend to be another person online. Further financial and credit damages can be done easily once a thief gains access to critical information, such as Social Security number and date of birth. For instance, identity thieves may "**breed**" further identities, creating more widespread and long-lasting damage. In this context, the term "breed" refers to the unauthorized use of identification means to generate and/or acquire additional fraudulent means of identification. It has been estimated that the financial harm toward victims is seven times more than the visible financial loss if the stolen identities are used by breeders to open new accounts, compared to abusing just existing accounts (Synovate, 2003). The above mentioned activities can be done easily and exhaustively in the cyberspace.

A recent example which illustrates the large scale of identity stealing acts is the underground online market for warehousing and selling stolen information. Symantec (2007) reported that underground economy servers, which are used by criminals and criminal organizations to sell stolen identity information of individuals, have emerged as a growing problem. For example, Symantec observed more than eight thousands unique credit cards advertised for sale in the first half of 2007. In addition, underground data warehouses have exchanged bank accounts, email addresses and passwords, Social Security numbers, and some other confidential personal information. The "price" of this illegally obtained information ranges from US$30 to $400 for a bank account, $5 to $7 for a Social Security number, and $0.5 to $5 for a credit card. The digital information of different kinds of identities stored in underground market servers has generated unprecedented opportunities to make profits from illegal transactions of this information.

Another widely used technique to steal personal identity information is **phishing**. The term phishing originated in early 1996 on the alt.2600 hacker newsgroup, where members discussed computer hacking and telephone phreaking on the posting board (Anti-Phishing Working Group, 2007). Hackers who knew how to crack the telephone network to make free long distance calls were called phreakers, and a hacked account was named "phish." During the early stage of phishing, phreakers routinely traded active AOL phish for free software. But just as crimeware evolved into profit-making practices, the simple stealing of AOL dialups has become a greedy act solely for monetary gain. The contemporary operation of phishing scams has adopted spamming emails in conjunction with fraudulent websites to steal pieces of confidential personal information. This stealing form, also known as a **social engineering**, is where fraudsters design and implement logical procedures to persuade victims to supply confidential information to a spoofed entity (Rhodes, 2006).

As the social aspects of phishing scams diversify (i.e., growth in the number of fraudulent emails, websites, and the types of targeted financial institutions), so does phishing technology. A variety of techniques have been used by phishers to evade anti-spamming or other phishing detections. For example, one evasion technique used by a phisher is to deliver the deceitful message in an email as a picture rather than text to avoid text-based anti-phishing filters. This hiding technique has been expanded to other formats such as PDF, MP3, Excel files (Mail-Filters, 2007). Technical sophistication is also reflected in the recently discovered toolkits studied by Symantec (2007). These toolkits are highly automated in terms of creating and sending phishing email messages and setting up websites that can spoof legitimate entities of different brands. The professionally-made kits can establish multiple fraudulent websites on the same compromised computer. These features enable phishers to generate a large number of phishing emails and fake multiple brands in a short period of time.

Complicating the social engineering scheme is voice phishing, known as **vishing**. Vishing goes beyond routine phishing by using Internet telephony's voice messages to facilitate the social engineering engagements with victims. This new scheme emerges as a result of the IP-based voice technology VoIP, short for Voice over Internet Protocol. With the assistance of VoIP technology, it is easy for phishers to increase automation and versatility in contacts with victims while maintaining their anonymity. In addition to emails, phishers employ mobile text messaging, voicemail, and live phone calls to initiate and execute their attacks (Ollmann, 2007). The full-fledged employment of these verbal and non-verbal methods is expected to gain a much higher rate of success than text-based phishing. Ironically, this more personalized scheme is accomplished mainly through automated harvesting on victim data. The professionalization of phishing products combined with the personalization of vishing will undoubtedly increase the chances of success of this type of instrumental theft.

Child Sexual Exploitation

Sexual exploitation of children and the Internet have become almost inseparable in this information age. During the pre-Internet era, child sexual images shown in photographs, films, and videocassettes were distributed through traditional delivery methods such as the postal service, adult stores, or commercial dealers. Although these conventional means of distribution remain operational, their role has been replaced largely if not entirely by Internet transmissions. Sentinel data have clearly demonstrated a persistent upward trend in the distribution of **online child exploitation** images over the past decade (Internet Watch Foundation, 2006).

A great concern accompanying this growth is the blending of the child pornography producer and victim. A New York Times reporter (Eichenwald, 2005) in his investigation of Webcam child pornography discovered that several hundred pornographic websites were created by teens to advertise pornographic showings of themselves. Within a week, Eichenwald was able to identify Webcam images of 98 teenagers. This discovery suggests that gratification from money, gifts, fame, and other profits received by the operating teenagers, plus the ease of site creation and networking, will drive more youngsters to operate online pornography businesses by themselves. To predators, the interactive nature of live broadcasting makes sexual displays more exciting and participative. Instant images also allow predators to evaluate whether the subject is a minor or not. Webcam technology has made the delivery of images more appealing to predators, while making it more difficult for the police to catch pornography consumers with decoy operations.

The growing popularity of social networking sites such as MySpace, Facebook, LiveJournal, Xanga, MyYearbook, Friendster, etc. have worsened the nature and scope of child exploitation. Some online child pornographers have gradually changed their role from passive possessors to aggressive producers or predators (Taylor and Quayle, 2003). It is well known that peer networking sites, especially MySpace, have been utilized by perpetrators to target and groom children for erotic and sexual behaviors. Our keyword search on cases related to child pornography and MySpace in the LexisNexis newspaper database resulted in only 14 records in 2005. The same search criteria generated 244 records in 2006 and 349 records for 2007. The increasing numbers suggest that social networking sites have been utilized as a platform by predators for preying on minors. Online profiles, which teenagers post on the websites, provide entry points for predators to connect with their targets. Blogs, photos, videos, and chat rooms featured at the sites have unfortunately become tools exploited by predators to enhance their interpersonal relationships with innocent children. This exploitation in any form must be punished and prevented in a social system of civil expression.

Social Responses to Proactive Technology

The fundamental difference between the proactive technology system and the reactive social control is given by nature. The question, therefore, is not whether the gap is removable, but how we can better control the emerging and progressing technology with the tendency to breed new forms of crime in the gaps. Answers to this question may first be addressed through a review of current efforts of social control, followed by a discussion of proactive approaches of social control.

Reactive Social Control

A society can exercise controls over its members through formal (e.g. courts and law enforcement agencies) and informal (e.g. community and personal networks) paths (Garland, 2001). In the "real" world, people have opportunities to craft physical interactions in which controls are enforced and reinforced. In the borderless and largely anonymous cyberspace, the types of interaction are more abstract and subtle. As a result, social control activities in the cyberspace are usually executed by conventional means in the physical world but are barely enforced online. This section demonstrates the emerging phenomenon of adopting internet technology as a formal means for greater **social control**, particularly crime control.

Traditionally, our crime control system has been designed to record and trace offenders based on their physical, demographic, and other characteristics on the assumption of a real space. The recording devices include those for identification purposes and relational systems in support of the investigation and apprehension of criminals. The Automatic Fingerprint Identification System, Combined DNA Information System, Facial Recognition Technology, and other biometric measures enable the social control system to identify offenders accurately with digitalization technology. Once an identity is confirmed, relational databases can be sought to check records, such as pending warrants, prior arrests, aliases, driver's license, and vehicle registrations, that associate with the particular individual.

Nowadays the police can use not only automated technology but also surveillance software to investigate crimes involving the Internet. Controversial programs such as Carnivore and Magic Lantern allow officers to intercept email communications or install spyware for capture of keystroke signals (Foster, 2005). Investigators can also use public data on the Internet to search for valuable information on suspects. For instance, Anywho.com can find information on prior addresses and relatives of a fugitive; Whois.com stores information about registered owners and their usage of websites; the Wayback Machine searching tool can look for unused Web pages published before a present investigation (National Institute of Justice, 2007). The supports for social control and information gathering have been improved and expanded continuously over the years; some collaborations have also been made to integrate various automated systems (Griffith, 2005).

But so far this reactive formal control system remains small scale and limited to traditional criminals. Factors like platform and data comparability continue to restrict social control agencies in information sharing at various levels of governments (Griffith, 2005). A noticeable amount of survey studies have indicated that many police agencies lack the equipment and resources to tackle the needs for enforcement of computer-related crimes (Burns, Whitworth, & Thompson, 2004; Hinduja, 2004). Police officers have perceived training in operating system, networking, and forensic tools as critically needed (Hinduja, 2004). These results suggest that today's formal control system is too slow to fill the gaps with resources and training to meet the social needs. Offenders in the cyberspace are at large exploiting a wide array of technological innovations in their crime commission while law enforcers are chasing behind.

Proposed Proactive Social Responses

One approach to narrow the gap is to move forward the reactive response of social control by introducing more proactive, informal practices. **Online community** policing has been suggested that computer users or third party actors can actively contribute to the prevention and deterrence of cybercrime (Jones, 2007; Williams, 2007). One strategy derived from Jones' (2007) user-based crime control model is to increase the distribution and use of open-source software that enables users to help defend the Internet system. Advances in system technology should be able to increase the security and reduce the opportunity for offenders (Williams, 2007). The other strategy of the user-based crime control model is to invite citizens participate in criminal detection and investigation online, which has been practiced recently by law enforcers and citizens. Through the posting of pictures or videos of offenders on MySpace and YouTube, police have received tips of suspects or gathered criminal evidence to make successful arrests (Kasindorf, 2007). MyYearbook and a few other social networking sites have begun to post the "Report Abuse" icon on every page of their sites. Still another proactive strategy under this framework is to utilize the multimedia-interactive features and informative resources of the Internet. Foster (2005) and Griffith (2005), for instances, have suggested that social control agencies should accelerate their pace in e-government to provide crime prevention services appealing to common citizens.

Another proactive approach to countering cybercrime may be to resort to private sectors in the technology industry. As the inventors and producers of computer hardware, software, and related equipment, these providers are adaptive to the constantly challenging environment and have the professional knowledge to supersede computer savvy criminals. The private sector's supporting role in digital and automated technology, therefore, can complement police tasks in many aspects (Rebovich & Martino, 2007). Forensic toolkit development, construction and management of databases, system integration, and digital monitoring are just a few examples. Byrne and Rebovich (2007) have envisioned an expansion of private sectors taking over the crime control role of public sectors in the areas of crime prevention, offender control and monitoring.

One shortcoming of this approach is the uncertainty over how much the public sector should be held accountable in a highly hybridization of private and public sectors in crime control (Marx, 2007). The recent civil litigation of the wiretapping orchestrated by AT&T and the nation's preeminent cryptology center National Security Agency (NSA) is a vivid example of such constitutional breach (Electronic Frontier Foundation, 2008). Without a warrant, private communications were rerouted to a NSA office with AT&T's technical assistance for surveillance. The question concerning the degree to which the social control system can police the technology ought to be answered and examined thoroughly by federal legislators and the U.S. courts. This requires a transparency system that oversees the twin entities to be institutionalized to protect interests of the citizens.

A more radical, direct approach to tackling cybercrime is the "strike-back" method used to retaliate against offending perpetrators (Rebovich and Martino, 2007). One of the well-known instances was a denial-of-service attack that was launched against the host of the World Trade Organization (WTO) website in late 1999 when the WTO had its meeting in Seattle, Washington. The WTO's hosting Web service was able to detect early and repel the attacks, subsequently redirecting the incoming packets to the source server for revenge. However, this approach has been criticized by security professionals for its possible wrongful attack against innocent servers and it may also lead to a series of backfires (Landergren, 2001).

Discussion & Conclusion

The social control mechanism is constructed on the assumption of people's rational choice from alternative actions and their assessments of consequences. Within this system full of rationality, the next highly relevant question is: Is cybercrime deterrable?

In his taxonomy of instrumental and expressive crimes, Chambliss (1967) argued that punishments may have differential effects on instrumental and expressive crimes. Instrumental offenses, being the crimes of gains, are rational and predictive. These offenses are more responsive to deterrence. Expressive crimes, on the contrary, are less deterrable due to their innate, psychological nature. Assuming this thesis holds, instrumental cybercrime such as crimeware exploitation, identity theft, and Internet fraud are subjected to deterrence via a more severe, certain, and swift punishment. On the other hand, control and prevention of expressive cybercrime will be most effective with the inclusion of the behavioral aspects of treatments. Online child sexual predators and digital terrorists are the least deterrable group given that their commitment to conventional "crimes as a way of life" is low (Chambliss, 1967: 713). However, child pornography distributors who gain profits from the instrumentation of child exploitation are deterrable because of the highly conventional rationality in their offenses.

The invention and power of the Internet have undoubtedly expanded the scope, opportunity, and distribution of crime. As computer hardware and software continue to ameliorate, a new generation of cyber deviance will develop greater challenges to the technical system. These challenges can be best addressed by collaborative efforts involving governments, private sectors, and Internet designers. Online community, groupware, and other collaboration technology ought to be employed to increase human interactions via computer among experts and concerned professionals (Mulder and Slagter, 2002; O'Day, Bobrow, & Shirley, 1998). The cooperative groups can be transformed into an open and informal social networking where connections and dependability of the above stakeholders are established to reduce cybercrime in the gap between the social and technical systems.

As to the strengthening of the formal control, it must be sensitive enough to align sanctions and enforcements with proactive consideration of the essence of cybercrime. Crime control agencies should work to cooperate professionally with Internet industry providers in the investigation and conviction of cybercrime cases. Law makers have to act more quickly to keep up the full control of the Internet outgrowth. Educators and public libraries can offer Internet safety awareness programs to teach students, their parents, and the general public about the hazards of online communication. Meanwhile, citizens should be vigilant in reporting criminal acts in the cyberspace to hotlines and authorities. Only by a fully cooperative effort can the social system help to protect the citizens, users, and infrastructure of cyberspace.

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KEY TERMS

Breed: to use without authorization identification means to generate and/or acquire additional fraudulent means of identification.

Cybercrime: law violations involving abuse and misuse of information conducted on or through the Internet.

Cybergap: the virtual discrepancy between the proactive technology and reactive social control systems.

Expressive Cybercrime: a type of Internet crime committed mainly for gratification purposes such as fascination, revenge, ideology fulfillment, social justice, or other reasons for human expression.

Identity Theft: the act of obtaining another person's identifying information and using it without the person's knowledge to commit crimes.

Instrumental Cybercrime: an indication of how and to what extent Internet technology is used as an instrument for the pursuit of profit or gain from the crime.

Internet Child Sexual Exploitation: the production, possession and/or distribution of digital child pornography and other sexual offenses against a minor through the Internet.

Organizational Cybercrime: criminal attacks against organizations via the Internet.

Phishing: a scam using fraudulent emails and websites to steal personal information for financial gain.

Social engineering: the design and implementation of logical procedures to persuade victims to supply confidential information to a spoofed entity.

Chapter XV
Developing Innovative Practice in Service Industries

Elayne W. Coakes
Westminster Business School, UK

Peter Smith
The Leadership Alliance Inc., Canada

Dee Alwis
Middlesex University, UK

ABSTRACT

This chapter presents the argument that service innovation is promoted by supporting divergent interpretations, enlarging the scope of employee and organizational skills and competencies, making interactions and knowledge sharing between people easy, and by encouraging close ties with customers. The chapter further argues that service organizations that utilize sociotechnical mechanisms for knowledge sharing through the use of a successful community of innovation (which we term a CoInv), and that build into their innovative capacities a strong relationship with their customers and suppliers, are very likely to innovate successfully. The argument is demonstrated through a qualitative case study where data analysis was deductive from multiple data sources. The chapter also demonstrates the power and efficacy of channeling activities through community innovation lenses. We argue that identifying innovation champions and comprehensively supporting them will potentially trigger more successful innovations thus improving service competitiveness in the market place.

The role of networks in innovation begins at the earliest stages of the innovation process, where they provide the collective support necessary to risk going against the established ways of doing things.

—A. Hargaddon (*How Breakthroughs Happen,* 2003)

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INTRODUCTION

Services lie at the very hub of the economic activity of all societies. Indeed according to Groönroos (2000), today's firms do not compete on the basis of physical products but rather on the basis of the services they offer. This is because from the customer's perspective there is often little to differentiate competing products. Over the last decade, deregulation and the globalisation of markets and service companies have made for severe and relentless competition among service firms. It is therefore no surprise that service innovation is at the heart of a service organization's competitiveness, and that constant adaptation in a turbulent environment requires a continuous flow of new offers (Stevens & Dimitriadis, 2005). Service executives are increasingly recognizing the need to regularly develop new services to stay competitive (Alam, 2006), and research has confirmed that new service development (NSD) is indeed a major competitive factor for the service industry (Johnson et al., 2000; Fitzsimmons and Fitzsimmons, 2001).

Stevens and Dimitriadis (2005) confirm that what facilitates new product development also facilitates new service development i.e. the way to foster innovation in either case is to foster learning. This is why, supporting divergent interpretations, enlarging the scope of skills and competencies associated with a particular development, facilitating testing, making interactions and knowledge sharing between people easier, and encouraging the formalisation of outcomes should be used more systematically as a guiding principle for managing NSD.

The authors have argued elsewhere (Coakes & Smith, 2007) that successful innovation must be based in co-ordination mechanisms that support the problem-solving efforts of the organisation's human capital and the dynamic processes of sense making and learning within the organisation, and that innovation-focused communities are one of the most effective supporting organisational forms for creative product development. Additionally, the generation of new ideas that activates innovation is facilitated by diversity and breadth of experience, including experts who have a great deal of contact with other experts in the fields; links to users; and links to 'outsiders'. The theory of innovation put forward by Pennings and Harianto (1992) emphasizes that innovation emerges from a firm's accumulated stock of skills (internal innovative capabilities) and its history of networking (external innovative capabilities). Creativity often springs up at the boundaries of disciplines and specialties, Whitworth (2007) agreeing that "...creativity seems to occur at the intersection of fields, so letting knowledge flow in new ways seems a good way to "water" a knowledge garden". Innovation-focused communities are effective because of collaboration between individual members and intra- and inter-organisationally. The authors have named these aggregations "communities of innovation" (CoInv) and propose that such communities are the place for best developing new practices, new services and new products.

It is therefore necessary to test out pragmatically these propositions: firstly that innovation-focused communities are one of the most effective co-ordinating organisational forms for NSD; and secondly, that these communities should be based around innovation champions and formally constituted as such rather than being communities for task-oriented practice, by using case-based experiences in a service oriented organisation. Technology as experienced by these communities is utlised as an addendum to their main function of knowledge sharing but is important in those functions it does support.

This chapter is structured as follows: firstly a discussion of communities of innovation (CoInvs) and their distinction from communities of practice (CoPs) is conducted; we then present the case material and discuss how CoInvs were formulated and technically supported; this is followed by a short discussion of innovation in the service industries and its application in our cases; finally we draw our conclusions and suggestions for future research including implications and recommendations for managers, researchers and policy makers.

Communities and CoInvs: A Distinction

The authors have argued (Coakes and Smith, 2007) that community socialisation processes are critical to innovation and entrepreneurship, and that based on abundant theory, CoInv are a special case of communities of practice (CoP). That is CoInv are a form of CoP that are very specifically dedicated to the support of innovation, and their formation and sustainability are the responsibility of those individuals charged with organisational entrepreneurship. CoInv may best be formed from champions of innovation since such individuals are well motivated; however, since networks are endemic to most service businesses (Heskett et al., 1990, p. 160), the social networks of innovation champions are also excellent foundations for CoInv. CoInv should be considered by management as subject to the same overall practices as other CoP e.g. providing opportunities for 'safe' sense-making and trust-tagged knowledge sharing.

CoInv may be formed not only from aggregations of individuals, but also where the members are organisations. Kogut and Zander (1992) argue that a firm's innovative-capabilities rest in the way it structures its relationships not only among individuals and within and between groups, but also among organisations. Teece (1988) points out the importance of inter-organisational relationships and linkages to the development and profitable commercialisation of innovations. Alliance relationships bring more perspectives and ideas, enable the access to the requisite resources and technologies, and realise the economic synergy among the partner organisations.

CoInv between vendor and customer/client organisations are particularly important since, according to Kandampully (2002), innovation or creativity *per se* are of limited significance in the current evolving business continuum—it is the value of the innovation as perceived by the customer that renders an advantage to a product or service. In particular, service innovation results when a firm is able to focus its entire energies to think on behalf of the customer for an outcome that surpasses customers' present expectation of superior value; mixed vendor-customer CoInv have great potential in this regard since relationships with external stakeholders such as customers, are built through long-term exchanges of information, goods, and services (Roos et al, 1998) and also provide relationship capital. relationship capital is often called the external realities of an organisation. It is usually conceptualised as the network of virtual and physical relationships, and connections, held by the critical stakeholders of an organisation, which enables the organisation to leverage intra-organisational achievements to the periphery of the organisation so that they can be commercially exploited.

Below we look at a case study where communities had become the norm for a project team tasked with product development. In this organisation formal communities had not been officially set up, but by default communities of innovation have developed from the actions of the organisation.

Case Study

Research Methodology

This research was a comparative case analysis; however in this chapter we only report the results from TeleX Company, which was a service oriented telecommunications organisation based in the UK.

Case study research permits the investigation of 'how' observed phenomena impact the items under investigation—in this case the development of innovation in organisations. As this research was contemporary as opposed to historical in time-line, the use of case study methods of investigation—direct observation and interviewing—permits current events and actions to be viewed in both their time and space contexts. Additionally, contemporary investigation permits the detection of previously unconsidered issues and relationships.

Two innovative projects within the organisation were studied over a number of months permitting the correlation of innovation outcomes with innovation practices. Focusing on the project rather than the organisation as the unit of analysis means that it could be argued that the generalisability of the implications is limited; to address this issue the two innovative projects were selected such that they were strategic and cross-functional, so that they encompassed all functions of the organisation.

TeleX was selected to represent one of the two main types of knowledge-intensive organisations: service and technology (Sullivan, 1998), TeleX being in the high-technology multimedia sector.

Information was collected about all phases of the projects by tracing their development over an eighteen months period. The key project members and main informants were selected from different functions of the organisation. Multiple methods of data collection were used including direct on-site observation, semi-structured formal interviewing and document review. As some informants were interviewed multiple times, in total 27 informal in-depth interviews and 6 formal semi-structured interviews were conducted. Interviews were not usually taped, but detailed notes made and transcribed afterwards.

The overall approach of data analysis was deductive, in which an orienting set of constructs directed the qualitative analysis of data and contributed towards the high construct validity. The use of multiple sources of evidence in a manner that encouraged convergent lines of enquiry further strengthened the data analysis and construct validity. External validity was established by employing an explanation building approach during data analysis.

The case study described below extracts from the data to discuss relevant concepts and information for the purpose of this chapter.

The Telex Company

TeleX has an annual turnover of around £10m and employs some 100 people. The core business of TeleX is the generation of innovative commercial opportunities for its clients through advanced technologies. These technologies are sold or licensed in over 30 countries.

Many of the technologies are joint ventures with its clients for international high growth markets, with these clients being largely concentrated in the blue chip organisational area but also including government departments. This external collaboration provides new ideas for, and access to, innovative technology, the ability to influence industry standards, and to provide for the rapid commercialisation of technology. In addition, alliances, such as through these collaborative partnerships, scientific networks and research consortia, joint research and working chapters are used to improve access to advanced technology all of which compliments their internal R&D capability. This case is based on a specific project team (Project A) within Telex which acts in effect, as the community of innovation.

Promoting Innovation at Telex

In this section we discuss some of the main ways that the case organisation has utilised in order to promote innovation.

Structure

Scientists and engineers carry out the technical activities while operations, sales and customer-relations managers influence the acceptance and commercialisation of the technology. Scientists and engineers are organised into four functions. Each function specialising in a specific area of technology and each being headed up by an operations director and marketing director.

These highly skilled individuals come together formally to work on a project or problem, or informally for learning purposes. They work in diverse, cross-disciplinary communities formed from different functions. The communities and projects in particular offer opportunities for them to combine related technologies in a complex manner that results in advanced products and services. These communities also include members who display context specific, social, and political skills whereby the two types of personnel facilitate the creation and implementation of innovative ideas.

They display creativity in two main ways:

- The conceptual insight of project members generates novel and useful solutions to customer needs;
- They also continually explore new perspectives to overcome potential problems and develop new ideas out of opposing circumstances or arguments.

Knowledge Sharing

Knowledge sharing is encouraged through both formal and informal means. Social networks, and CoPs (best practices focus) are widely used, plus regular use of workshops and seminars as well as data repositories. The Intranet is used to store and disseminate procedures, meeting minutes, project schedules and discussion forums.

Formally there are meetings, forums and networks dedicated to knowledge transfer. Additionally, the project teams operate social processes such as discussions, and communities through which they build on each others' ideas to mutual benefit. These communities are essential to TeleX. They have initiated a significant number, both internally and externally where their alliance partners can contribute to the discussions and knowledge sharing activities. These in particular facilitate the informal knowledge sharing that permits the absorption and exchange of knowledge about customers and their markets as well as competitors, suppliers and services. This knowledge sharing is essential as although key workers have been with the company for long periods, many more junior staff move on within 2 years of joining the company, and thus potentially much of the intellectual capital of the organisation is continually under development and/or being lost.

As well as participating in CoPs, employees of TeleX also participate in consultative activities across their field of technologies and special interest groups where they can influence the development of standards.

Motivating the Workforce

Key members of TeleX have long established tenure which signifies a high involvement and absorption in their projects and organisation. Extrinsic motivation for these people is supplied by bonuses and other incentives combined positively. Project related financial incentives such as a bursary scheme for patents and monetary rewards for journal publications are available.

Management confirms these contributions and this motivates further creative output. Contributions for instance, are recognised and acknowledged through company-wide announcements. In addition, project leaders employ a consultative style of management with an encouragement to participation thus increasing involvement and promoting self-initiative.

The scientists and engineers are also allowed the freedom to develop ideas and to experiment with novel approaches—indeed one of their most successful products—3D audio technology—was a direct result of the leadership of a particular chief scientist.

Employees of TeleX display intrinsic as well as extrinsic motivation but are primarily driven by the intrinsic. All employees rate highly the need for originality, a willingness to take risks and entertain new ideas, and to maintain an independence of judgement within their working practices. They consider their projects to be challenging and intellectually stimulating, and display a deep interest and personal satisfaction in the work and a feeling of accomplishment.

There are several aspects in their work environment that stimulate creativity and permit innovation to unfold. They have autonomy and the power to act on their understanding to pursue individual insights. Creative ideas are encouraged through shared experience, constructive feedback, and through the leadership commitment and support.

Project A : The Community of Innovation

Project A is a long standing project that has been in existence for many years—it is in effect a team rather than a project as its work is never considered to be completed but rolls on to the next innovation or product development.

Project A began some 10 years ago as a corporate funded R&D project. Although initially set up to develop a particular technology, in the course of its work it identified further applications for the technology and many variants were thus developed. So far, Project A has 55 patents filed and work on further applications still continues.

The potential applications for the technology were discovered partly from external influences and contacts. The developer-relations manager commenting *We are pleased to be the first company that implemented the new guidelines as prescribed by the (XX) special interest group.* Members of the team of Project A were members also of this specialist group and thus took part in the development of the guidelines as well using them for their own work-based innovations.

Project A consists of 5 management level members—an managing director; a marketing director; an operations director; a chief scientist; and a developer-relations manager. All hold doctorates and are 36-55 years of age. They have all worked for Telex for many years with a minimum of 6 working years and a maximum of 10 years in Project A itself. The remainder of the project members held a minimum of 6 years of company experience and a maximum of 20 years.

Examples of Innovation within Project A

The technology that was developed in this project has now become the de facto industry standard and was formed by *applying creative thought to little known fundamental scientific processes* [Chief Scientist].

Several patents [Chief Scientist] *identified unexplored opportunities in the various markets* [Marketing Director] *breaking away from pre-conceived ideas when interpreting results* [Customer Relations Manager] this creativity has resulted in several unusual and unexpected applications of the technology in different marketplaces. Project A members possessed a high level of motivation and considered that their work was challenging and stimulating. The work was designed such that tasks were allocated according to skills and expertise and there was an atmosphere that ensured a continual search for new solutions and applications.

Additionally, the founder members of Project A were awarded the Royal Academy of Engineering—MacRobert award—UK's most prestigious engineering prize with the chairman of the judging panel commenting: *this technology is an excellent example of software's enormous role in contemporary engineering. The team richly deserves the reward. Their in-depth research and development has produced truly astonishing results, demonstrated by their success in the global market.*

Discussion

TeleX demonstrates the service-business efficacy of implementing the innovation fundamentals highlighted in this chapter's first section. TeleX utilises formal co-ordination mechanisms that support the problem-solving efforts of the organisation's human capital and the dynamic processes of sense making, learning and knowledge sharing within the organisation, plus fostering informal socialisation and motivational behaviours that complement and enhance its formal efforts. Networks as anticipated are endemic at TeleX, and CoP and CoInv evolve formally and informally from within these networks.

The emphasis on formation of CoP, and in particular CoInv, between TeleX and its customers adds service uniqueness and value for TeleX, and helps the firm focus its energies more effectively on outcomes that surpasses customers' expectation of superior value. Intense dialogue has articulated the real needs of their customers and related stakeholders and so has provided the company with the ability to translate customer requirements into the development process. By this means TeleX has developed high relationship capital with its customers that has permitted the development of highly customised products and services.

In addition, the relationship capital developed with customers is an enabler of the flow of technological knowledge between the parties, which in turn influences the development of the technology for further commercial exploitation in cyclic fashion. These strategic alliances with customers demonstrate the kinds of commercial benefits that each organisation on its own could not achieve. The project teams identify the close relations with the customer as providing the ability to translate customer requirements into development needs and give them the ability to be more responsive, to accelerate product development times and the ability to incorporate client technology into the new product. All of the above reduces the effect of competitor activities and enhances Telex's reputation and value.

Collaborations have not only developed TeleX's relationship capital but have also helped develop new competencies and internalised the new know-how. Collaborative business intelligence impacts on innovation. This has been done through the:

- Formation of an alliance strategy with carefully selected partners; benefits (such as intellectual property rights) accrued to each partner are then identified;
- A locus of innovation with a learning opportunity is provided (which we would identify as a CoInv);
- Risk sharing with the partner, the provision of access to new resources and capabilities, with the synergy and internalisation of know-how through communication, participation, and learning;
- Development of strategic partnerships with customers including licensing agreements; the co-development of customer-specific products and services; an opportunity to assess the impact of the product or service to the customer; interaction for developing new products; regular feedback; and close collaboration over the products' conceptualisation and operationalisation.

The Project A team has also formed a strong web of links with the external scientific community, the suppliers of ancillary technology, and the various specialist groups that may provide them with additional know-how. They felt that this external influence was important in ensuring that their new products not only matched the required standards but were at the leading edge and had influence over these standards. Project A realised that external relationships not only enabled a pooling of expertise through a long-term exchange of ideas and knowledge, but also broadened the range and capabilities of the products developed. They realised that this may have been a risky strategy because there may have been *insufficient prior knowledge and experience of the technology* [Chief Scientist] or, *mismatched expectations of partners, hindering technology releases* [Managing Director], and concerns about the *proprietary technology* [Marketing Director]. Nevertheless, there were sufficient benefits from the variety of perspectives obtained enabling innovation through a broadening of product range and time to market that the Project continued to develop these relationships.

HRM Practices to Encourage Innovation

Factors that influence the success of these collaborative partnerships according to staff include *complementary strengths, realistic aims, mutual trust and openness, mutual benefits and commitment to the same goals, flexibility and frequent communications* in particular:

- Bursary scheme for patent requests lodged;
- Monetary rewards for journal publications;
- Organisational recognition for creative ideas;
- Stock options and profit sharing to encourage staff retention;

- Organisational recognition and orientation that innovation meant a stronger business and thus supported;
- Close co-operation with quality assurance, legal, finance, and marketing when promoting innovatory ideas and new products.

The positive social and business fabric at TeleX must be acknowledged as foundational to the formation, sustainability and successful exploitation of CoInv by the company. The case results indicate that TeleX in many ways exemplifies a learning organisation (LO) where the essence of organisational learning is the ability of the organisation to use the mental capacity of its members to create the kind of processes that will improve its own learning (Dixon, 1999). The organisation has also provided a number of facilities typically associated with a LO, such as central repositories of relevant knowledge, mechanisms for information transmittal and diffusion, and rewards for people who use these mechanisms and discipline for not using them (Warren, 2006). The case results also point to superior leadership capabilities whereby a supportive context has been built in which CoInv can flourish and be exploited, and where customer relationships are encouraged e.g. "They build close ties with the communities where they do business—They develop intimate relationships between their companies and their employees, customers, and suppliers" (Burringham, 2006; p18).

Cops and CoInvs

The overall organisational context of Project A was that of a CoInv—whereby this organisational context was that of creativity and innovation. Problem-solving through creativity was an expectation and socialisation of new staff encouraged and mentored this through a spirit of co-operation. Project A had, in addition to codified knowledge, developed a large pool of expertise over its years of operating and this tacit knowledge was developed in their internal close working relationships and mentoring.

In Table 1 below we see the main features of a CoInv as compared to that of a CoP. We then compare the actions of Project A against the features of a CoInv.

Comparison of Case (Telex and Project A) to CoInv Characteristics :

ProjectA held regular lunchtime technical workshops on selected themes. These were held in a comfortable room with sandwiches and coffee, and were used for a knowledge exchange and discussion of projects. Progress or technical problems were regularly discussed and peers from other parts of the organisation were invited at times to give comments and advice. These regular community of practice-type meetings enabled the development of a shared (team) meaning and embedding of this knowledge into routines and processes. Thus we see that social activites enabled a collective knowledge base to develop.

The personal characteristics of Telex and Project A staff demonstrated a high willingness to take risks, enjoyment of experimentation, readiness to entertain new ideas. The key Project A members act as champions of innovation through displaying participative leadership; inaugurating and supporting shared values, assumptions and beliefs; providing staff with significant high employee autonomy; and also providing staff with a loose job description which permitted flexibility in working.

In Project A we see the following match to the characteristics of a CoInv—where the numbers correspond to those in Table 1:

1. All staff are expected to innovation biased;
2. HR practices are focused on strategic rotations of staff between technology and projects to broaden knowledge and skills base;
3. Intended to develop and mentor champions of innovation;
4. *At Telex we place great importance on our involvement with the Special Interest Group (SIG). the SIG has been highly influential in the development of .. standards, features ...*

[Customer Relations Manager];
5. Collaborative partnerships for expertise pooling, long-term exchange of know-how, skills expertise;
6. No match;
7. Long service predominates amongst managers;
8. Strong internal networking encouraged and facilitated—senior mgt possessed of high level of social and political influence externally;
9. Generative learning took place.

Technology for Communities of Practice and our Cases

In order to operate successfully communities of practice (CoPs) require a number of resources and facilities made readily available to them (Coakes, 2007). There are six main resources or facilities that CoPs require in order to operate (Coakes, 2006).

"These are:

1. a space to meet; this could be provided online through software that permits discussion groups; eForums; threaded discussions; online chat-rooms for instant communication and virtual meeting rooms.
2. a place to store ideas; virtual discussions of course, are easily stored in discussion threads and best practice databases that are generated and extracted from these discussions.
3. a memory of activities; databases storing content and documents; virtual presentations; webinars; and possibly also on-line courses can provide this memory.
4. a record of members and their interests; member profiles once stored on a database provide the community with not only a pool of searchable expertise, but also with the ability to link members with similar interests to enhance social networking within the community. Once expertise is stored in a database, CoP members can enhance their profiles by linking to their own records or reports, articles, web pages, web logs etc. to provide additional expert content and enhance the 'library' storage of ideas.
5. a means of communication amongst CoP members; the high-technology format for this is video-conferencing with all its requirements for well supported technical assistance and resources; the low-technology version is one that can be utilised by any home PC user – the web cam and a telephone.
6. ways to share tacit knowledge. This if course is very difficult to utilise technology to perform

Table 1.

	Special features of a CoInv	Comparison to a CoP
1.	Membership limited to those with an interest in / experience of innovation	Unlimited membership but related to the development of best practices for a specific item eg process; specific technology; or a specific process.
2.	Non-specific 'practice' experience	Specific practice experience eg procurement, server support
3.	Intended to develop and mentor champions of innovation	Mentoring and further development in practice skills expected
4.	Outward facing	Inward facing
5.	Customer oriented	Practice oriented
6.	Contains all levels of staff but more senior predominate	Contains all levels of staff but less senior predominate
7.	Contains all levels of length of service, but longer service predominates	Contains all levels of service but less service length more common
8.	Members are strongly socially networked within and without the organisation	Members may or may not be socially networked
9.	Generative learning	Adaptive learning

> although if the tacit knowledge is (explicit rather than) implicit it may be possible."

Communities of practice can also utilise appropriate technology to provide research tools such as knowledge repositories; communication support; plus synchronous and asynchronous discursive support and additionally, iCohere in their CoP design guide (available from www.Icohere.com, 2006) state that there are four focal areas for technical support for CoPs' actions – relationship building; learning and development; knowledge sharing and building; and project collaboration. Whitworth (2007) arguing that electronic interaction permits for multimedia exchanges; more connections between people who would not normally interact; faster transmission of knowledge and information; and a many-to-many interaction that permits group actions.

CONCLUSION

The case presented here confirms that service innovation is promoted by supporting divergent interpretations, enlarging the scope of skills and competencies associated with particular developments, facilitating testing, making interactions and knowledge sharing between people easier, and encouraging close ties with customers. In other words fostering learning is an excellent guiding principle for managing NSD. The case also demonstrates the power and efficacy of channelling these activities through formal and informal community innovation lenses which we have termed communities of innovation (CoInv) utilising appropriate technology for purpose.

It is further concluded that service organisations that utilise CoInv mechanisms for knowledge sharing, and that build into their innovative capacities a strong relationship with their customers and suppliers, are very likely to innovate successfully. However, it is also acknowledged that the success of CoInv, or any focused community action, is highly dependent on having an appropriate supportive organisational context e.g. far-sighted competent leadership, a learning organisation related approach and the supporting technical infrastructure.

Although the work presented here provides implications and recommendations for the guidance of managers, researchers and policy makers with respect to contexts that may be expected to promote service innovation, the authors are cognizant of the vast array of services in the marketplace, and the increasing blurring of the boundaries (Dreyer, 2004) such that as Ettlie notes (2006; pp. 21) " … *services are difficult to define and quantify, they have sometimes been called anything that can be bought or traded that cannot be dropped on your foot…* (and by) *1996 constituted 78.5% of all jobs in the United States*". The authors therefore appreciate the need for research to further define those services to which the work presented here may or may not apply; however in the interim the implications and recommendations the authors set out may be applied to service initiatives in the expectation that they will promote service innovation, with the confidence that at the very least they will enhance organizational effectiveness through improved knowledge sharing and self-organising learning (Stacey, 2001; Smith, 2005).

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KEY TERMS

Communities of Innovation: CoInv are a form of CoP that are specifically dedicated to the support of innovation, and their formation and sustainability are the responsibility of those individuals charged with organisational entrepreneurship.

Communities of Practice: Wenger et al (2002; p. 4) have provided a widely accepted definition of CoPs as *Groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis*. These authors add that "These people don't necessarily work together every day, but they meet because they find value in their interactions" (ibid; pp. 4).

Innovation: *the process of bringing new problem-solving ideas into use* (Amabile 1988; Glynn 1996; Kanter 1983). The emphasis in this quote is on the phrase *into use*, for Tidd (2001) argues that just the invention of new knowledge is insufficient and Sullivan, (1998) and Teece, (1998) say that innovation has only occurred if the new knowledge has been implemented or commercialised in some way.

Intellectual Capital: Various definitions in the literature including: "The collection of intangible resources and their flows" where resources equal "any factor that contributes to the value generating processes of the company and is, more or less directly under the control of the company itself". Bontis N, Dragonetti NC, Jacobsen K, & Roos G (1999) Knowledge and knowing capability of the collectivity. Nahapiet J & Ghoshal S (1998) "Everything everybody in a company knows that gives it a competitive edge" Stewart TA (1997)

Relationship Capital: Relationship Capital is often called the External Realities of an organisation. It is usually conceptualised as the network of virtual and physical relationships, and connections, held by the critical stakeholders of an organisation, which enables the organisation to leverage intra-organisational achievements.

Service Industry: firms competing not on the basis of physical products but rather on the basis of the services they offer

Section III
Socio–Technical Analysis

How to gather and analyze data from a socio-technical system

This section addresses the question of how one approaches a system that is both technical and social, as one must consider not only social and technical issues, but also their combination. It addresses questions like:

1. What is socio-technical analysis?
2. What is socio-technical information?
3. How can a socio-technical analysis be carried out?
4. What are the benefits of a socio-technical analysis?
5. What distinguishes a good socio-technical analysis?
6. How does socio-technical analysis relate to other forms of analysis?

Prologue
Socio-Technical Analysis

Mark Aakhus
Rutgers, The State University of New Jersey, USA

Gathering and Analyzing Data From Socio-Technical Systems

Social-networking media have developed as an outgrowth of human motives, expectations, and values about social interaction and through innovation and astute reinvention of prior technology and social practice. As computing and telecommunication technology become increasingly embedded in human activity, new forms of interactivity and grounds for communication emerge. Will these changes involve fundamental changes in the ways and means of interaction and sense-making or incremental adaptations of deeper, underlying principles of communication (e.g., Hutchby, 2001; Katz & Aakhus, 2002; Meyrowitz, 1985)? Can the practice of socio-technical analysis respond by illuminating and rendering sensible the relations between the social and the technical in social-networking? These questions tap into practical, empirical, and philosophical matters and the answers hinge on how several issues are worked out.

What is socio-technical analysis in social networking and what are its benefits? It will not be enough to rely on standard practice in social sciences or computing sciences and yet the very understanding of human and technical systems that has built up in these domains will be indispensible in formulating ways to respond to the continued incorporation of technology into everyday human interaction.

What is socio-technical data/information? The use of computers for social practices did not arise in a social vacuum nor does it occur in a social vacuum. The same will be true for the data/information gathered for the purposes of analysis. Social networking media generate many new forms of data beyond text. Identifying and determining the kinds of claims that data will support is an important goal in developing social-technical analysis. Indeed, gathering data presupposes much about the point and conduct of socio-technical analysis of social networking.

What are the issues are faced by those who propose socio-technical analysis methods? Analysis is a kind of reflection on practice that is no longer the sole province of the philosopher but is a constant part of the evolution of a socio-technical system. The technical requires attention that brings forth reflection on the most fundamental ways in which humans interact with each other including the technical artifacts and agents. The methods of socio-technical analysis also invite reflection on who participates in analysis just as social-networking

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systems have rewritten rules of participation across human activities.

What are the properties of a good socio-technical analysis? The claim that any socio-technical analysis has on subsequent action and structure relies on developing the practice of analysis. Such claims will involve both empirical and normative dimensions. The conduct of socio-technical analysis will depend on methods that coherently and transparently attend to these dimensions (Aakhus & Jackson, 2005). How these matters are worked out will have implications for the relevance, reliability, and legitimacy of analytic claims whether produced through expert-analysts or through stakeholder approaches.

How are different ways of socio-technical analyses connected? Analysis is also a creative act as good analysis enables new insights that can be taken up in subsequent development of socio-technical systems. Approaches to social-technical analysis of social networking will likely vary and thus raise questions about how the approaches may connect to provide a better overall understanding of social networking systems. Moreover, socio-technical analysis in domains other than social networking can provide insight into analysis of social-networking, yet the domain of social networking will have its unique aspects. Thus how social networking analysis appropriates approaches from other domains without losing sight of the unique phenomenon of social networking will be an important challenge.

The chapters in this section take up these issues, and the authors stake out important grounds for inventing, understanding, and advancing socio-technical analysis for social networking.

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Chapter XVI
Using Communication Norms in Socio-Technical Systems

Hans Weigand
Tilburg University, The Netherlands

ABSTRACT

Often socio-technical systems are designed simply on the basis of what the user asks, and without considering explicitly whether the required process structure is right and wrong. However, poor communication may cause many problems. Therefore, a design cycle should always include diagnosis, and in order to be systematic, the (process) diagnosis should be model-based and driven by explicit communication norms. Such a diagnosis process is outlined and illustrated with a case from a financial service process. Furthermore, it is shown that recognition of universal communication norms can also improve tool design and quality management of socio-technical systems in general.

On the other hand, in a society whose communication component is becoming more prominent day by day, both as a reality and as an issue, it is clear that language assumes a new importance.

—Jean-Francois Lyotard

INTRODUCTION

Traditionally, designers of information systems often follow a "waiter strategy". That is, they collect requirements from the customer, and build a system that meets these requirements. However, what if the customer asks for a wrong system, a system that arguably will cause trouble in the form of misunderstandings, inefficiencies and failures? So designers have learned to be a bit cautious: do not take the wishes of the users and the current ways of working at face value. However, what are the criteria that we should apply then? Is it just intuition based on experience? In this chapter, we suggest another more systematic way.

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Before doing that, we first recall that today's Internet-age information systems are much more communication than computation systems. They include not only workflow management systems and enterprise resource systems, but also applications that support complex communication processes, like discussion and group decision making, and many kinds of collaborative work such as group authoring, often not under the control of one single organization. It is becoming increasingly essential to view the technical systems as being embedded in a social context, to consider the socio-technical system as a whole, including the people and their relationships.

In order to deal with these new requirements, Ronald Stamper has argued that we need to move away from the traditional information *flow* paradigm, in which positivistic modelling aimed at producing automated solutions is central. Instead, an *information field* paradigm is needed (Stamper, 2000). At the core of this paradigm are fields of norms. Norms bind groups of people together. Shared norms constitute what is called the "social reality" –something not given once for all, but constantly in the process of being redefined and renegotiated. Note that "norm" should not be interpreted in the narrow sense of laws or ethical rules imposed by some society or institution. A norm is any rule (mostly implicit) that we apply in our daily practice and that we expect others to apply. Often, but not always, they have a rationale: not following the norm has some undesirable outcome. There are several kinds of norms: how to behave in a certain situation, how to interpret a certain term, how to draw conclusions; etc.. Some norms are context-specific; some are more general or even universal.

This chapter focuses on an important subgroup of norms that can be characterized as "communication norms", for the obvious reason that these are the norms most relevant to communication systems. We are specifically interested in general norms that can provide guidance in process diagnosis and design. What exactly falls under the heading "communication norm" will become more clear when we move on.

Norms are to be distinguished from goals (Mylopoulos, Chung, Yu, 1999). A goal is a certain state that a stakeholder wants to reach or to maintain, whereas a norm corresponds to a shared expectation. A goal is usually specific to a certain time and a certain context, whereas norms tend to have a universal character (although the weight given to the norm may differ from one context to another; and there are also particular norms). For example, profitability is an economic norm in the market; to increase sales of our company by 20% next year, is a goal.

In (Weigand, De Moor, 2003), a certain list of general communication norms was presented based on an analysis of workflow models in the Language/Action Perspective (LAP—cf. Winograd, Flores, 1986; Denning, Medina-Mora, 1995; Dietz, 2005). For example, a communication norm is that organizational actors should commit explicitly to a request, or decline explicitly. If not, the requester and the executor may easily have different expectations with disappointments as a result. Some more norms on the way communication processes are realized by means of signs between actors are analyzed in (Weigand, De Moor, 2007).

The objective of this chapter is to show why it is recommendable to apply communication norms explicitly in process diagnosis, quality management and group system design, and how to do it. The aim is not to present a list of specific norms (we refer to the publications mentioned above for a proposal), but to show their use.

Our view on diagnosis is that it is an essential step in the design cycle. It cannot be replaced by just collecting requirements. In certain design approaches—evolutionary development in particular—diagnosis is even the most important step. These approaches are very suspicious of design projects aimed at reaching an abstract desired situation rather than solving a concrete problem. Indeed, such projects tend to have a high failure rate.

Process Diagnosis Using Communication Norms

How can communication norms be used in diagnosing workflow processes? Let us look at a business case that we have analyzed a few years ago.

Business Case

The business case considers the settlement of mortgage finance within a Dutch banking organization. A diagnosis of the communication in this process was performed within several local offices. An elaborate description of this diagnosis can be found in (Poll, 2002).

Our case starts with a customer initiating a request for a mortgage contract. The interviews revealed that several scenarios are possible, of which we will present one as an example. For a good understanding of the example, the reader should know that the mortgage selling process is handled by local offices, but some of the administrative tasks have been delegated to a central service center geographically located at another place. The internal communication process at the service center falls outside the scope of this example.

A customer initiates a request for a mortgage contract by delivering a signed tender to a bank employee. In this case the delivery occurs by sending the signed tender per post to the local office. When a tender comes in, it is registered by a commercial assistant into a workflow management system. The purpose of this registration is to report reception of a request for a mortgage contract. Furthermore this serves as a means of control for the office manager. Before a promise is made to the customer to deliver a mortgage contract, the commercial assistant has to check for any missing items that are necessary for further processing. If items like an employer's certificate or health certificate are missing in the customer file, the commercial assistant will draw up a letter of thanks, saying that a mortgage contract will be drawn up as soon as the local office receives the missing items, thereby stating a conditional promise.

When all missing items have been delivered, the commercial assistant will request the service center to process the tender data and draw up a mortgage contract for the customer. This request is done through an automated mortgage system. The tender data will then be visible for a service center employee. According to the agreements between local office and service center, the commercial assistant talks with one service center employee and vice versa. So the data needs to be made visible to that specific service center employee. At the same time the commercial assistant will deliver the physical customer file to the administrative support department of his local office. The administrative support department is responsible for the settlement of the mortgage finance within the rest of the mortgage finance process at the local office.

Before the contract is drawn up the service center employee will report the date of signing obtained form the notary, to the commercial assistant at the local office.

Two days before the actual signing of the contract the service center employee sends a letter to the commercial assistant, stating the amount of money that needs be transferred to the specified mortgage account.

In this particular scenario, somewhere in this time period the administrative assistant of the local office needs to know when the signing of the mortgage contract occurs and which amount of money needs to be transferred, because he/she is responsible for settling this matter within the banks local administration. In this case the only thing the administrative assistant can use as a trigger for action is the notification of the signing date send by the service center. In this case we assume that the commercial assistant is 'smart enough' to forward this notification to the administration department, so that the administrative assistant knows when the signing takes place. One day before signing occurs a request for information is made to the service center about the amount that has to be transferred, after a decline a request is made to the commercial assistant who delivered the customer file. The letter stating the transfer amount is then handed over or sent per post to the administrative assistant.

A Framework for Diagnosis

Figure 1 shows a framework for diagnosis. Typically, diagnosis starts after complaints have been raised, but it may also be part of a regular evaluation in which complaints are revealed. A complaint expresses a certain problem, where a problem is defined as a gap between the factual and desirable situation. What is a desirable cannot be determined without taking the norms of the stakeholders into account. A problem means a norm violation to at least one stakeholder. The identification of the norms and the norm violations (that is, problems) is represented at the bottom tier of the framework.

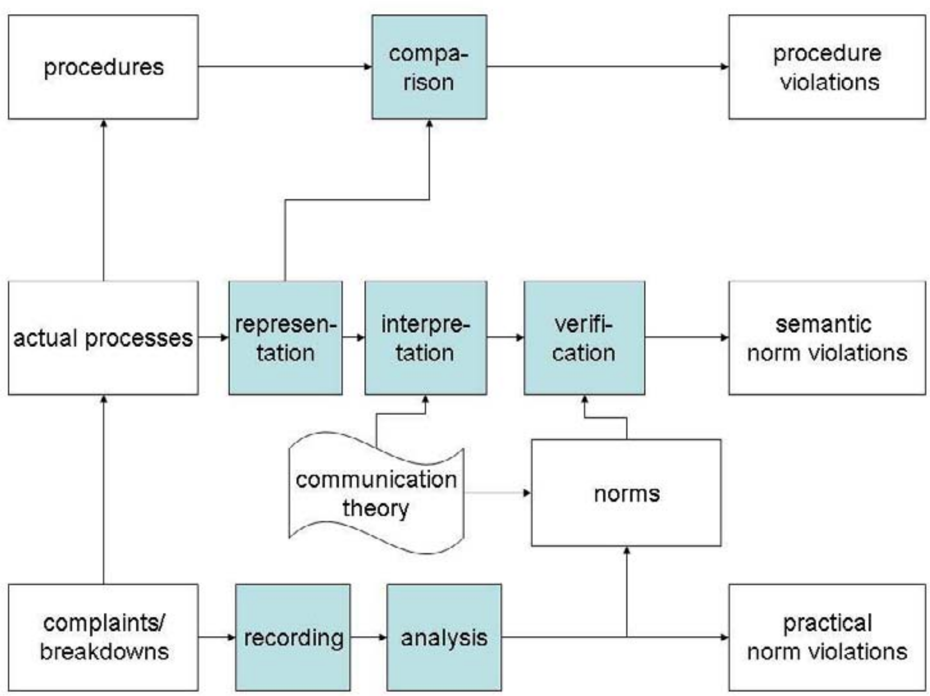
When analysts try to address user complaints directly, there is a risk that only the symptoms are treated, rather than the underlying causes. For that reason, proper diagnosis should be model-based. The goal of this model-based diagnosis is to find core problems; that is, problems (gaps between factual situation and what is desired) that at least partially have a causal effect on the problems that we start with. The core problems, being problems, are also norm violations. So we have norm violations at the complaint level and at the core problem level. In the present context, we focus on one important class of norms at core problem level: communication norms. The model-based diagnosis is represented at the middle tier of the framework.

It is characteristic of norms in organizations, and in groups in general, that they are often implicit and evolve over time, whether it is to avoid confrontations, to foster dynamic evolution of the group, or whatever. As a consequence, the identification of norms often means making them explicit for the first time, which can be a delicate social process.

The diagnosis process starts at the bottom level with the recording and analysis of complaints. If the discovered problems warrant further attention, the model-based diagnosis starts with data collection, using interviews or other techniques, such as direct observation. A coding scheme needs to be in place like the one used in (Te'eni, 2000) that can be of guidance to the data collection.

The first step at this level is schematic *representation* of the data. Its objective is not understanding,

Figure 1. A multiple-level framework for diagnosis



but faithful recording of the process as it carried out, and as there are usually many ways it can be carried out, it is necessary to set up several schema's representing different actual scenarios and points of view. It is important that the schema technique does not introduce too much abstraction, since it must be an accurate picture of the 'as-is' situation. This means that techniques like Action Workflow (see below) will not be suitable for use at this stage, because the structure and level of abstraction they impose on the collected data are too high.

The third step is interpretation. For example, a certain message from A to B is interpreted as a request. For Te'eni, interpretation has to do with taking the actors into account as intentional beings. In terms of (Dietz, 2005), interpretation means moving from a data level to a communication level. Although it is possible to detect certain pathologies without interpretation, many communication problems can only be identified after interpretation. Action Workflow (Denning, Medina-Mora, 1995) provides useful modeling techniques for the interpretation step. It should be noted that the aim of the interpretation is not an exhaustive description of the communication acts, but only on those aspects that are crucial to the diagnosis process.

The next step is model *verification*. In this step, the quality of the current process is assessed using general communication norms such as the ones listed in (Weigand, De Moor, 2003).

The fifth step is the *comparison* of the 'as-is' description with existing "ought" models (procedures). This comparison is useful and may reveal that these models can be improved, or that they are ok but should be communicated or implemented better. Of particular interest is the question why the "as is" deviates from the "ought"; this has usually to do with some tension in the organization that may be due to internal evolutions or changes in the environment. For that reason, simply restoring the "as is" situation to comply with the "ought" is not always the best reaction. If we may draw a comparison with medical diagnosis, a medical doctor would not recommend a certain therapy or medicine without having asked what cures the patient has been following or is currently following, and assessing their effect or lack of effect.

After the verification (norm checking) and the comparison, recommendations for improvement should be formulated that can be discussed and implemented within the organization. This is the point where the diagnosis as such stops.

Application of Diagnosis Framework to the Business Case

To collect relevant data on the communication within the process of the settlement of mortgage finance we used semi-structured interviews and observations. We kept an open mind and focused on all sorts of communication that lead to actions. The coding scheme that guided the interviews and observations had to reveal information about the: communicating actors, purpose of the communication, specific messages that are exchanged, medium used, structure of the messages, goal of the message (request, promise, etc.), formulation, coordination and control of communication, breakdowns as a result of miscommunication.

We choose to *represent* the collected data with a UML sequence diagram. A sequence diagram shows the time order in which messages are sent and received among actors and between actors and other objects or systems (Booch, Rumbaugh, Jacobson, 1999).

During the *interpretation* stage we used modelling techniques that are slightly more abstract and take a communicative perspective. An action workflow diagram relates messages to speech-acts. The focus is on representing acts and conversations (Denning, Medina-Mora, 1995; Kethers, Schoop, 2000). This diagram takes a communicative perspective, but its elements correspond almost 1-1 with the sequence diagram and will therefore be used to for the first interpretation of the schematised data.

We used the framework for normative analysis of workflow loops to check the created models of our example on violation of the communication norms as described in the theory. An example norm violation that was already manifest in the example scenario is that the administrative assistant at the local office is not directly involved in the communication with the service center. However, he seems to be a beneficiary of the work performed by the service center, as he needs to know *at least* the date of the signing. This information is sent to the local office, but does not always reach the administrative assistant. If he is a beneficiary, he should be an evaluator; in other words, he should receive the information and if it is consistent with his own data (the physical file that he possesses), he can give a positive confirmation. Note that in fact there are two related norm violations: one being that the task performed by the service center (on behalf of the local office) is not evaluated and confirmed, the other being that the beneficiary (or one of the beneficiaries) is not involved in the evaluation.[1] An alternative interpretation (interpretations are not always univocal) of the situation is that the administrative assistant is the executor for the service center. But also in that case, there should be a conversation between the two.

The final step in the diagnosis process is a comparison between the diagnostic model and the existing "ought" prescription of the example process. This may give directions for solutions. Sometimes the problem has to be sought within the acceptance, adoption and integration of the process descriptions within the organization. However, it may also be the case that the process description is incomplete or that it can be improved (process reengineering). Then the diagnosis of the norm violations may give directions for reengineering.

One surprising difference we found is that in the process description the administrative assistant is responsible for sending the tender data to the service center. This means that the process description assumes that the service center employee communicates with the administrative assistant, and this assistant communicates with the service center, and that all the information coming back from the service center has to go directly to the administrative assistant. This is in contrast to what we found in our diagnosis. We note that when the existing process prescription would have been followed, the norms would not have been violated.

The diagnosis has revealed that something is wrong in the "contract" between local office and service center, in which the existing process prescriptions are not followed. The problems that we had in finding out who is the beneficiary are a

Figure 2. Representation: UML sequence diagram (source: Poll, 2002)

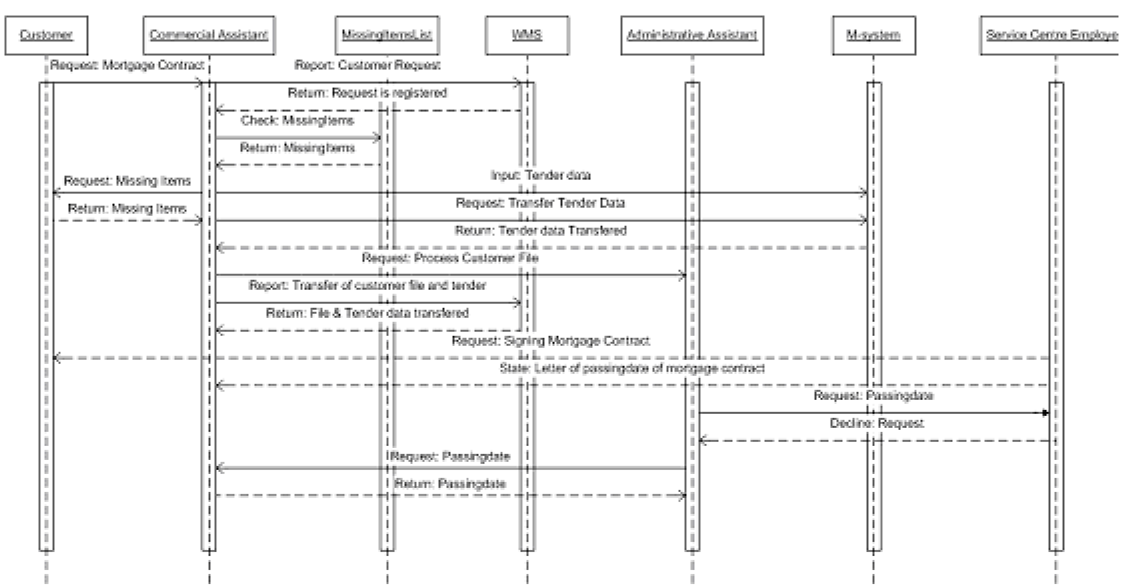
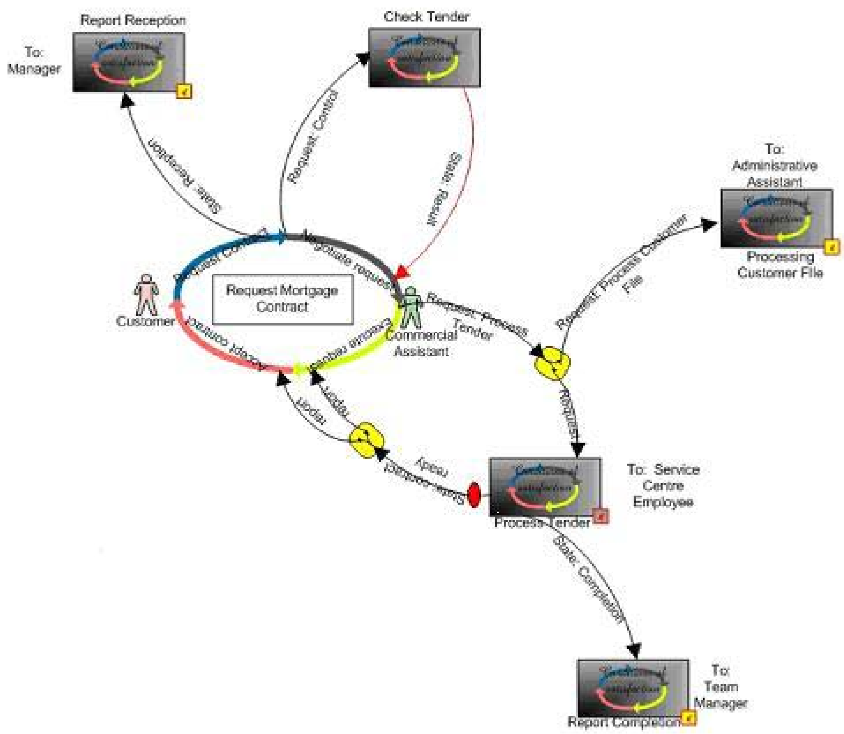


Figure 3. Interpretation: Action Workflow diagram (source: Poll, 2002)



reflection of a certain ambiguity in this contract (who is serving whom?).

From Diagnosis to Redesign

At the end of the day, the diagnosis should lead to recommendations for improvement of which we can give here only one example. Roughly speaking, the modeling and interpretation steps of diagnosis give indications of the *occurrence* of problems (such as inefficient or incomplete loops). The verification using norm checking gives indications of the *causes* of these problems. The comparison with the "ought" models gives indications about possible *solution*s. In the abbreviated example of this article, a problem occurrence was noticed in one of the scenarios: although the administrative assistant, in this scenario, needs certain information, he does not get it or only after several attempts. The norm analysis revealed some violations: in particular, the fact that there should be a conversation between administrative assistant and service center. The comparison with the existing models reveals that in this case, practice deviates from the process description.

Although in practice, the problem is usually dealt with quite well by additional communication within the local office (the informal organization), the recommendation must be to reconsider the "contract" between local office and service center. It must be made clear who does what for whom.

In principle, there are two possible solution directions. One is to reestablish the existing model, that is, to agree that the commercial assistant hands over his work to the administrative assistant, and that the *latter* informs the service center—and also gets the results back. In this approach, the administrative assistant is the customer of the service center. The other approach is to reconsider the process description, assuming that there must be a reason why the prescribed procedure is not followed. In the current practice, the communication chain to the service center is shorter: the commercial assistant circumvents the administrative assistant. This may be more efficient, but as our diagnosis reveals, it may lead to failures and repair communication afterwards. If this alternative is chosen, at least the communication between commercial assistant and administrative assistant must be improved. Even more important, it must be made clear to all parties that the commercial assistant in this case is the leading customer, and the other parties are supposed to serve him.

To make a good choice, the two approaches must be compared on the basis of criteria such as operational costs, time constraints, and the costs of changing the organization, but also the risks involved and the present failure costs. This needs to be considered before a decision can be made to change anything.

Quality Management Using Communication Norms

As much of the basic technological infrastructure such as PCs, software packages, and electronic networks have become widely available, the concept of quality has become increasingly important in the field. Comprehensive methods and philosophies like ISO9001 and Total Quality Management are used to standardize and certify information systems development practices, in order to improve their quality. However, such approaches, popular and useful as they may be, are no panaceas. They lead to much bureaucracy and many ill-understood documents, often do not end up in results that are directly useful for system developers, and do not deal with different perspectives and conflicts of interest. Most often these approaches are grounded in the information flow paradigm. Alternatively, a quality management approach grounded in the information field paradigm can help to optimize the information systems development process (De Moor and Weigand, 2002).

The LAP communication process model makes a distinction between three levels of abstraction in the communication process: the media level, the information level, and the communication level (cf. Dietz, 2005). The media level of communication describes the physical characteristics of the communication process. The question is: how? How are messages put across? The information level of communication has to with the data contents. It is not about how messages are transported, but which messages are transported. The communication level is about what people intend to do with messages.

At each process model level, quality attributes can be provided. Quality attributes at the media level include media richness, interactivity, reliability and efficiency. Information quality attributes are for instance integrity, completeness, precision, and timeliness. Integrity constraints in the communication system can be used to enforce some of these qualities. An example of a communication level quality attribute is the communicative rationality expressed by communicating parties in their interactions.

Traditional quality management systems mainly focus on the two lower levels. In reaction to that, the Language/Action Perspective has emphasized the importance of the third level. A comprehensive quality management approach is needed that accounts for all levels and their dependencies.

A fundamental aspect of quality is fitness-for-use. The quality of a tool cannot be assessed without taking into account the goals it has to serve. As a consequence, total quality management should explicitly account for the dependencies between the levels. For example, communicative acts that are aimed at fixing commitments between parties are better served by a medium that offers persistence (such as paper or email), whereas explorative acts are often better served by a medium that does not offer persistence (such as a face-to-face meeting or a telephone call).

Our model takes an information field perspective on information systems, including the three levels of the communication process model. The explicit attention given to the communication level distinguishes our model from perspectives focusing on the technical or use quality. For each layer, relevant quality attributes need to be selected. Then, for each attribute, a customized set of quality management processes needs to be defined.

Core to an information field approach is that for each combination of quality attribute and management process, a set of norms is defined. For example, take the quality control process of the "availability" attribute at the media level. A perceptual norm could say that a user can conclude that his mail inbox does not open anymore when a corresponding error message is received after starting the mail program. A cognitive norm could say that if a mail inbox does not open anymore, then the helpdesk expects that disk space is full. An evaluative norm can be used to conclude when the helpdesk thinks a mail service is faulty—for example, when the allocated disk space is less than 10 MB. Finally, behavioral norms represent the desired actions, for example, that the helpdesk should assign disk space for each new user within 1 day, or that users should clean up their mailbox when they receive a warning.

Example: Improving the Quality of a B2B Negotiation Process

We have applied the communication quality model to B2B negotiation, such as supported in the e-commerce prototype MeMo (Weigand et al, 2003). One of the negotiation protocols supported is a so-called tender-based negotiation protocol. This means that a buyer sends a request for bids to a open or closed set of potential sellers. The seller can reply using a bid message. This protocol is often used by contractors in the Dutch building sector.

The quality of the process can be managed at all three communication levels. The medium level quality is determined by attributes such as reliability of the medium (Internet vs. telephone) and timeliness. At the information level, the need for quality requires clarity of product identification terms. The use of standardized product identifications can contribute to this goal. Finally, at communication level, the protocol can be evaluated in the light of the organizational goals. One of the goals is to promote competition among sellers, to reduce prices and to comply with European laws. MeMo found that management sometimes complained about their purchasers not selecting enough potential sellers. One complex aspect that determines different attributes at the various levels is *competitiveness*. At the media level it may determine an attribute like *security*, which would entail that no company-specific files should be accessible by competing organizations. One—very specific—attribute at the communication process level could be *competitor diversity*, which would mean that enough companies bid for the tender. There are several norms involved, for example with respect to the quality control process of this attribute. First, the manager apparently has an evaluative norm of what is the appropriate number of potential suppliers to be involved in a tender (since he has the authority). This number can be fixed or depend on the amount or product category. To integrate the quality control process in the information system, and possible automate part of it, the manager should make this norm explicit. To improve the process, the manager can instruct the purchasers to increase the selection set—an example of a behavioral norm for the purchaser.

Group Process Design Using Communication Norms

Norms in general and communication norms in particular, are indispensable in diagnosis and evaluation, but they can also directly improve the design of tools and processes. An example can be found in a study performed by Whitworth and McQueen (2003) on group decision making. Many group decision support methods assume a rational process of decision making, as articulated by Simon, and this is reflected in the design of electronic tools (GDSS). In these methods, voting can be done at the end of the process when a choice between alternatives needs to be made. In contrast, the researchers claim that (electronic) voting can be quite useful before and during discussions.

The limitation of the rationalist paradigm is that it largely ignores social influences on group decision making. Each group member does not only perform cognitive tasks—involving factual information exchange and processing—but also is constantly relating to others and representing the group identity. These are quite different tasks, involving different psychological processes, but they must manifest through the same set of communicative acts. For example, if a certain suggestion is made and a group member has to respond, he can give a positive response because he deems it a good idea. At the same time, he may want to express support to or dismissal of the other person. In fact, whether he likes it or not, his response will be evaluated in that way. That is why it is common to distinguish socio-emotional from task levels in communication, and that is why messages may be self-contradictory. For example, if the group member wants to support the idea but not the person who suggested it, he may express his opinion on the idea on a flat tone. Other group members may misinterpret this expression as lack of support for the idea.

Group members not only relate to each other, they also represent the group identity. This means that they try to maintain agreement on the shared norms of the group, to avoid the group falling apart. "Maintain" should not be interpreted in a conservative sense; it might include active development of the norms as well. Whitworth and McQeen use the term "normative influence" when talking about this communication level, which corresponds to the discourse level as defined by Habermas (1984) and used in the Language-Action Perspective. From the point of view of communicative rationality, group members should be able to express themselves on the discourse level. This (admittedly abstract) rule imposes a design norm on GDSS approaches. It does not mean that every GDSS tool should contain some kind of discourse functionality, as it may also be a design choice to deal with this kind of communication in another way.

Whitworth and McQueen proposed to deal with it by means of voting support throughout the discussion, as an efficient exchange of positions. In other words, the "voting before discussing" not only addresses the discourse norm just mentioned, but efficiency is also considered a relevant norm as far as the implementation is concerned. A small case study was performed in an educational institute in New Zealand, where meetings were held to formulate a strategic marketing plan for the institute. The results of the study were encouraging. People were quite satisfied, it apparently reduced or avoided personality clashes and fostered group agreement. As a result, people felt that the process was also more efficient and effective.

Conclusion

In this chapter, we have described three different cases. The common denominator is first of all sensitivity to norms. Although norms are often left implicit, for strategic, cognitive or whatever reasons, they do play an essential role in the way people interact and in the systems that they use. The challenge is to explicate the norms without carving them in stone, as living social systems require a certain flexibility, and sometimes even ambiguity. Secondly, we have stressed the centrality of communication norms as far as information systems are concerned. Perhaps this is not that surprising, if we realize what information systems are for, but still too often communication is narrowly interpreted as information flow, and communication norms get overlooked. We have argued for a broad view of communication, from the physical (medium) level up to the social aspects.

Of course, the focus on communication is a limitation. For instance, economic norms (cost/benefit ratio) also play a role, especially in commercial companies. We do not claim that only communication norms are relevant, but claim that they should be recognized in their own right, not the least because we live more and more in a communication society. Consistent violation of communication norms will have an economic effect (e.g. higher failure costs), but benefits and costs are not always easy to estimate. Even if it is possible in a certain situation, the economic analysis alone gives poor guidelines on what to improve. Communication norms provide designers with objective quality criteria that help to sort out the good and the bad in current processes and in what customers may want.

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KEY TERMS

Communication: a complex social process in which people coordinate their behavior by creating and maintaining a shared definition of the situation

Communication norm: a rule governing communication practices based on shared expectations

Diagnosis: an analysis process that aims to reveal the causes of a complaint or expressed problem

Language/Action Perspective (LAP): a perspective on Information Systems that focuses on what people do and achieve when they communicate.

Problem: a difference between the actual state of something and what is desired by some stakeholder.

Quality: a characteristic of something that is of value to someone or for a certain task

Rationalism: the belief that action and decision making should be governed by reason only

Chapter XVII
Socio-Instrumental Pragmatism in Action

Jonas Sjöström
Uppsala University, Sweden

Göran Goldkuhl
Linköping University, Sweden

ABSTRACT

This chapter introduces the theoretical framework of Socio-Instrumental Pragmatism (SIP) and illustrates how it has been used as an analytic instrument in the process of diagnosing a work practice and co-designing business processes and IT artefacts. A practical inquiry process has been conducted in a project group consisting of a group of Swedish municipalities, currently experiencing a number of administrative problems. SIP has informed the design process, and aided the designers in shaping the design product (a new workflow and a new IT system). Conclusions are drawn regarding SIP as an analytical tool, stating that it has guided the inquirers to focus on actors, actions and relations between actors, and supported the designers in finding design solutions to the major problems experienced in the organization.

I have come to recognize that industry faces numerous problems that are outside of the scope of the traditional analyses of design. In particular, there are management and organizational issues, business concerns, and even corporate culture.

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INTRODUCTION

The social dimensions of information technology are obvious in certain types of IT systems, like chat, email and other groupware applications. For IT systems used for management and operations in organizations, the social dimensions may not be as apparent. We claim that *all* IT systems need to be designed as socio-technical systems, comprising features to promote social interaction. For this we need approaches to IT development which make the social dimensions visible.

This chapter deals with design as a *process* and design as a *product*, with an emphasis on how to make IT artefacts empower human and organizational communication. The focus is a stakeholder-centric design process, and the norms governing those stakeholders. IT system design (both process and product) needs to be informed by a proper understanding of both social and technical aspects of IT systems. One theoretical framework aiming at encompassing the interplay between the social and the technical domains is *socio-instrumental pragmatism* (SIP); see e.g. Goldkuhl (2005) and Goldkuhl & Ågerfalk (2005). SIP is a synthesis of different action-theoretic frameworks, including American pragmatism, symbolic interactionism, language action theories, social phenomenology, ethnomethodology, affordance theory, and activity theory. The SIP framework explains IT artefacts as instruments for human communication in some action context. SIP is however not to be seen as just a theoretical framework. As a *pragmatic* framework, it should also be put into action. It should be used as a conceptual instrument for designing and evaluating socio-technical systems. The aim of this chapter is to present one such application of the SIP framework, including its consequences both for the design process and the design product, and some theoretical reflections which were made as part of the study.

The chapter is structured as follows: We provide an outline of socio-instrumental pragmatism and some additional action theoretical concepts, and the application of these theories in an action research study. The study has been carried out in the Swedish public sector, where local governments experience administrative problems connected to providing personal assistance to persons with certain functional impairments. The SIP framework has been used as an analytic instrument both for conceptualization and diagnosis of the work practice, and for co-design of business processes and IT artefacts. We present the design product in one section, followed by a section describing the design process. The chapter is concluded with a discussion about the application of SIP, and reflections about the usefulness of the framework. We also discuss some theoretical findings regarding social transparency as a means for business process accountability, which are likely to be valid in a broader public sector context.

Socio-Instrumental Pragmatism

In the discipline of information systems (IS), studies are often informed by the use of external theories from reference disciplines. Structuration theory (Giddens, 1984) and actor-network theory (Latour, 1999) are two examples of this. Socio-instrumental pragmatism (SIP) is another theorizing strategy. It is an action-theoretic synthesis created and adapted to be used for IS research (Goldkuhl, 2005). It is informed by several external action oriented theories coming from different reference disciplines. The two theories mentioned above have given some inspiration, but there are other more important sources like American pragmatism (e.g. Dewey, 1938 Mead, 1938), symbolic interactionism (Blumer, 1969), pragmatic sociology (Weber, 1978), and speech act theory (Searle, 1969; Habermas, 1984). Confer Goldkuhl (2005) for more theoretical sources. As being a theoretic synthesis, socio-instrumental pragmatism does not try to make any complete integration of these diverse action theories. It picks different categories from these reference theories and integrates those into a coherent whole, tailored for IS studies (ibid).

Socio-instrumental pragmatism is based on foundational pragmatic insights leading to action as a core concept. Herbert Blumer, one of the founders of symbolic interactionism, claims that "the essence of society lies in an ongoing process of action - not in a posited structure of relations. Without action, any structure of relations between people is meaningless. To be understood, a society must be seen and grasped in terms of the action that comprises it" (Blumer, 1969 p 71).

The main concept in SIP is social action. The great sociologist Max Weber has made a classical definition of social action: "That action will be called 'social' which in its meaning as intended by the actor or actors, takes account of the behaviour of others and is thereby oriented in its course" (Weber, 1978 p 4). Our interpretation of this definition is that a social action (performed by an actor) has *social grounds* ("takes account of the behaviour of others") and *social purposes* ("thereby oriented in its course"). The social world is created and re-created through human actions. This means that most human actions are of social character, i.e they are social actions.

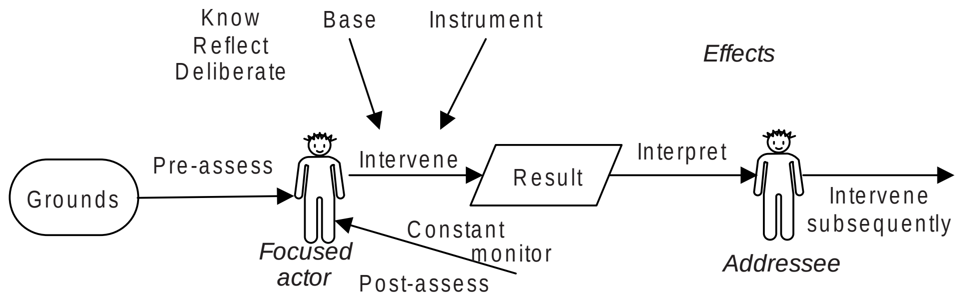
From this follows that (most) actions are directed towards other humans. There are *addressees* of most actions. When we, as human actors, create or change some material object, there may be addressees for this action object. When we say something, there are definitely addressees for these communicative actions. In SIP, there is a basic model of social action (figure 1). This model consists of two actors. One actor is conducting an intervening action (a communicative action or a material action) directed towards the addressee. The addressee actor performs a receiving action; i.e. the receipt of a material object or the interpretation of a message. The intervening actor is the focused actor in the model. This actor has social grounds and social purposes for the action. The actor pre-assesses external and internal grounds in a deliberative phase before the intervening action. After intervention, the actor post-assesses the result and the effects. The social grounds and purposes, and the assessment of the results, can be more or less well-reflected, but always take place in some way. This builds on a continuity model of actions with a division into three stages: 1) pre-assessment, 2) intervention, 3) post-assessment (Goldkuhl, 2005). Originally, this builds on Mead's (1938) four stage model of human action; the stages of impulse, perception, manipulation and consummation. In SIP these stages have been re-named and the first two stages have been integrated into one.

Figure 1 is a one-directional model; from intervening actor to receiving actor. These are actor roles which may change and shift continually into interactive and conversational patterns. As mentioned above in the continuity model of actions, humans continually change between receiving and intervening modes of action.

Human actors often use instruments when acting. Such instruments enable, direct and thus constrain human action in certain ways (Wertsch, 1998). Instruments are mediational means for human action. As artefacts, they are created by humans, and hence given certain properties and affordances for action (Gibson, 1979). Artefacts can be more or less independent. Some instruments must be actively used by humans; for example an axe must be wielded in use. Other artefacts (automatons) have been given properties of independent operations like a washing machine; after initiation it works by itself. Artefacts can thus do things; some artefacts by virtue of their passive properties when "cooperating" with humans and some artefacts by virtue of their abilities of independent activity (Goldkuhl & Ågerfalk, 2005). SIP acknowledges the action character of artefacts, although it does not adhere to a symmetrical view on humans and artefacts as in actor-network theory. The very idea of a dynamic material artefact is that of controlled and mimeomorphic behaviour (Collins & Kusch, 1998). The behaviour of artefacts should be determinate and repeatable in order to be reliable.

As mentioned above, socio-instrumental pragmatism is seen as an eclectic action-theoretic synthesis. As such it is a *progenetive theory* for other descending theories and models in the information systems discipline, which enables *seamless theorizing* between different areas within the discipline (Goldkuhl, 2005). One important descendant theory of SIP is IS actability theory (e.g. Ågerfalk, 2004; Goldkuhl &

Figure 1. Socio-instrumental action: a basic model (from Goldkuhl, 2005)



Ågerfalk, 2005; Sjöström & Goldkuhl, 2004). This theory embodies a pragmatic and socio-technical view on information systems. An IS is considered as a *mediator of communication* between different stake-holders in some work practice context. An IS is at the same time social and technical in character. This is conceptually demonstrated through the notion of *pragmatic duality* (Sjöström & Goldkuhl, 2004). Pragmatic duality means that a user at the same time is 1) maneuvering and interacting with the IT artefact and 2) communicating with other people through reading and writing.

An IS embodies a physically detached communication between humans. Normally, different users are not physically present to each other when communicating through an IT artefact. This gives rise to certain challenges to retain the *accountability* that is common in face-to-face communication (Clark, 1996). Ågerfalk (2004) elaborates on different actability principles and addresses the issue of accountability through the *principle of recorded action*: Information about previously performed communication actions and communicators should be recorded and easily accessible.

Socio-instrumental pragmatism and actability theory are rooted in pragmatist knowledge traditions. This means that these are not only theories about the world of social interaction and IT usage. They are, in a pragmatic spirit, meant to be used for improving the world of social interaction and IT usage.

Research Through Practical Inquiry: The ISS Case

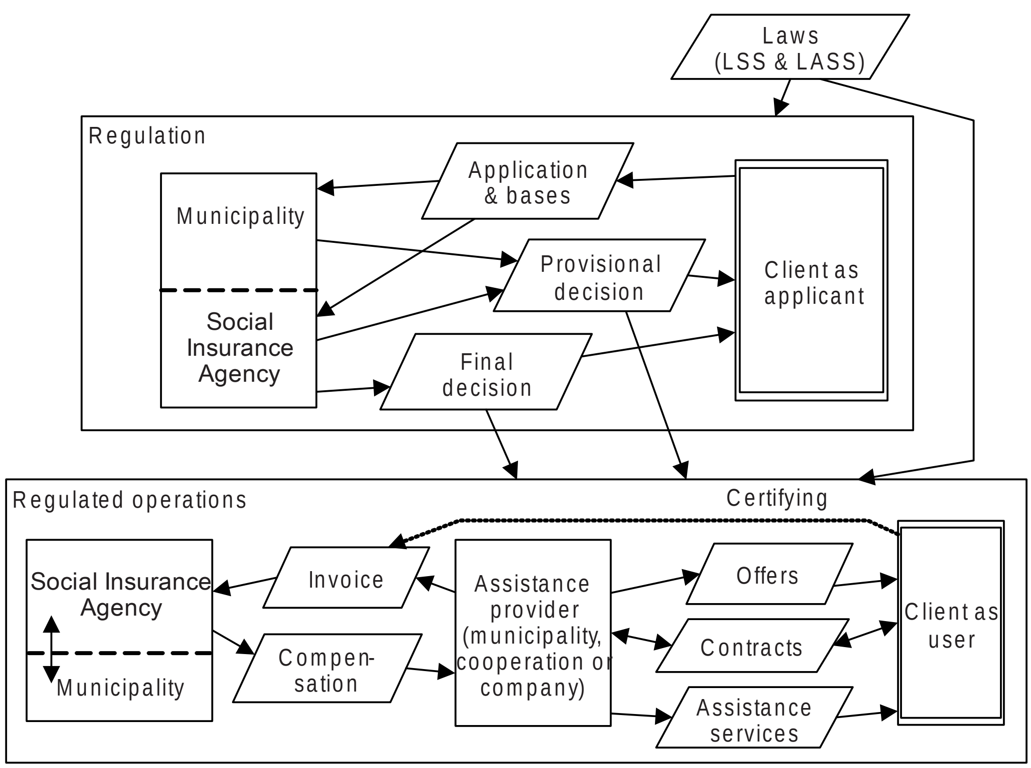
In Sweden, the *Act concerning Support and Service for Persons with Certain Functional Impairments* (LSS) regulates ten types of services provided by the municipality to the individuals. The intention of the law is to enable persons with functional impairments full participation in everyday life. One of the services regulated in LSS is personal assistance. In October 2006, 3698 persons received personal assistance (The National Board of Health and Welfare, 2007). A personal assistant may be assigned to a person belonging to a group of people entitled to special services. The legislation has gone through a series of changes over time, and as a consequence, the municipalities have updated the way they work in order to comply with these. In addition to the municipalities, The Swedish Social Insurance Agency is a major stakeholder in the LSS-administration. Given the legislation, the municipalities and the Social Insurance Agency have different responsibilities with regard to decision-making and funding of personal assistance. An overview of this work practice is found in Figure 2, which provides an overview of interactions between different parties with respect to both the *regulation of operations* and the *regulated operations*. The figure is an instance of the Generic Regulation Model (GRM), which is a theoretical concept sprung from this work. The GRM model is thoroughly discussed by Goldkuhl

(2008). Another aspect of this development is that the number of people entitled to support has increased over time. A large part of these costs are administrative overheads. As a result of this development, these stakeholders currently face a complex and costly administrative situation. The prognosis in Sweden is that the costs for LSS-related activities will increase drastically over the next few years. The policies governing these processes require accountable documentation of these tax-funded processes, both to assure the legal rights for citizens, but also to make it possible to take legal action if some party has violated the legislation, i.e. received funds by misleading the authorities in some way.

In January 2007, a project was initiated, aiming at finding ways of improving the LSS-administration. The project team consisted of representatives from 14 municipalities, the Social Insurance Agency, and project management from the Platform for Co-operative Use (*Sambruk*)—a Swedish non-profit organization which primarily supports collaborative e-government development projects in the Swedish public sector. Two researchers (the authors) participated in the project as analysts/designers. An action research approach was used in this study. The researchers combined the roles of 1) active inquiring and designing in the development of new work processes and IT artefacts and 2) observing as well as exploring and testing new design processes and design outcomes. This is typical in action research projects to combine a role of active change with a research focused role (e.g. Susman & Evered, 1978; Davison et al, 2004). The process has also followed a typical action research loop with diagnosis, action planning, action taking/intervention, evaluation and specifying learning/reflection (ibid). The study is a long term study, still in process after one year's work. This means that further work still remains. However, sufficient data have been collected in order to report and draw conclusions for this chapter.

Action research means an interest to contribute to the immediate practice. This research has also the ambitions to contribute to the general practice of e-government development and even beyond

Figure 2. An overview of the studied work practice



this. The practical contribution is thus not restricted to the actual local practices. The study should also result in practical knowledge of more general character—practical theories which are disseminated in various ways (e.g. in this book chapter), thus aid designers in other development situations. This makes the study a *practical inquiry* (Goldkuhl, 2007) with the double aim of contributing to local and general practice. The concept of practical inquiry (ibid) is based on the ideas of inquiry in American pragmatism (Dewey, 1938). One important aspect of this is the use and development of practical theories during a practical inquiry. The concept of *practical theory* has been articulated by Cronen (2001) and is based on Dewey's work on inquiry; confer also Goldkuhl (2007). Practical theories should help us to see things, aspects, properties and relations which otherwise would be missed (Cronen, 2001). "Its use should, to offer a few examples, make one a more sensitive observer of details of action, better at asking useful questions, more capable of seeing the ways actions are patterned, and more adept at forming systemic hypotheses and entertaining alternatives" (ibid, p 30). Practical theories should not only help us in observation and diagnosis, but should also be a companion in design issues. In such cases a practical theory becomes a design theory. The concepts we focus on the design of technology as part of changing the social world, which is very much in line with a design research approach. We acknowledge that design theory (and design research) within IS research is typically assessed using other lenses, such as the work of Hevner et al (2004), which points out a number of issues to consider in design-oriented research. Design theory, as presented here, is not explicitly formulated or evaluated based on their thoughts. However, an action research approach share essential characteristics with design research, as pointed out by Järvinen (2007). This particular project is an action research project, with a special focus on the emergence of a new work practice through the design of an IT artefact. This way of reasoning is in line with design research, and theoretically grounded in socio-instrumental pragmatism.

Socio-instrumental pragmatism and several of its descending theories and models have been used as practical theories in the actual practical inquiry. Initially, the work processes were studied in terms of the structure of the (formal) social interaction between different stakeholders. The SIP perspective, including several generic work practice models, has been used as conceptual instruments for investigating and diagnosing the existing practice. Based on insights from this inquiry, new work processes (including new ways to communicate) have been proposed and supporting IT artefacts have been designed. The practical theories of SIP have not only informed the inquiry and design process, but the process has led to further development of the theories. What we report in this chapter is part of this re-development of the practical theories.

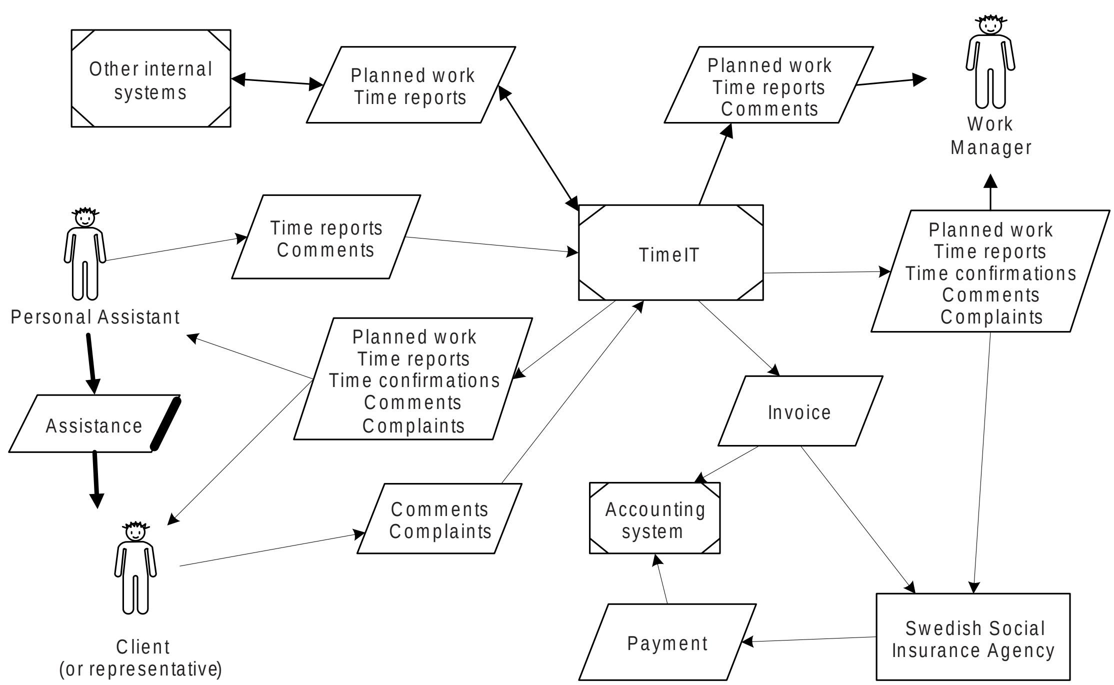
The Design Product: Designing *FOR* Social Interaction

The work practice diagnosis revealed a number of issues in the administration. These issues were categorized into the problem areas *decision making*, *time reporting and auditing*, and *citizen information services*. Setting out from the diagnosis of the work practice, a brainstorming session was performed in the project group, aiming at formulating change proposals. This resulted in 14 change proposals—most of them related to the problem area time reporting and auditing, specifically the administrative complexity that follows from the requirement that citizens sign invoices. The workflow is quite complex, and is only described briefly below.

There is a schedule for each client. Each time a personal assistant assists a client, the time for the work session needs to be documented and signed by the assistant. Today, it is required that this is done using a form from the Social Insurance Agency. The form is handed over to a team leader at the local government. At the end of each month, the team leader has to create an invoice, by aggregating all the time reports from all the assistants, and sum the time spent on each client. This is one of the problematic steps—the assistants' forms are often missing, incomplete, or hard to interpret due to ambiguity or low quality hand writing. These invoices need to be signed by the clients—in order to fulfil this, the invoices need to be delivered (e.g. by mail) to the clients, then signed, then delivered back to the team leader. The team leader then sends all the invoices to the Social Insurance Agency, who require these as they are co-funding the assistance. As discussed in section 3, the Social Insurance Agency requires these signatures, as a means to achieve accountable business processes. The strategy individual certifying through signatures is strongly rooted in the norms in the local governments, as well as in the Social Insurance Agency. The complexity of the workflow causes many consequential problems, such as i) intensive paper work, ii) erroneous payments due to incorrect or incomplete information, which in turn causes iii) the need to adjust payments back and forth between local governments and the Social Insurance Agency. These are some examples of consequences; however the list of problems caused by the requirements of signatures is a lot longer.

Based on the thorough work practice diagnosis with problem, goal and process analysis, the project group embarked on an idea generation process in order to propose remedies to the problematic situations. In a brainstorming session one idea was created to skip the signatures. The project groups agreed that there is a need for accountable information, however there was also a consensus that we may achieve this goal in different ways. The project group decided to adopt the idea of skipped signatures, and continue the development work based on this decision. Before moving on, it is important to state that socio-instrumental pragmatism has been a general perspective and a practical instrument for this work—the latter through the concepts for IS design presented in Information Systems Actability Theory (e.g. Ågerfalk, 2004; Sjöström & Goldkuhl, 2004). This action-oriented perspective is a way of conceiving IT systems as socially embedded artefacts, with agency properties as well as a medium for complex human-to-human communication (Sjöström & Goldkuhl, 2004). This has lead to a design process focused on socio-pragmatic use qualities. Given the 14 change proposals, of which

Figure 3. Desired stakeholder collaboration using TimeIT



several included the development of an IT system to support the future work practice, the first step in the design of an IT system was to outline the new system's role as an instrument for business communication. This work was initiated in the brainstorming session, and documented as a collaboration diagram (which has been revised several times into the current version).

Figure 3 presents a subset of this diagram, primarily explaining the desired action relation between people (assistants, clients, and administrators) and other actors through the use of the new IT system. The centre node (TimeIT[1]) is the IT system to be built. This implies that there are (at least) three different user interface views of the IT system, one for each role, to support the scheduling of work sessions, time reporting, and confirmation of time reports.

The collaboration diagram was the starting point for prototyping the IT system, where we aimed at designing support for core actions performed by different actors. The prototypes and the collaboration diagram were useful in the design process, to receive feedback on the design ideas and allow them to emerge in a number of iterations. As such, they can be considered as design languages, promoting discussions on these topics that are more precise, thus promoting dialogue in a more constructive way than natural languages. The following core actions were identified in the process:

- **Scheduling:** the work manager designs a plan for personal assistance, which needs to be communicated to clients and assistants.
- **Time reporting:** the assistants report the actual work done in the start and the end of a work session.
- **Time confirmation:** the work managers confirms the time reports, and follows up incomplete reports or reports that deviate from the plan.
- **Commenting / complementary communication:** The stakeholders need to be able to write comments when scheduling, reporting, and confirming, to support other to interpret what has been done.
- **Complaints:** since the clients no longer need to sign time reports, there needs to be some other mechanism to ensure accountability in the process. The design process informed us that the option to complain is a proper substitute for signatures, in the sense that it is appropriate and time-saving for the administration in the local government.

All these acts (including comments and complaints) should be made visible to all other stakeholders in order to enable a fully transparent dialogue and documentation. These core actions are meant to be supported in the IT system, complemented by a high degree of action transparency revealing *who said what*. The concept of *social transparency* refers to transparent action-oriented design in combination with an option to talk: comment and complain. This allows for generating reports, revealing what has been done, and when it was done, which in turn make us argue that the work process will be accountable. The project group considers this social transparency as a fully adequate alternative to individual certifying (signatures) to achieve the goal of accountability, and advocates this solution since it will reduce the complexity of the administrative work and it is expected give much higher quality of the time data.

The proposed solution (an IT system enhancing social transparency) is claimed to be more in line with the principles of socio-instrumental pragmatism. The main features are collective reconstruction and quality assurance through making all actions visible to all stakeholders. The IT system has one layer with time information (scheduled time, reported time and settled time) and one commentary layer on top of the time layer with comments and objections. What is said (both layers) can be reviewed and criticized by the different stakeholders. Different comments can be traced to each other (in the commentary layer) and also traced back to what has been said within the time layer. The IT system should work as a socio-pragmatic instrument to create social transparency concerning the work practice. In the current situation there are very poor instruments for control and communication of what has been done.

The individual certifying approach relies totally on personal notes and memory.

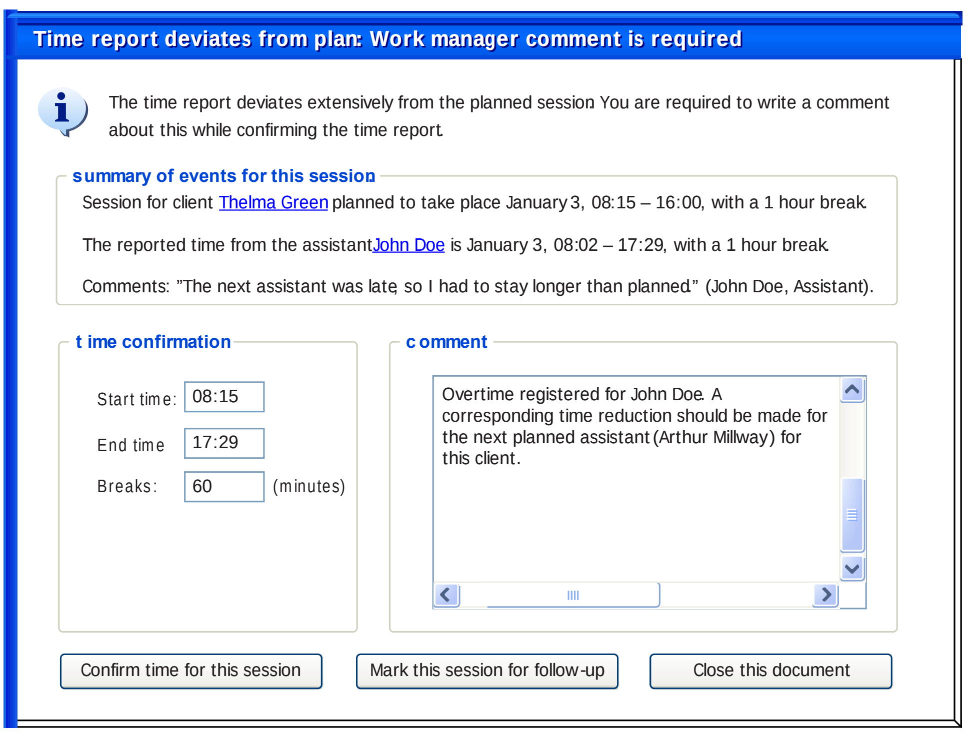
The elicitation of core actions through prototyping triggered a number of discussions concerning design challenges. These challenges include, among other things:

- Capturing data when things are done (e.g. reporting at the client's place when a work session starts and ends). This principle reduces the risk of missing, erroneous or incomplete reports. This also allows for some monitoring which increases the safety for the client. If no assistant has reported that a work session is initiated, the manager is informed about this (it may be a safety problem, since the clients are functionally impaired).
- Time confirmations may be problematic to work with for managers, since there are a large number of a work sessions each month. Therefore, there is a need for multiple views in the manager's user interface, such as "deviating reports" or "incomplete reports". The manager also needs to be able to define the concept of "deviation" by specifying time tolerance levels. Based on the manager's definition, the IT system acts as an agent, helping the manager to filter information which is necessary to make proper confirmation decisions and follow-ups.
- There are different types of user interface media: The manager can do his/her job using a desktop application. The client needs a web interface. The assistant needs a mobile device, and/or a web interface. Each stakeholder group in relation to the medium in use implies its own challenge in the design process, e.g. designing inclusive web interfaces for functionally impaired or designing small device interfaces for assistants.

The project group's emerging awareness of core business actions and design challenges have resulted a design prototype and a requirements specification.

Figure 4 is an example screenshot from the de-

Figure 4. Sample screenshot from design prototype, illustrating the work manager's view



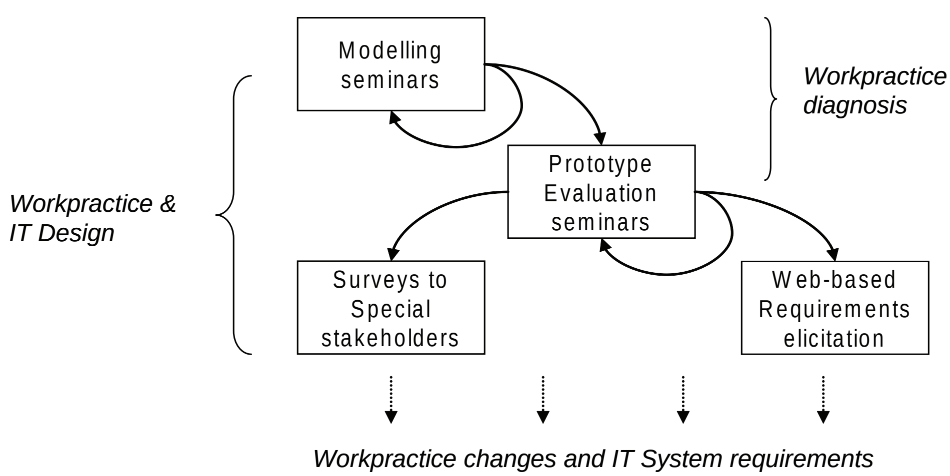
sign prototype for personal assistants, illustrating agency properties of the artefact: A work manager is not allowed to confirm a time report which deviates from the plan without commenting the reason for the deviation. Further, all the actors' names are hyperlinked, so that the work manager can easily click them to find more information (e.g. phone numbers in case something needs to be discussed).

The design prototype is clearly a design product in this project. A design product can also be conceived in a broad sense—*all* artefacts that have been created in the project are products of design, and meaningful in different ways to the project members. We do not consider these different design products as valuable *per se*, but rather as important representations which help the various stakeholders make sense of different phenomena, and consequentially be able to participate in important conversations, thus communicate their work practice knowledge. In the IT system construction phase, an elaborated requirements specification including design prototypes is essential, in order for system developers to interpret the documentation in a proper way.

The Design Process: Designing *THROUGH* Social Interaction

There are several reasons to centre a design process around its stakeholders. *First*, it is a means to understand the work practice and its problems. We need to focus business problems initially, in order to come up with change measures which solve the actual problems in the work practice. There is also a need to be open for different kinds of innovative changes, and avoid the trap of just creating IT support for the current processes in the organization. *Second*, there is a need to make sure that the requirements for a new IT system are based on the actual needs of the organization. The requirements thus need to be evaluated by the practitioners who will use the IT system. *Third*, the strategy of engaging people at an early stage in a change process increases the chances that they actually accept and adopt the changes (e.g. Kotter, 1996). In addition to this, there are a number of additional arguments for stakeholder-centered change processes of businesses with a high degree of stakeholder participation (ibid). A user-centered design process has also proven to increase the chance of building *usable* IT systems (e.g. Bevan, 1999; Sharp et al, 2006), which are usable to *all* stakeholders, in line with Bevan's (1999) discussions on quality in use for all.
Figure 5 shows the design process in this project. The included phases are further explained in the following four subsections.
The Swedish legislation concerning public procurement of products and services excludes (or at least constrains) certain approaches to development (e.g. agile approaches). The way forward which most

Figure 5. The design process



clearly complies to the laws constrain us to a process where we first elicit and specify requirements, then allow all interested vendors to provide us with an offer based on the requirements. By analyzing these offers, we can then select one vendor who gets to build the system based on a binding contract between the involved parties. This means that the requirements need to be 'frozen' at some point. Making changes to the requirements after this point implies that we need to re-negotiate the contract Based on the above, in the current development context, we argue that the requirements specification a) is a necessity and b) needs to be thoroughly elaborated in a stakeholder-centric design process.

Modelling Seminars

The project group consisted of 20 persons, representing 14 municipalities and the Swedish Social Insurance Agency. The two researchers and the project manager from Sambruk have had a joint project leading responsibility. The group has been challenging large to work with. We had a participatory intent from the start aiming at involvement and collaboration. The work practice diagnosis (which was the first part of the project work) was from its inception performed through modeling seminars (e.g. Conklin, 2006). The two action researchers used practical theories (e.g. generic models such as GRM) and modeling methods in order to create different models of the work practice together in the project group. The overview regulation model (Figure 2) was one important model that emerged through these seminars. Several other graphical models (interaction models, process and action models, problem models) were created in these modeling seminars. One action researcher drew and presented models in active dialogues with the group on a shared display (a whiteboard or a computer projected screen). Confer e.g. Conklin (2006) for principles of modeling seminars and the use of notations and shared collaborative displays.

The project group has met at recurrent meetings. There has been homework between the meetings. The municipality representatives have gathered documents and other information. They have reviewed models from the modeling seminars and they have also checked these models with colleagues in their respective municipality. In the mean time the action researchers refined models produced during the seminars and sometimes they also created some new models based on reading of documents and reflections from the seminars. These new models were of course presented and discussed at the next modelling seminar in the project group.

The created models have been important communicative instruments to create commitment and a shared understanding in the group. We have also used the models when presenting and discussing the results with other stakeholders that have not participated in the project. The proposed solutions and the two rival strategies for accountability (individual certifying vs social transparency) have been presented to other important stakeholders like managers and experts at the Swedish Social Insurance Agency and representatives of a government official investigation that are working with refinement of the legislation. There have of course been disputes and controversies both in the project group and in meetings with these other stakeholders. The active use of models has, however, contributed to make these discussions conceptually clear and avoid unnecessary confusion. So far, our socio-instrumental approach has been successful. The creation of appropriate social arenas and the active use and adaption of communicative instruments have been working well in tandem.

Prototype Evaluation Seminars

A prototyping approach has been part of the design work to stimulate further discussions within the project group. Non-functional prototypes have been designed and evaluated in workshops. The feedback from these workshops has been used to further improve the prototypes, and helped the participants to understand the characteristics of the future IT support in a less abstract manner. In total, six prototyping seminars have taken place. The three first occasions were within the project group, which rendered feedback from stakeholders within the local government administration (middle management, operative work managers, and a few representatives from accounting and IT staff). In addition, there has been one prototyping session with personal assistants, one session with clients, and one session including among others a Swedish special interest group for functionally impaired. The last session was also opened up for virtually any stakeholder by open invitations to a number of local governments in southern Sweden. In total, approximately 50 persons representing a number of stakeholder roles have attended the sessions and contributed to the design process through these discussions.

Surveys to Special Stakeholders

The design activities mentioned above mainly focus business issues and user views of new IT support. The requirements, however, need to include a number of issues more oriented towards technology, such as IT system architecture issues and IT system interaction issues. Thus, there is a need to involve additional stakeholders to make sure that these issues are properly addressed. With the backdrop that the aim is to specify requirements which can be used for a number of Swedish local governments, all having their own IT architecture and different IT systems running, we need to understand and take into consideration the feasibility for this variety of existing IT systems to interact with other IT systems (i.e. the one we are designing). Thus, the members of the project group were given the assignment to forward a number of questions to their IT strategists/architects and work actively to make sure that answers to the question were brought back to the designers in the project group. The answers to these questions are imperative to formulate system interaction requirements which match the needs of the local governments.

Web Based Requirements Elicitation Community

The final stage of requirements elicitation means that all the knowledge from previous phases need to be formulated in the form of a requirements specification for a new IT system. The question that posed in the project was how this can be done. Since the project group is distributed throughout Sweden, we decided to create a web site where all the requirements and related documents are accessible. The project group, and other invited actors, can log in to this web site in order to analyze and comment the requirements. The web site handles a number of issues, such as revisions of requirements, workflow support, delegation of work to people with different roles, and some other aspects of collaboration. By promoting an active discussion about requirements in this community, we have the ambition of minimizing the so called requirements engineering gap (Ågerfalk, 2004), since work practice members actively question the formulations. When there seems to be a consensus in the requirements elicitation process, and a decision is made in the project group that the requirements are finished (satisficing is likely a more appropriate word), the requirements specification can be exported from the web site.

Note that the development and use of the web based requirements elicitation community is a design research project in its own, which will be addressed separately in other research publications.

Discussion and Conclusions

First, the use of socio-instrumental pragmatism and its accompanying analytical instruments have guided the diagnosis and design process in constructive ways. It has guided the inquirers to focus on actors, actions and relations between actors. Principal relations between different actor groups have been reconstructed and clarified. Described actions and relations in the work practice have been evaluated by the project group and the problems in the current situations have been thoroughly elaborated. Especially the acts and relations of *regulation* have been investigated in order to clarify the underlying essential properties of a very messy work practice. This clarification was pivotal for getting a conceptual clarity preceding the creation of possible change measures. Several project members were enthusiastic about the models produced and they were very eager to show them to their colleagues back home. With SIP, there follows also to direct attention towards texts and artefacts as action objects. Different legal texts have been studied in-depth and related to current practice. Through this close reading we discovered that the municipalities have problems to reach their informative obligations stated in the law. We have also identified several problems in the current legal formulations and these insights are feed-backed to the legislation committee and other powerful stakeholders.

Second, a direct consequence of the action-oriented design process, is the notion of accountability as a goal for an organization, and the possibility to reach this goal through different strategies: *Individual certifying* through signatures (the prevailing norm in the public sector) versus *social transparency* (the proposed strategy for the studied work practice). Individual certifying means that different actions are made accountable mainly through the use of signatures that certify that these actions have been conducted. Social transparency means that performed actions are made visible and thus accountable through proper IT artefacts and common communication practices among different stakeholders. In the social transparency strategy, the norm is that we have easy access to relevant information and the option to complain when something is inaccurate. The norm in the individual certifying strategy is that we always confirm that something is accurate. No matter which strategy is in use in the organization, IT may improve the processes. However, the social transparency strategy allows for a more innovative way of improving public administration. Certain features of IT artefacts have been utilized in order to reach the goals of social transparency. The new IT system (with its designed socio-technical features) will afford a collective inquiry and dialogue of the time dimensions of the assistance work in order to reach a possible consensus between the stakeholders (clients, assistants, managers and the Social Insurance Agency). Without IT support, it seems unlikely to achieve an adequate level of social transparency. The norms on how to perceive what is accountable are different among the different vital stakeholders, which in turn makes immediate revolutionary changes unfeasible in this empirical context. A bottom-up analysis of the work practice suggests that social transparency is a preferred means to achieve accountability for local governments. The generalizability of these results needs to be further investigated, but at this time we assume that similar situations may be experienced in other change projects in the public sector (not only in Sweden). Conclusively, there is potential for increased efficiency in administration through the implementation of the social transparency strategy for accountability, but the process may be slow, and projects may be stalled, due to the need for cultural change within government authorities or possibly even legislative change to implement the transparency-complaint strategy.

Third, the combination of work practice diagnosis and a user-centered approach to requirements elicitation has lead to a rich picture of the current practice, and possible future ways of working. An interesting reflection, which needs to be further investigated, is how the use of the different elicitation techniques trigger discussions. On the one hand, in the early stages of the project, project members seemed to be in a hurry to discuss solutions (i.e. the future IT support). On the other hand, the discussions triggered by the prototype evaluations often introduced business problems that were not mentioned in the work practice diagnosis. A tentative conclusion from this is that these two techniques (or similar techniques focusing these two domains of interest) are complements, which are both needed, and together help us form a better understanding of the work practice problems and possible IT solutions to those problems.

Future work in this project includes evaluation of the project outcome. A number of questions need to be addressed. Will some of the municipalities implement the proposed IT support? Will it solve the problems we identified? What other problems will arise? Another issue is to investigate how the project group evaluates this approach to development. Our indication is that the approach has catalyzed high participation in the project and that is has been highly appreciated, but we have not yet evaluated this methodically.

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KEY TERMS

Accountability: From a social action perspective, accountability may be conceived as the feasibility for a person to make sense of the social grounds and purposes of their actions, thus act in a well-informed, responsible, and auditable manner.

Actability: An action-theoretical framework focusing design and evaluation of IT artefacts in their social context. Based on the SIP framework.

Design process: a set of interrelated activities with the purpose of inducing change in some social setting. In an information systems context, this is typically done through the development and implementation of an IT artefact into its social context, accompanied by other changes such as new roles and tasks.

Design product: The result of a design process, i.e. new artefacts and the induction of change in some social setting.

IT artefact: A man-made piece of technology with some information-processing and mediating capabilities.

Socio-Instrumental Pragmatism (SIP): A framework of theories serving as a practical and progenetive theory for Information Systems Research. Mainly sprung from American Pragmatism.

Stakeholder-Centered Design: A design process which aims at engaging various stakeholders in order to improve the design product, and increase acceptance for new IT artefacts in the social setting where they are about to be embedded.

ENDNOTE

1 Short for *Time Management through Information Technology*

Chapter XVIII
A Framework for Using Analytics to Make Decisions

Paul J. Bracewell
Offlode Ltd., New Zealand

ABSTRACT

Analytics provides evidence for objective corporate decision-making. Lack of understanding of analytical techniques can create confusion amongst decision-makers. Confusion generates mistrust which leads to the exclusion of analytics from the decision-making process. Confusion is avoided by ensuring that results are justified. This requires that the analytical process is auditable. Aligning technological design and deployment with human roles creates the necessary framework for auditability. This is achieved with four analytical technology components: data manipulation, statistical and quantitative analysis, creation, and export of exploratory and predictive models, and delivery of output. These components correspond with key stages and phases of collaboration in the analytical process. Describing the interaction and alignment leads to a proposed framework for the socio-technical development of analytical software and process which considers both user and non-user needs. This framework can be expanded to other domains where technology and users of technology must collaborate with non-users who dictate acceptance.

In everything one must consider the end

—Jean De la Fountaine, 1668

INTRODUCTION

Business is latching on to the power of analytics using skills derived from fields such as statistics, mathematics and operations research, conducted with tremendous (and increasing) computing capacity and storage capability. To deliver robust results to business in a timely manner requires deployment of applicable theory, which can only be achieved via suitable software installed on appropriate hardware

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and interpreted by someone with relevant domain knowledge. This process is concreting the abstract; the conversion of raw data and theory to tangible insight, leading to action.

Action in this instance is fact-based decision-making within the corporate environment. This requires collaboration between different entities who tend to have minimally overlapping skill-sets; hence the need for collaboration. To ensure that the outcome of this political process is consensual requires a number of conditions to be meet to the satisfaction of several key players. Parallels are drawn between the requirements of the key players with the demands of the process to meet these requirements. This congruence defines the technological requirements.

The key players in a business orientated analytical exercise are: analyst, data expert, consumer, sponsor and analytical software. Analytical software is a tool, or set of tools for quantitative analysis, enabling the four other human roles to successfully combine efforts to the benefit of business. Consequently, analytical software must allow for open, transparent, truthful and cost-effective communication, thereby presenting a unified foundation for decision-making. In order for that to be achieved, the version of the truth presented to the business must be plausible. This requires that the analytical process is transparent, or auditable. Crucial to this is how the analyst interacts with the software and other key players.

"Apart from the price tag, there is very little difference between a model that is not built and one that is not deployed" (Bracewell, 2006, p.5). Many factors influence the acceptance and deployment of analytical results within business culture. Those entities with an interest in the use of analytical software within a business environment are described and their potential impact upon the decision-making process examined.

An observational study of more than 30 Australasian corporations from the banking, quasi-government, utilities, retail and telecommunications sectors over a five year period is coupled with a review of the literature to develop a socio-technical framework for development and deployment of analytics and analytic software. Despite some industries being more analytically advanced, the needs are virtually identical as far as integrating analytics into the corporate decision-making process are concerned. Consequently there is no need to differentiate between the different industries. The development of analytical software to meet the needs of both the individual and the collective are then discussed. Importantly, the congruence between the needs of the key players and software design determines the manner in which analytics is integrated into the decision-making process. This process is auditable which ensures that those ultimately responsible for decision-making are able to interrogate how a result was acquired, thereby generating confidence in the results, enabling them to deliver the results to the wider business.

Corporate decision-making relies on analytics for a variety of tasks, limited only by the imagination of the business. Generic examples include: deciding whether or not to acquire/sell/close a business, what type of customers to acquire/retain, how those customers should be targeted, the budgetary requirement to acquire/retain and which customers should be personally managed. More specific examples include development of a personal finance product in the banking sector, where various factors such as pricing, likely uptake, target audience and profitability must all be determined in building a business case to have the product accepted.

Present literature describes either the properties of analytical software, or the nature of the analytical process, or those involved, but not the interaction between software, people and process. Whilst a number of analytical tools have the core features, the rationale for these features is not well documented. This has meant that the wide-spread adoption of analytics within business has been slower than would be expected.

The intersection that arises from the software-people-process interaction is used to propose a more coherent model for socio-technical development and deployment of analytical software. This model highlights the importance of those that use the results, but not the technology. The generic description and conceptual integration of elements enable this chapter to serve as a template for both the development and deployment of analytic tools for developers, analysts, information consumers and senior executives.

Key Players in an Analytical Exercise

Politics is the process by which groups of people make decisions. In the analytical arena of business, software is a core aspect of that process. Typically, analytically-orientated handbooks refer to three key players: Data Expert, Analyst and End User (Walsh, 2005). There are two other aspects that also impact on the process: Project Sponsor and Analytical Infrastructure. Analytical infrastructure consists of components enabling the key players to perform. Analytical Software is a major element of Analytical Infrastructure.

This section will define the key entities involved in an analytical exercise, how they interact and examine the impact that they have on the decision-making process. Analytics is a poorly understood term. It will be defined first to avoid ambiguity. Explanation of this term is crucial so that the role that technology has in the process is clear.

Analytics Definition

Analytics are "the extensive use of data, statistical and quantitative analysis, exploratory and predictive models, and fact-based management to drive decisions and actions" (Davenport & Harris 2007, p. 7).

In business, data mining and analytics are often viewed as synonymous. Both are an optional subset of Business Intelligence; "a set of technologies and processes that use data to understand and analyze business performance,…, includ[ing] both data access and reporting, and analytics" (Davenport & Harris, 2007, p. 7). Essentially, analytics answer the higher-value and proactive end of the Business Intelligence (BI) spectrum (Davenport & Harris, 2007). Struhl's (2000) review of data mining definitions concurs that from a user's perspective analytics is more sophisticated than other data driven approaches. SAS Institute, a leader in the development of data mining software (Herschel, 2007), use analytics as the broader term to describe tools from the fields of statistics, data and text mining, forecasting, econometrics, optimization and quality improvement (SAS, 2007). This highlights that data mining is a subset of analytics. Based on this relationship, definitions of data mining can be used to further inform the role and purpose of analytics in the business environment. This will help determine the desirable features of analytical software.

Issues with understanding analytical results from a wider business perspective often stem from the view that analytics and data mining are synonymous, the varied perception of data mining and confusion regarding where analytics fits in the Business Intelligence spectrum. These three points are socially-orientated and can be resolved through education. Davenport & Harris's (2007) definitions above adequately describe analytics and the role it plays in Business Intelligence while Struhl (2000) and SAS (2007) indicate that data mining is a subset of analytics.

In the typical business environment, education often comes from observing the outcome of an analytical exercise or from discussion with colleagues and not the literature. As opinions and internal definitions of analytics are largely experiential, it is the role of the three entities described below to ensure that these definitions mirror that of Davenport & Harris's (2007).

Data Expert

"The data expert understands the structure, size, and format of the data" (Walsh, 2005, p.1-10). More specifically, the data expert "knows the transaction system(s) from which the [data] will be drawn. [They] manage expectations on what data is available, and if it's not, what it will take to acquire that data" (Rasmussen et al., 2002, p.148). "The data expert will be aware of the process for capture, maintenance and dissemination of the data" (Blythe, 2006, p.9) thereby understanding the idiosyncrasies of the data. Typically, this entity will be an operational manager in a functional area of the business with day-to-day responsibilities for managing business process and establishing business rules for production transaction systems (Blythe, 2006).

The analyst is heavily reliant on the data expert to ensure that appropriate data are used for analyses in a reasonable fashion. Appropriateness is determined by factors such as data quality, intent, timeliness and availability.

Analyst

The analyst has the required understanding of the capabilities and limitations of the methods that may be relevant to the problem (Walsh, 2005). A good analyst will also know the limits of their expertise, understanding and tools. This is important to effectively manage business expectations, especially given that analytics envelops a number of specialist fields as outlined in the definition earlier. The use of appropriately designed and featured analytical software can offset the need for extensive knowledge of specialized statistical methods. However, Davenport and Harris (2007) argue that this type of skill set is necessary in order to deliver a competitive advantage rather than deliver business as usual activity.

The most important contributor to an analytical exercise is the analyst. However, they cannot be productive in isolation. The analyst must satisfy the needs of the data expert. Specifically, the data expert must be satisfied that the right data is being used appropriately. Furthermore, they must be assured that if any transformations are applied, such as imputation of missing values or merging of data on key elements, that this process is entirely reasonable.

The analyst must also demonstrate to the power consumer that appropriate answers to business questions are deliverable. Sufficient interpretation must be generated to enable the power consumer to implement insight.

Effective communication is paramount for the analyst. The attributes described above refer to "front room statisticians" or "PhD's with personality" which Davenport and Harris (2007) describe as "individuals with heavy quantitative skills but also the ability to speak the language of the business and market their work to internal (and, in some cases, external) customers" (p. 144.).

The analyst uses technological interactions to satisfy both data expert and power consumer requirements. Failure to do so places an analytical project in jeopardy.

Power Consumer

The terms business domain expert, consumer, end user and occasionally stakeholder are synonymous for the entity tasked with using the output of an analytical exercise. In an analytical exercise the role assumed by the end user is more advanced and is described here as a power consumer. The power consumer has sufficient knowledge of the analytical process and/or business problem to request from, or collaborate with, the analyst to determine expected outcomes for servicing the needs of the business. The power consumer understands the particulars of the business problem. As well as possessing relevant background knowledge, context and terminology, they will be aware of the strengths and deficiencies of any existing solutions (Walsh, 2005). As a result, the power consumer is able to assess the value of new work. The power consumer will also influence the wider business's perceptions of analytics. This influence can be problematic, especially if the power consumer is not appropriately skilled. In that instance, the duties of influence default to the sponsor.

Sponsor

The sponsor is the person with ownership for the project within a company. Ideally the sponsor is senior management, preferably at 'C-level', and thus an influential decision-maker. Typically, the sponsor is responsible for: championing the project, obtaining budget approval for the exercise, and taking ownership of documents such as the business cases and proposals (Dinsmore & Cooke-Davies, 2005). The sponsor should have adequate standing within an organization to successfully promote a particular project or business objective. They must also be sufficiently business savvy to overcome resistance to a project. Otherwise the onus falls on the three key entities to promote the exercise.

The three core contributors (data expert, analyst and power consumer) should be heard equally by the sponsor to provide a balanced overview of the project. Accordingly, this places pressure on the analyst to satisfy both the data expert and power consumer to ensure that the desired message is communicated to the sponsor. It is crucial that analysts have a close and trusting relationship with decision-makers (Davenport and Harris, 2007).

A project manager may be required for large projects. This role ensures that the project meets the specified requirements (Project Management Institute, 2000). This includes facilitating communication and resolving conflicts. A project manager can be considered as part of the wider project infrastructure.

Analytical Infrastructure

"Analytical infrastructure consists of generic analytical engines, such as data mining methods" (SAP, 2001, p. 19). This environment enables analytical business problems to be answered, through access to, and delivery of, data (SAP, 2001). This broad, brief definition addresses two key points hinting at the true scope of analytical infrastructure.

The first point is that the analytical engine is comprised of analytical algorithms bundled as software. The second less clear point regards the environment. In this context, the environment refers to a wide range of business infrastructure ranging from the obvious (data warehousing and hardware) through to the softer aspects of communication (e-mail, telephone and video-conferencing for example). Location of the entities is also a function of the environment. This requires of analytical software to enable collaboration on the same project by geographically separated entities.

Analytical software is the aspect of the analytical infrastructure that enables the analyst to justify the trustworthiness of the results through demonstration, interpretation and translation.

Analytical Software Definition

Expanding on the definition by Davenport and Harris (2007), analytical software is software that: 1) allows data sets to be manipulated, 2) performs statistical and quantitative analysis, 3) creates and exports exploratory and predictive models and 4) delivers output that can be used to drive decisions and actions.

Analytical software must adequately perform each of these four core functions. Each of these aspects will be explored in detail in a subsequent section. However, to fully understand the implications of these features, the potential inter-entity relationships are outlined. It could be argued that just the ability to perform statistical and quantitative analysis is the minimum requirement of analytical software. However, in defining analytics, that solitary component is insufficient to meet business needs. Thus, all four components must be present to ensure sufficient return on investment from the analytical exercise is delivered to the business.

Relationship between Entities in an Analytical Exercise

The analogy of a "bowl of soup" is used to describe the relationship between the key entities. Crudely, the sponsor is the bowl and the three core contributors are the "solids". The analytical infrastructure is the liquid which the three core contributors are immersed in.

Broadly, the sponsor must:

1) Have insulating properties:
    a. to keep the project hot (topical),
    b. keep the project together, as well as

c. protect the core contributors from the wider business and vice versa.

The core contributors:

2) Add substance and flavor (ideas/innovation) to the analytical exercise.

The analytical infrastructure enables:

3) Free and unrestricted access of core contributors to the other entities,
4) exchange and combination of ideas, and
5) adaptability to meet business requirements.

Transparent analytical exercises yield greater visibility to interested parties leading to wider retention of intellectual property and acceptance of analytics in the decision-making process. The sponsor and the core contributors must continually market results to the wider business. Figure 1 shows the hierarchy of interaction between the entities engaged in an analytical exercise. The direct interactions are displayed.

This diagram shows that there are multiple levels of interaction with the software. The analyst has a first order interaction with technology as they directly use the toolset. The data expert and power consumer have a second order interaction as their relationship with analytical technology is via the analyst. The sponsor has a third order relationship as this role interacts with the data expert and power consumer. Despite interacting with the analyst, the weakest connection needs to be considered as any breakdown in understanding would occur at that point. Those with second order interactions and above will be described as non-users. The converse applies to the decision-making process. Whilst the analyst provides the evidence, they are the furthest away from the decision. This highlights the need for socio-technical design to consider not only the interaction between humans and technology, but how higher order human-human interactions are shaped by technology.

If the analyst is considered as the user, and all other human roles considered as non-users, then the above figure is the generic representation of the analytical-based model derived in Figure 1. Deployment is governed by the non-user, thus special consideration must be given to their needs when developing both software and process. Delivery in this sense is the communication of results, whereas deployment is the actual implementation of output. It is important to note that the non-user does not interact with the technology, yet dictates how it is used and developed due to the influence on deployment. Thus developers of both technology and solutions derived from technology must review non-user requirements to ensure that the technology and uses of technology are successful. Importantly, the above framework for emphasizing non-user requirements may only be true at the start and end of development.

As discussed earlier, the sponsor should form a balanced overview of the project by giving equal weight to the comments from the three core contributors (data expert, analyst and power consumer). Whilst this places pressure on the analyst to satisfy both the data expert and power consumer to ensure that the desired message is communicated to the sponsor, this tension between the data expert, analyst and power consumer drives excellence. If one of the three entities has too much control, analytical innovation becomes difficult, hindering an organization's competitive advantage. The following outcomes are likely to occur if one entity is overly dominant:

1) With the data expert as the governing entity, the tendency to adopt purely data driven approaches will not completely satisfy the needs of the business, nor will efficient methodologies be adopted. The usefulness of analytical methodologies will be neglected.
2) When an analyst assumes the influential position, this can lead to results becoming too academic in nature; that is timely delivery of pragmatic business relevant results can be difficult to obtain.
3) If control is held by the power consumer, business relevant answers will be delivered, but efficiency, robustness, insight and fact-based creativity will lack due to the absence of ana-

Figure 1. Specific representation of the interactions between core entities that contribute to an analytical exercise in the business environment

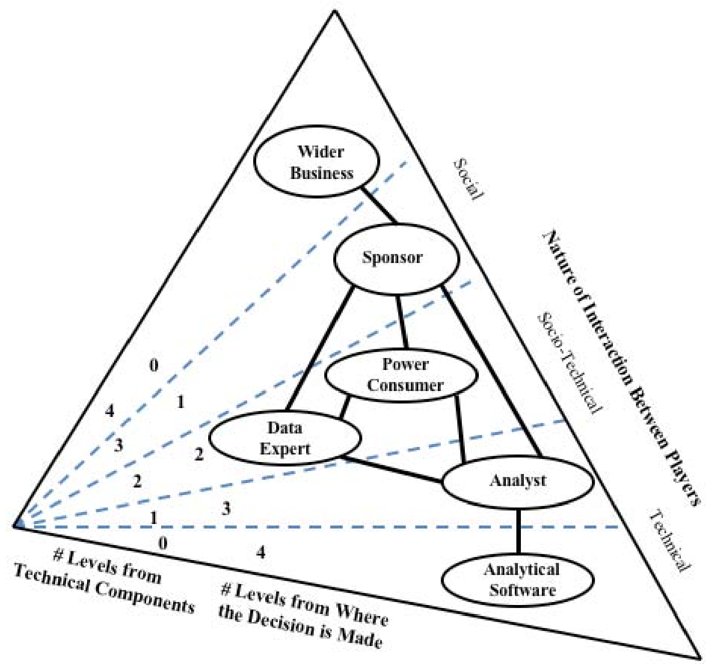
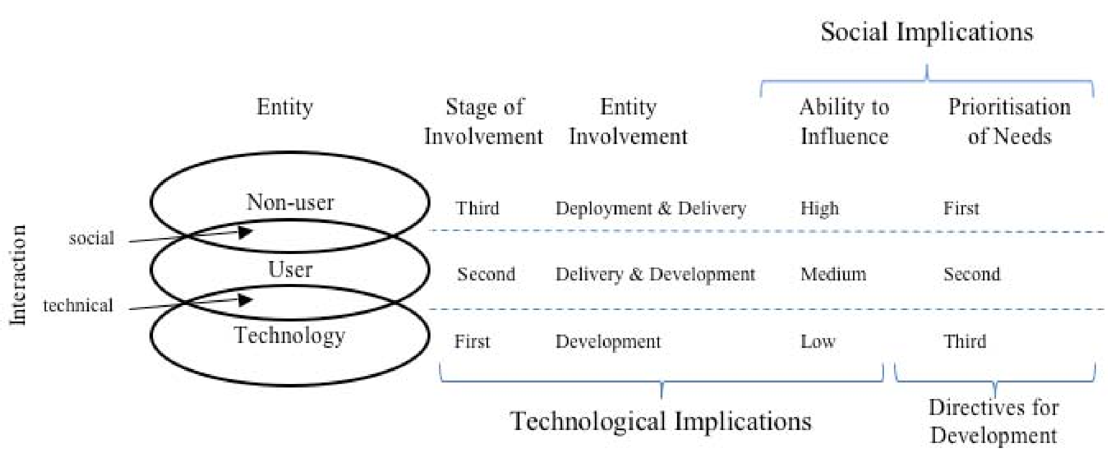


Figure 2. Generic representation of interactions between core entities where deployment is influenced by a non-user of technology for the purposes of socio-technical development



lytics. Long-term, consumer driver strategic direction will be absent from the business.

4) A dictatorial sponsor will override any results that do not conform to the political position that they have adopted. This will present an ethical dilemma to the three contributing entities. This final point is beyond the scope of this chapter.

The combination of attributes from the three core contributing entities leads to practical and robust business solutions. Satisfying the data expert that the data is manipulated and used correctly, and giving the power consumer business-orientated insight with supporting evidence is enough to ensure these entities will align with the analyst in communicating to the sponsor. Consequently, data manipulation and publication of results are features of analytical software required to negate organizational politics. This means that the needs of those who do not directly interact with the software must be considered when developing the software. These features and other essential components of analytical software are outlined in the next section.

Features of Analytical Software

The social aspects of an analytical exercise have been outlined in previous sections. The interactions between the social and technical aspects of analytics are introduced in this section. Specifically, the core technical features of analytical software to meet the needs of humanity are explored, which is crucial for defining the socio-technical framework for development and deployment.

There is no shortage of marketing material describing the features of the top analytical products such as SAS, SPSS, SAP (Business Objects), Minitab, IBM (Cognos) and Oracle (Discoverer, Siebel) which is available on their respective websites.

As discussed earlier, based on an extension of Davenport and Harris's definition of analytics, there are four essential components of analytical software: 1) Data Manipulation, 2) Statistical and Quantitative Analysis, 3) Creation and Export of Exploratory and Predictive Models and 4) Delivery of Output. The sub-sections below describe how these components (technical) impact on the key entities (social). This discussion is a domain specific representation of the proposed socio-technical framework for design and deployment of analytics within the business environment. A major consideration is the needs of the non-users. Consequently, developing technologies that enable effective interaction between users and non-users is an important consideration in socio-technical design.

The order in which an analyst approaches an exercise flows from data manipulation through to the delivery of output. These components will be outlined in the reverse order, starting with the aspect closest to acceptance of results which stems from the output, as this mirrors the order in which the sponsor and the wider business are introduced to the exercise. These touch-points (phases of collaboration) are vital for determining the analytical process from a socio-technical perspective due to the level of non-user interaction.

Delivery of Output

The delivery of output has two stages. The first stage is the initial communication of results and the second stage is the ongoing deployment of results. The challenge of analytical software design for business is to confront the political aspect of the analytical environment. Trust in results is the greatest political challenge, earned through all interested parties understanding the communicated results. Thus, the minimum requirement for analytical software is effective communication of results. It is highly recommended that the necessary requirements for stage two are met. These requirements are outlined broadly below.

Non-technical parties gain understanding from the presented results. Consequently, analysts must cater for the lowest common denominator. Typically this will be either the sponsor or the power consumer. Visualization aids the analyst in interpreting the model to determine if it is suitable for the business problem as well as evaluating the practical significance of results. Furthermore, visualization enables complex concepts and results to be communicated effectively. “Scientists and researchers have known for a long time that the best way to decipher vast quantities of data is to display it visually” (Totty, 2006, p.R6).

Ultimately, internal marketing of results is reliant on presentation quality and the ability of interested parties to relate the findings to their own perceptions. The notion of quality of presentation covers both the appearance and the interpretation of the insight associated with the results. Presenting data in a manageable way enables a decision to be made rapidly (Totty, 2006). Providing the analyst with software that has visualization functionality reduces project time as the output is created during the development phase of the analytical exercise. Visualization functions should make it easy to create intuitively meaningful content, but also allow for customization.

The impact that the quality of a presentation has on the wider business must not be neglected. First of all, it captures the attention of the audience. Secondly, appropriate content aids understanding. Finally, report quality results produced in common formats: 1) simplifies the work required by the analyst to produce impressive-looking presentations and/or prototypes, 2) reduces the time taken to automate and publish results, 3) minimizes the challenges to publishing results across the wider business, and 4) ensures consistent output which makes it easier to educate the wider business on the capabilities of analytics.

For instance, the automated export of graphs as JPG format can lead to automated production of static hard-copy reports or updating of web-content to be accessed by authorized parties via a web-portal or intranet. Electronic delivery of results can be extended to dynamic content such as labels, definitions and other dimensions allowing consumers to independently probe ActiveX or Java content. Production of tables and other numeric content, such as ANOVA regression tables, in stylized html format makes it easy for an analyst to directly integrate or publish results.

It is vital that the analyst has access to the underlying processed data which generates the tables and graphics as this enables the analyst to enhance the visualizations. This also aids automated delivery of model output. Ongoing timely delivery of output is crucial to provide the business with a competitive advantage. “In a recent Information Week survey, 59 percent of the IT executive respondents said they were trying to support real-time business information” (McGee, 2006).

Essentially, the output facility of the analytical software must meet the needs of the key entities whilst minimizing the required input from the analyst. The analyst should be able to extract the required content to sell the results with minimal effort. As a result, the analyst should be able to control what output is delivered, through either a user-friendly wizard, or using code.

Once the wider business has accepted the results, the natural progression is then to illustrate how those results were obtained. Primarily this is to convince the wider business that the results are an accurate reflection of the phenomena of interest. This is an important step to further solidify trust in the analytical exercise.

Creation and Export of Exploratory and Predictive Models

Accepted results and processes often need to be deployed. The ease of exporting a suitable model can be a barrier to the use of analytics in the decision-making process. Time is the largest barrier. SAS Institute’s premier analytical tool, Enterprise Miner 5.2, is an ideal example of analytical software that performs this task well. Models are created quickly and easily by connecting nodes that perform potentially complex analytical functions. A scoring node is available in this tool that generates production quality code for deployment. This vastly reduces deployment time. Exporting the model, as process flows or code-based scripts, enables faster deployment of the results to the wider business. “Analytics need to become automated and embedded into business process to continuously drive fact-based decision-making based on subtle changes in the market environment" (IBM, 2005). Models need to be built and deployed quickly to enable organisations to compete. Furthermore, "Most organisations should adopt a right-time approach, in which the decision time frame for a class of decisions is determined within an organization, and the necessary data and analytical processes are put in place to deliver it by that time" (McGee, 2006).

A shortage of analytical talent (Blattberg et al, 2001) places additional pressure on analytical software development. The tool should enable top quality analysis by lesser skilled talent. This can create a risk if inexperienced analysts attempt analyses well beyond their skill-set. Menu and wizard driven processes lessen the expertise required to operate analytical software meaningfully. Preferably the menus or wizards will intuitively follow a natural process for modeling. The layout of SAS Enterprise Miner leads the analyst into using the SEMMA approach for modeling. SEMMA is an acronym representing these five steps: Sample, Explore, Modify, Model and Assess.

The modeling process should also allow a collaborative environment so that teams can work simultaneously on a project thereby reducing lead times. The sharing of tasks across geographical disparate locations must also be considered. This requires the model development process to be stored easily, be transparent (auditable) as well as ensure the approach can be easily replicated. However, the ease of building, testing and modifying models should be tempered with security measures that ensure that source data and production code is not over-written.

An audit trail in the creation of a model essentially chronicles an analyst's thinking. This is necessary to explain an approach and/or identify problem causes. Additionally, functionality within the analytical software that monitors the model performance to ensure that it continues to perform well is desirable, although other models can be created for this purpose.

Statistical and Quantitative Analysis

Statistical and quantitative analysis is the engine of analytical software. This engine must have a variety of commonly accepted algorithms. Additionally, the analyst should be able to integrate bespoke algorithms. These algorithms come from many fields and applied in many different environments, so no detail regarding the types of algorithms will be specified here. The minimum requirement, however, is to cater for both linear and non-linear modeling for supervised learning. This can be encompassed with regression and decision tree algorithms. Similarly, unsupervised learning functionality should include dimension reduction, like principal components, and clustering.

To establish suitable approaches and confirm underlying assumptions, exploratory data analysis functionality is crucial. This functionality can be rudimentary as it is designed to satisfy the analyst's requirements, not the other entities. Specifically it is to check assumptions such as the assumptions for regression which are: normality, linearity, independence and homoscedasticity.

The ability to control the nature of the output from the underlying algorithms, through selection, suppression and customization can be beneficial to the analyst, as it enables the supporting evidence to be compiled easily.

Once the interested parties are satisfied that the results and approach are suitable, the next logical step is to determine where the data came from and how it was processed.

Data Manipulation

It would be very easy to digress and cover the concepts related to data warehousing which addresses issues such as extraction, transformation and loading (ETL) of data. This data should represent a single version of the truth and address data quality issues. These concepts are well beyond the scope of analytical software. However, leading analytical software vendors, like SAS, encompass this aspect.

The data manipulation requirement of analytical software is to prepare the data for analysis. More often than not data manipulation is a powerful aspect of the analytical process; it can surface otherwise hidden elements of the data to be modeled. Specifically, data preparation is required to fix errors, merge tables and convert data to a consistent format suitable for analysis. This may be as a ‘short-fat’ single-entity view for propensity modeling, or ‘long-thin’ transactional-view for market-basket analysis.

Enabling users to access and manipulate data in a timely, low-cost fashion stems from flexible software. Wizards for importing data can simplify repetitive tasks, but analysts must also be able to control interactions directly using programming.

To enable manipulation, analytical software must be able to read source datasets. It must read/write a number of common formats, such as DB2, tab delimited and comma-separated values (csv).

Analytical Software Socio-Technical Design Requirements

Previous sections have outlined the human requirements of the analytical process and how this shapes the technical requirements. How the technical requirements impact on the key players closes the loop on describing the interaction between humanity and technology in the analytical environment. The intersection within this relationship is summarized in this section.

Analytical software must allow an analyst to produce valid, defendable, practical work that the wider business will accept as a viable perception of the environment and is suitable for decision-making purposes. The key requirements of analytical software to enable the analyst to meet the political challenges are: robust importing of data from disparate and inconsistent data sources, timely processing of data, up-to-date analytical algorithms with the facility to program bespoke algorithms, embedded logical flow for performing analyses, control over output with effective delivery of results and the ability to seamlessly deploy adopted models back into the business. These software features combine with the expertise of the analyst to deliver effective analytics for effective business.

Intuitive GUI interfaces for performing tasks that, if necessary, can be replicated, customized and enhanced by the analyst reduce the time to deliver results to the business. Additionally, a fully integrated product suite that covers all the aspects described in the previous section minimize the specialist training required, thereby reducing the risk of losing intellectual property with staff turnover. Publication of results in common formats increases the likelihood of uptake by the wider business. Uptake is further enhanced if non-specialists users in the wider business can perform interactive modeling and “what-if” analysis independent of the analyst. Real time analysis and automation meet the business need to deploy results.

SAS Enterprise Miner is a leading analytics tool (Herschel, 2007). The provision of a GUI-driven, Java-based product for cross-platform deployment supporting all necessary steps for addressing business problems in a timely fashion means that it is a suitable template for the design of analytical software for both the social and technical requirements outlined previously.

However, the features of the analytics tool are not enough. As outlined in this chapter, the deployment of analytical software within a suitable process that considers the needs of the user, non-user and decision-making process is essential.

The proposed socio-technical framework for business analytics specifies the software requirements that enable the user to communicate to non-users in a structured manner. This framework also describes the analytical process for use of that tool which acknowledges the requirements of the key players. This socio-technical interaction creates an environment for structured collaboration which generates an audit trail enabling those with ownership of the decision to justify that fact-based decision.

CONCLUSION

Technology (software and hardware) is a crucial aspect of the corporate decision-making process. Increasing demands will be placed upon analytical practioners as data volumes increase. However, for demand to keep pace with technology, the manner in which the data is processed, from database to sentence, must be intuitive to the key stakeholders in order to build trust. Failure for analytical software to integrate seamlessly into the human-orientated decision-making process removes the involvement of analytics. This subsequently stunts the effectiveness of a business. Humans are notoriously poor at detecting patterns in large datasets; the non-use of appropriate tools for detecting these patterns significantly reduces the possibility of gaining a competitive advantage. Integrated correctly, analytical software reduces the barriers to retention of intellectual property thereby substantially reducing the risk associated with staff losses. In practice, non-users often incorrectly consider analysts as technology. Thus the manner in which users approach their work should follow the guidelines specified in this chapter to aid in trust building.

This chapter outlined the necessity for a number of people to work together with the help of technology to engage in fact-based decision-making. The requirement of the analyst to respond to the challenges of other key players not only defines the necessary software features, but also the analytical process. The overlap and interaction between people, process and technology defines a concise socio-technical framework for analytical software development and the subsequent deployment of this technology.

The core requirements of this framework are data manipulation, statistical and quantitative analysis, creation and export of exploratory and predictive models, and delivery of output. More specifically, these features encompass robust importing of data from disparate and inconsistent data sources, timely processing of data, up-to-date analytical algorithms, embedded logical flow for performing analyses, control over output with effective delivery of results and the ability to seamlessly deploy adopted models back into the business.

A business orientated analytical exercise has several key players: analyst, data expert, power consumer, sponsor and analytical software. Analytical software is a tool, or set of tools, enabling the four other parties to combine efforts and contribute successfully to the business decision-making process. The four essential components enable the analyst to satisfy the data expert that data is handled appropriately and provides the power consumer with fact-based business-orientated insight. Meeting these requirements ensures that these entities will market the results, first to the sponsor, and then with the sponsor's help to the wider business.

Davenport and Harris' (2007) book 'Competing on Analytics' is regarded as the first comprehensive review of analytics. This chapter builds on the definitions discussed in that book, and states more explicitly the roles of the key entities and the level of interaction with analytical technology. Analytical software is defined based on the role it fulfils and its four core components are outlined. Additionally, the dependency of the key entities on the core components is described to show how this socio-technical relationship combines to offset political challenges within the business environment.

The lessons learnt from the development of this framework can be extended to other domains. The central theme is that technology must not only satisfy the technology user, but also meet the needs of non-users, who may be several layers away from direct interaction with the technology, but are impacted by the use of the technology nonetheless. Regardless of the quality of the analysis generated, if the non-user does not trust the results, or the process by which the results were obtained, then the entire analysis can be dismissed. This is a harsh lesson. As described in this chapter, the needs of the non-user assist in process definition by indicating the touch-points where software user and non-user intersect for the achievement of common goals. This is particularly relevant to other domains where non-users have an inherent distrust for technology.

Analytics highlights the importance of considering the non-user in development of technology. In this environment those furthest away from technological interactions determine whether or not output is used; this requires that technology allows the conduits (analysts) between technology and humans to deliver auditable, meaningful results, which is essential for effective analytics for effective business.

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KEY TERMS

Analyst: The person(s) with the required understanding of the capabilities and limitations of the analytical methods that may be applicable to the business problem; thereby enabling them to conduct the analysis.

Analytical Software: software that: 1) allows data sets to be manipulated, 2) performs statistical and quantitative analysis, 3) creates and exports exploratory and predictive models and 4) delivers output that can be used to drive decisions and actions.

Analytics: the extensive use of data, statistical and quantitative analysis, exploratory and predictive models, and fact-based management to drive decisions and actions.

Business Intelligence: a set of technologies and processes that use data to understand and analyse business performance encompassing data access, reporting and analytics.

Data Expert: The person(s) who understands the structure, size and format of the data, where the data is drawn from and how it is captured.

Power Consumer: The person(s) tasked with deploying the output from an analytical exercise. They have sufficient knowledge of the analytical process and/or business problem to request from, or collaborate with, the analyst to determine expected outcomes for servicing the needs of the business.

Sponsor: The person with ownership for the project within an organisation. Typical accountabilities include: championing the project, obtaining budget approval and responsibility for documents such as business cases and proposals.

Chapter XIX
The Challenges of Co-Design and the Case of e-Me

Mikael Lind
University of Borås, Sweden

Peter Rittgen
Vlerick Leuven Gent Management School, Belgium
University of Borås, Sweden

ABSTRACT

Setting up co-design processes involving several stakeholders is a complex task. In this chapter the authors have looked upon experiences from involving 120 future users in a process of incrementally developing and deploying an electronic assistant for students. The vision is to develop an electronic assistant, an e-Me, that acts as a filter and an agent in the information society. By interviewing some of the future users we have managed to derive some different challenges associated with co-design processes. These challenges have been discussed related to the following categories; perceived usefulness, user involvement in the development process, learning process and critical factors for future development. The authors analyze the empirical data and derive suggestions for possible improvements.

INTRODUCTION

The idea behind the e-Me project (www.e-Me.se) is simple and challenging at the same time: To build an electronic assistant that helps students in organizing their life. This involves activities such as organizing the course schedule, buying or lending course books, planning public transport, managing study progress, and so on. So far students have to go to a number of places, both physically and virtually, to accomplish that. e-Me is supposed to turn that process around (Albinsson et al, 2006b). The vision is that the students should not need to go to the information; the information rather comes to the students based on the active profile set by the student.

The project, that this paper reports experiences from, explores whether an e-Me acting both as an agent for individuals and as a filter in the information galaxy for desired information services would be of use for creating a better society (c.f. Albinsson et al, 2006ab). It takes as its starting point the individual and his/her life situation, instead of the

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organization which is providing services to the individual. The project, which formally begun in 2005, has applied a co-design (Albinsson, 2005; Albinsson & Forsgren, 2005ab) approach starting from a vision about an electronic assistant as a solution to student self-administration. An important part of the vision was also that the e-Me should evolve over time with input from different stakeholders by letting them share and design their view of reality together with others. To ensure both open and reflective participants a student setting at University College of Borås has been chosen. The e-Me project is in part a governmentally funded Swedish research consortium consisting of representatives from Umeå University, the University college of Borås, the city of Stockholm as well as several partner companies like Intel, Microsoft, VISA, Telia, Mecenat, and smaller student oriented companies (Lind et al, 2007).

One condition for e-Me is that e-Me Student-related services become accessible. To identify the relevant services a number of co-design workshops together with students in Sweden and Spain were conducted resulting in ten different scenarios (Albinsson et al, 2006a). To ensure representative results the participants of this study had been selected from different environments (e.g. cities and small towns), age groups (20 to 35) and countries (Sweden and Spain) with an equal gender distribution. These scenarios covered eight situations the students want to improve, such as *apply to university and begin studies, Monday morning, You've got lots of mail, change of plans, form-filling and reviewing, the elective course, finding jobs, the purse chase,* and *co-buyer groups.* During, the spring and summer of 2006 these scenarios were verified by sending a questionnaire to 16 000 students in Sweden which resulted in more than 3 200 responses (Lindell et al, 2006). The most relevant services were implemented in a prototype. This prototype is the object of the current study. Figure 1 shows one snap-shot from the user interface of the e-Me pilot.

The scenarios were also used to involve the above mentioned stakeholder organizations in a conversation about their roles in a world with existing e-Me's. After this verification a pilot version of the e-Me concept was designed and built (Lind et al, 2007). A small group of students were involved in testing and evaluation during this phase. After three months the first prototype of e-Me was deployed for a group of approx. 120 students (January 2007) who became a part of the e-Me project group and co-designers. The students co-designed e-Me by trying out the prototype – both in order to identify shortcomings in the application and identify new situations, both within and beyond the school setting, when an e-Me would be of assistance (ibid).

The core of the e-Me consists of the following components (Lind et al, 2007):

- **Calendar management,** in which the user's calendar can be shared with other e-Me users' calendars. Different categories of bookings can be highlighted by using different colors.
- **Mood management,** in which it possible to set and manage in which mood the e-Me user is. Three possible moods have been implemented in the prototype so far; private, meeting and open.
- **Mail aggregation,** in which mail can be popped from different sources and distributed dependent on the mood that is set.
- **Contact Management,** in which contacts can be grouped into different categories and a status of the contact, can be set in relation to the possible moods.
- **Archives,** in which files (of different types) can be stored and shared with other e-Me users.
- **Assignment,** in which the user manages all tasks assigned to the e-Me. In the pilot version four assignments has been implemented. These are the possibility for e-Me to receive study results (from Ladok – a national system for reporting study results), get the schedule into the calendar (from NeverLost – the school's scheduling system), receive this weeks lunch menu, as well as matching desires

and needs of offers from organizations with students discounts (from Mecenat).

- **Community,** where the stakeholders; users, developers, e-Me project management and service providers can discuss the e-Me, suggest improvements/additional services and share experiences.

In the left part of Figure 1 different "blobs" (views) of the e-Me is depicted. In the right part of the same figure one of the blobs (the assignment blob) is expanded. e-Me also supports device independency in the sense that e-Me gives a possibility for the user to interact with his/her e-Me via a web-browser or his/her mobile phone. This aspect of mobility also means that the e-Me could notify the user concerning different events (such as emails from contacts with the right mood, changes in schedule, matched offers, changes in the study results etc.).

But the purpose of the e-Me project is not only to develop a student assistant. At the same time it was desired to explore new ways of developing an information system. The development of e-Me was inspired by the philosophy of co-design (Albinsson, 2005; Albinsson & Forsgren, 2005ab). The term co-design is used in different ways. In the context of our study it refers to an idea that was elaborated in (Forsgren, 1991) where it was still called co-construction. It has its roots in "systems thinking" as established by (Churchman, 1968). His principal idea was that we can design an unlimited number of views on reality. They may differ in their granularity (level of detail), their perspective, their level of abstraction, and so on. But from Churchman's point of view this is not sufficient. We must also "calibrate" the viewing instrument (or measurement scale) to arrive at (or agree on) a view that is supposed to be implemented. The necessity to agree upon some common design for a system has also been put attention on by other scholars (c.f. Liu et al, 2002). This collective process of designing views and choosing the best one is called co-design. It has shaped the way we look at social systems in general and information systems in particular (Ackoff, 1981; Checkland, 1988; Mitroff and Mason, 1981). The notion of co-design is considered to go beyond the notion of participatory design (Mumford, 1983) in the sense of admitting and letting *several* views of reality shape and drive several complementary design processes.

Figure 1. The e-Me User Interface (c.f. Lind et al, 2007)

The purpose of this paper is to analyze experiences developed by some users involved in the stage of the e-Me project when 120 students were invited to participate in order to make some reflections over different dimensions of co-design processes as such. Even though that the e-Me galaxy is an arena letting several stakeholders, where one of them are clients (in our case students), we will in this paper just explore experiences derived from the student's participation in the proof-of-concept phase of the e-Me project. Following this section the research method adopted in this paper is described by starting out discussing in what ways students, as clients of an innovative artifact, could be seen as and involved as co-designers. In this section the procedures and results of the data collection made in the paper is also put forward. This is followed by an analysis of the empirical data in order to reflect upon perceived usefulness by the students, the development process as a co-design process, the learning process for the students as well as future development of e-Me. Before the conclusions we reflect upon how the co-design process could be supported even better, e.g. by different kinds of tools.

Research Method

Co-Design as a Way to Involve Clients in the Design, Deployment and Test of e-Me

A core idea in the co-design, which is both a scientific approach as well as a development approach, is that there is a close relation between innovative product/service development and knowledge creation (Forsgren, 1995; Lind et al, 2007). Businesses and organizations constantly try to capture knowledge about ideal situations for customers or clients, which they match with knowledge about resources they have or can create. Successful businesses/organizations are able to constantly developing their knowledge about customer ideals and their own matching resources. Customers or clients on the other hand constantly try to imagine and find out knowledge about their own ideal situations and look for affordable resources, which can make it possible for them to come closer to ideal situations. In this view, researchers ideally collaborate with businesses and organizations as well as customers in discovering the lacking knowledge. The researchers place themselves in between the organization(s) and the customers trying to manage the design in order to come to agreements among the different stakeholders. The dynamic interplay between these actors and processes constitutes the core of the co-design knowledge creation process (Grönlund, 2000). All the way trough this process there is also a constantly ongoing inspiration communication flow. The involved actors try to get inspiration from the knowledge creation in other relevant projects as well as they try to get others inspired by their work.

This e-Me project shows how researchers in collaboration with different stakeholders have created a new type of arena, e-Me, where the customers, in this case the students, can develop their ideals into a profile, which govern e-Me as an electronic assistant and filter (bodyguard). From the service providing companies perspective e-Me can serve as input for new service development activities, as well as it gives a relevant and high precision channel for marketing and service delivery. In this project the aim was to continuously involve students as clients in the development process. At different stages in this process this was done by involving:

1. a smaller group of students (approx. 50) to be active in the process of ideal-oriented design of scenarios where e-Me would be of support to them (Albinsson et al, 2006ab)
2. a larger group of students (approx. 16 000) to both quantitative and qualitative evaluate generated scenarios (3200 answers) (Lindell et al, 2006)
3. a key group of students (approx 10) as test group for refining requirements, testing and evaluating the continuous growth of e-Me as an artifact towards the development of the first

version. These students were highly involved in pinpointing micro-scenarios for different (thought) usage situations of the artifact. These students also became ambassadors and coordinator of the student involvement in the next stage.

4. a group of students (approx 120) as early users and evaluators in the pilot implementation of e-Me (c.f. Lind et al, 2007). This evaluation was made both in terms of functionality and usability. This evaluation also meant that situations when e-Me would be of support were identified and shared among the users. This process also triggered the students to identify new situations where e-Me would help out in finding new areas of application in which it would be of support the life situation of the student. The different ideas for refinements put forward by the students were handled by the development team. Several deployments were made of refined versions of the e-Me during the 3.5 months when the e-Me was up and running for this pilot group.

In terms of co-design this means that students were involved in many different stages of the development process of e-Me, which has been true for a variety of other stakeholders also. The results so far is a proof-of-concept of the e-Me as an artifact as well as requirements when e-Me is developed and deployed, as a full-scale application, for many users. It is important to note that e-Me relies on letting both many users, and many service providers take part in the same galaxy. For the different stakeholders value is created through the existence of many actors.

This means that the users' comments and design proposals have been of different characteristics throughout the e-Me project. In the last stage these comments served as essential parts of the communication going on between different stakeholders involved in the project. The arenas for this communication were a virtual community, interaction with student ambassadors and by workshops involving several stakeholders. In this sense the notion of co-design is conceived as a an approach spanning all the way from taking different stakeholders insights and ideas for development into account in the knowledge creation process to involving several parties in the phase of design and realization of IT-based artifacts. Several roles were involved such as evaluators, designers, programmers etc, where the students mainly served as evaluators and in principal as designers.

The purpose of this paper is to qualitatively analyze some experiences developed by a few users involved in the last stage of the process described above.

Data Collection and Procedures for Analysis

As one part of the project we collected the empirical data with the help of semi-structured interviews. Other collections of empirical data were made during the project such as:

- statements made by different stakeholders in the (virtual) community space that was created as a part of e-Me. In this space interaction between different stakeholders, such as the project management, researchers, designers, service providers, the programming team, and the students as users could take place. The goal was to create an on-going dialogue between the various stakeholders in order to improve the design and the understanding of the concept of an electronic assistant (Lind et al, 2007).
- logbooks from different meetings with student coordinators reflecting the current state of concern as well as decisions made for advancing the refinement of the prototype
- intermediary workshops evaluating the students experiences from using e-Me involving other stakeholders to investigate their concerns (Lind et al, 2007).

In this paper we adopt an individual perspective of the user by the semi-structured interviews. This analysis is to be seen as a complement to other evaluations made as described above. Out of the group of the 120 pilot students who tested the e-Me system 3 enthusiastic students (student A, B, and C in the table below) who use the system on a regular basis were chosen. The perspective of the disappointed student was also chosen (student DISS in the table below). This perspective was derived by letting the student coordinator of the e-Me project formulate answers that would be given by a disappointed student based on impressions derived during the pilot period. The questions and the answers of these users are summarized in Table 1.

The empirical data has been analyzed on qualitative basis taking the four core categories used in the semi-structured interviews. Within each category similarities and differences in the answers given by the respondents were identified. Results captured in other evaluations, as described above, has been related to this division when needed to complement the analysis made of the empirical data put forward in this paper.

Analysis of Empirical Data

We have divided the analysis into four areas of concern: perceived usefulness of e-Me, the development process as a co-design process, learning process, and future development of e-Me. The reason for this is that we wanted to study the development process as a co-design process which means that we must look at the development process itself, but also at the product of this process and the individual learning processes of the people involved.

Perceived Usefulness of e-Me

All students have initially thought of e-me as a relevant and important contribution to their life by helping the student in his/her administrative and daily chores. This seems to indicate that there

Table 1. Answers of the regular users

Question		A	B	C	DISS
Perceived usefulness					
What was your first thought when you heard about e-Me?		Innovative	Useful	Interesting	Hard to understand what e-Me was
What made you decide to try e-Me?		Need for that software and being part of the test group	To help out with testing	Because it seemed useful	Everybody else was trying it
How often did/do you use e-Me:	In the beginning?	1-2/day	4/week	2/day	A lot
	After having understood the software?	2-3/day	8/week	2/day	Much less since I got tired of the bugs
	Currently?	2-3/day	2-3/day	2/week	No
What is your major reason for using e-Me?		Email is tied to it	Calendar, email is tied to it	I use e-Me seldom because of email problems	Inventive GUI, nice integration
Which functionality are you using most?		Email	Email	Calendar, student admission & documentation system	Calender integration with NeverLost, SMS notification
Which functionalities do you not use and why?		Lunch menu (bring own lunch)	Lunch menu (bring own lunch)	Email (forwarding & attachments are unreliable), lunch menu (bring my own lunch)	Email (since it did not work perfectly) and offers (the content did not match my desires)

Table 1. Continued

Question	A	B	C	DISS
What change or new feature would make you consider a more frequent use?	Better GUI & functionality of email	Integration of bus schedule	Reliable email attachments & forwarding, integration of e-learning platform	More (user-decided) notification via SMS and connection to existing web-applications
Development process				
Which bugs have you reported bugs and were they fixed?	Email attachments are lost (partly solved)	Moods always red (solved)	Email attachments and forwarded emails are lost, (not solved)	Problems with the e-Me message application (solved)
Which improvements/new features have you suggested and were they implemented?	Printouts available on site, integration of library services, bus schedule, loyalty cards and menus from other restaurants (none implemented)	Integration of bus schedule (not implemented)	Integration of e-learning platform (not implemented)	---
Do you feel that you have an impact on the development?	Yes, at the early stages.	Yes, strongly.	Not directly.	Not directly
What impact did you make?	Layout of the GUI	Calendar design, integration of student discount card	I hope that my suggestions are considered for the next version.	I hope that my suggestions are considered for the next version.
What would make you assume a more active role as a co-designer?	Personal feedback from the developers	Don't know	Higher usability of e-Me, regular meetings with face-to-face discussions ≥ 1/month	---
Learning process				
How did you learn how to use e-Me?	Introduction & self-learning	Introduction & self-learning	Self-learning	Self-learning
Was it hard to understand?	Some parts (e.g. the calendar)	No, only the date format	No	A bit difficult to learn the GUI
Which learning method would you have preferred?	Personal tutoring & self-learning	Manual & self-learning	Self-learning	Computer-based tutorial integrated personal tutoring
How would you judge your computer literacy on a percentage scale?	80 – 95 %	90 – 95 %	80 – 90 %	80 %
Future development				
Which other software do you use for a functionality covered by e-me and why?	Other email clients **in addition to** e-Me (because they offer more functionality and because some mail providers do not support pop free of charge)	Other email clients **in addition to** e-Me (because they are more reliable and because some mail providers do not support pop free of charge	Other email clients **instead** of e-Me (because email is not reliable in e-Me)	Other email clients instead of e-Me (because some of the functionality of e-Me is provided by other email clients)
How much of your vision of a student assistant is available in the prototype?	50 %	40 %	10 – 20 %	10 – 20 %
What are the major features missing with respect to that vision?	Full-fledged email & calendar, integration of library services	Full-fledged email & calendar, integration of bus schedule	Full-fledged email & calendar, integration of e-learning platform	More connections with other software that is used in everyday life

is indeed a demand for an integrated solution for students and that students are missing something in existing solutions used by them today. The regular users have mostly begun to use the system hesitantly but made frequent use of it after having become acquainted to it. There is one notable exception though of a student who complained early about problems with lost email attachments. Because this problem was never completely solved this student ceased to use the email functionality of e-Me and reverted to the use of other email clients. As email is a central component of e-Me this implies that the respective student is hardly using the system anymore and perceives very little usefulness.

The students however found that the idea about email aggregation, from many different sources, governed by contacts and mood had a lot potential. It has been found that students have 3-4 email addresses and that the e-Me email client is supposed to meet a demand of the students by making it possible to aggregate emails from several email clients. So – from a pilot perspective of e-Me one can, even if there were some bugs reported, claim that an important requirement for a full-scale e-Me is an email client that can handle aggregation based on mood and contacts from several email sources. Most users indicate that the email component is one driving force for them to use the e-Me system. This is not because the students perceive this component as well-designed (the contrary is true) but because, besides that the e-Me email client solves a problem, their mailbox is tied to the e-Me mail client and it would require some effort to change it back to some other client. This is interesting because it shows that simple technical measures such as default settings/installations can be enough to make a user continue using a system (similar to the Internet Explorer in Windows systems). This mechanism can therefore be used to sustain the interest of the pilot users of a prototypical and innovative system beyond the point where the software becomes sufficiently mature to be really useful. The ambitions from the management team of e-Me was to ensure transaction-intensive components in e-Me for driving the students to continuously use the e-Me. Especially the email and calendar components fulfilled such goal.

Among all components provided by e-Me, regular users name email and calendar as the most important ones. The email receives the highest valuation and is perceived as important per se. The calendar is seen as the second most important component and considerable weight is attached to the integration of the calendar with the NeverLost course schedule management system. This allows students to see each class as an entry in the calendar and to synchronize their courses with other activities in a straightforward way. The possibility to share the calendar among other e-Me users were also identified as important by the users and implemented in the pilot during the pilot period. The component with the least perceived usefulness is the lunch menu of the student cafeteria because many students bring their own food. To be noted is that the lunch menu was not part of the initial scenarios. This was an initiative made by some of the pilot students. The evaluation reported upon in this paper shows that the lunch menu was not enough adopted by as many users as desired.

Interesting to note from this evaluation (see table one) is that there are some dimensions of the e-Me pilot that are not drawn attention towards. Some examples of this are the study results module and the offers module. We do however have other reports from the pilot period of the value of these two components (c.f. Lind et al, 2007).

All regular users stressed the importance of a professional email component for the continued use of e-Me. Beyond fixing the bugs already mentioned this means that the e-Me mail client should provide the same or similar functionality and user interface as others available on the market. In order to avoid such comparisons the ambition from the management team was to derive a user interface that not looked like other solutions of today. The uniqueness of the user interface did make many users of e-Me think that it was something else. After the pilot period the management team will however consider the possibility of exporting (filtered) data to existing calendar and email clients as an important complement/alternative to the existing email and calendar clients bound to the e-Me as such. In addition to this the students required a more convenient access to printouts which currently have to be collected in a different building. It is also apparent from the students' comments that the existing features are not sufficient for an integrated student platform. Among the high-priority issues for a future release are the integration of library services, e-learning platform, bus schedule, loyalty cards, integration with the bank and menus from other restaurants. These requirements were possible to draw out when the e-Me concept became externalized in the form of a (pilot) artifact and the users started to use it and saw the potential. Besides that it also meant that the basic idea about personalization through mood management and the e-Me as a social proxy of the user (c.f. Albinsson et al, 2006ab) could be tried out and reflected upon. Besides the importance of creating an e-Me space in which a lot of different services, private and public, became integrated it also turned out that notification, when your e-Me tells you when something (as desired) has happened, was conceived as very useful and important.

Development Process as a Co-Design Process

The development process during the pilot period had the ambition to follow the principles of co-design. The goal of the co-design in this stage was to arrive at proof-of-concept and (hopefully) have several future users reflecting over existing and new usage situations, and thereby new services, for the e-Me. The first version of the e-Me consisted of some bugs, and users were able to report upon identified bugs interactively in the community space. The developers responded quickly to the bugs that were reported and fixed them as soon as possible. As a result the regular users were largely satisfied with the way their concerns were treated. The problem with the lost attachments was not completely solved, though, and remains an open issue. As the problem occurs only seldom now most users are nevertheless satisfied with the situation. But some users expect the email component to be 100 % reliable and they have therefore stopped using it. An important experience to draw upon is that it is important that if we expect users to continuously use and evaluate artifacts as co-designers we need to be sensitive in the sense of ensuring enough quality so the users continue using it. As reported, most of the bugs were fixed quickly and most users were satisfied. It is however a risk that the goal of the co-design in this stage never would be reached if the users concentrate on finding bugs and complaining about the quality of the software instead of having a mindset oriented towards future improvements.

A different situation was encountered regarding suggestions of additional features (for details about them see section "Perceived Usefulness"). Due to budgetary restrictions some of these could not be considered for the current version although some of them were seen as highly desirable by the students. An important challenge that this situation unfolds is how to ensure a continuous use and evaluation of the artifact given the fact that some of the initiatives of improvement taken by the students were not possible to realize. In these cases the co-design process was put on hold in the sense that the knowledge creation was started, but not finalized in the due to that additional designs were implemented in the artifact. A co-design process could therefore not be observed in the later stages of the design process but only during the earlier stages of requirements gathering. A further investigation of this issue seems worthwhile as the design of new functionality provides a richer arena for the unfolding of creativity.

There was however other situations where some of the interviewed students were involved as co-designers from idea to implemented solution (during the pilot period). They helped in designing the layout of the user interface, a new version of the calendar and the integration of the offers module (Swedish student discount card) into the pilot. They thereby contributed substantially to the way the software looks and works. They did so in close collaboration with the developers and they felt that they had a real impact on the development. The majority of the test users were however during this stage of the project more actively involved in the early stages of the co-design process such as identifying requirements and in the design of new usage situations, but not in the specific development of the artifact. In a more open environment an ambition is that users themselves would be able to also design and implement additional features (user-generated services). This is an ambition for the future, but in this stage of the project the goal was to arrive at proof-of-concept.

This raises a number of interesting questions concerning the feasibility of the co-design approach. The first could be phrased as: How can we stimulate people to participate in co-design? The study results show that the mere interest in the software is not enough for that. From this question we can see two important areas of concern. First of all we believe that the input made by co-designing users need to be taken seriously and followed up during the process. Secondly we need to pedagogically ensure that the user adopts a co-designing mindset. Potentially we believe that the virtual community was not enough to solve the whole situation – in some situations a user needs personal feedback from the developers and regular face-to-face meetings with them to discuss issues and possible solutions. Some needs in the co-design process could be taken care of through a virtual community, as e.g. informing others of what is happening etc., but some tasks might demand more direct contact between certain roles. Another area of concern is also what level of activity that key persons associated to the vision of the project should have in making statements in the community.

This takes us to the second question: How can the involvement of a potentially large number of co-designers be organized in an effective and efficient way? Each new feature has been suggested by many students. Can and should they all participate in all the phases of the co-design process concerning all features? Including additional co-designers involves the risk of duplication of effort if some of them come up with very similar solutions. By excluding them we run the risk of losing some important contribution. How do we determine a reasonable composition of the co-design team for the latter phases of the co-design process such as design and implementation? Our study cannot finally answer these questions but it indicates that a team should consist of the clients who are most committed to the particular feature, i.e. have a vital interest in seeing it implemented and using it. This is typically a small group of two or three students that can be an effective co-design team complementing the development team. In the project the student ambassadors worked in close collaboration with the development team. On the other hand we must also avoid putting expectations on such users of being experts in software design, but they should, as super users, at least represent a wider group of users in their involvement in the knowledge creation process relying on collaboration between several stakeholders.

Another question is related to the treatment of conflicts. What do we do if some co-designers prefer incompatible solutions? A survey of a representative part of the student community could decide this conflict one way or the other. As such a survey would necessarily be hypothetical we cannot be sure that the respondents understand the implications of their choice for the use of the software. Another alternative is the implementation of conflicting solutions as configurable run-time options of the software. This result in more flexible software that can be adapted to the needs of a broader range of users but it also makes the system harder to maintain. So far the e-Me project did not exhibit problems of this kind.

Learning Process

Most of the students that participated in this study consider themselves as capable computer users. They prefer to learn about the use of software by themselves, possibly complemented by a manual or a short personal introduction. They all described e-Me as an application that is very easy to understand and get started with. They experienced only a few minor problems during the learning period. These problems were related to the calendar function and the entry of dates. The latter was rather a bug that has subsequently been fixed by the deployment of a new calendar during the pilot period.

Related to learning and getting users to work with the artifact is the question of how users could influence each other by telling each other of different configurations of their e-Me that were made in order to facilitate different situations when e-Me was of value in their daily life. The experiences from the pilot period were that this task is tricky. It had to do with how such situation should be documented, how to get users engaged in telling such stories for each other, and how such information was supposed to be distributed among the participants. The virtual community was used for this purpose.

Future Development of e-Me

Asked about the use of other software for purposes covered by e-Me, most students answered that they use additional email clients or webmail agents. Partly this is related to the fact that a few free-of-charge email providers popular among students do not offer the POP protocol required by e-Me. But to a considerable extent it is due to the relatively simple functionality of e-Me's mail component as compared to common clients. Students have therefore come to expect a standard that cannot be achieved by a research prototype. But even for a commercial endeavor it seems hardly reasonable to invest money into building something that already exists in multitude. A more viable alternative for e-Me can consist in the integration of existing open-source email clients into the e-Me framework. Due to the fact that the students have several email clients the important thing is not to create a new e-Me email client – rather too ensure that e-Me filters out and distributes emails from several email clients based on mood and contacts.

Regarding the most important next steps in the development the students mention integration before high level of functionality on each component (c.f. Lind et al, 2007). Example of additional integration to e-Me are library services, e-learning platforms, public transport schedule, and financial management related to their bank accounts. They expect these features to be part of the next release. As information systems for these purposes already exist, the integration of these services into e-Me is primarily a question of suitable interfaces. It is interesting to observe, though, that many of the regular users consider that even the first prototype already contains almost half of the functionality of an envisioned "ideal" system. This seems to indicate that the groundwork for e-Me has been done thoroughly and adequately with respect to the requirements of such a system. Further work is necessary though to involve a larger number of students as active users. A higher degree of robustness of the existing components is a key issue in this work.

This paper has been about reporting upon experiences that students as users and clients have found. Since the philosophy behind e-Me is to put the client in the centre and that e-Me as an artifact is much about integrating services from private and public service providers there is also a similar discussion to be held regarding these providing parties involvement in the co-design process. This is however not within the scope of this paper. One future issue concerning the development of the next version, towards a full-scale e-Me artifact, is also to develop a protocol and business model that encourage many new service providers to adopt their services to the e-Me galaxy.

One Challenge of Co-Design: Tools for Collaboration

As identified in this paper, running co-design processes is a complex and challenging task. Especially when there are a lot of stakeholders involved. It is popular today to use different kinds of (virtual) tools for enhancing collaboration among different people. In the e-Me project an important step was taken by establishing a virtual community as an integrated part of the artifact as a complement to different kinds of physical and face-to-face meeting for stimulating interaction between the involved parties. Let us therefore reflect upon which role the virtual community had in this project and potentially come with some additional instruments to be tested in future applications.

The virtual community was implemented on share-point server technology. This community (as can be seen in figure 1) was an integrated part of e-Me. The purpose was for the different stakeholders in their appurtenant roles communicate with others.

The communication was about reporting upon bugs and refinements, identification of usage situations for the existing e-Me, as well as finding out new usage situations for the e-Me.

Incrementally this community was continuously filled with messages/comments of different kinds. At the end of the pilot period this virtual community was filled with the following categories of content:

- Messages (from the development team, the management team, and the researchers)
- Messages from the helpdesk
- Usage situations
- Existing functionality and proposals for improvement (for each existing component of e-Me)
- Proposals of improvement – new functions and usage situations
- Common discussions
- Documents (statistics, e-Me news etc)
- Latest

This virtual community, which also was called meta-community, was a first step towards inspiring dialogue among involved co-designers (project management, developers, designers, researchers, service providers, and students as users etc.). Besides the virtual community other face-to-face meetings such as management meetings involving student ambassadors, workshop involving different stakeholders etc. were arranged. Different incentives were also given to those who engaged themselves in a good way in the co-design process.

After the project period two reflections can be made regarding the use of the community – could the community be used even more actively? These two reflections are about how communication is performed and how structure can be given to some of the communication. First of all it is necessary to avoid that the community becomes an information storage. In this situation we can see a conflict *between* using a community in which the communication is directed to everyone *and* the desires of communicator's utterances to be directed to specified communicators. Such communicative dimensions have been addressed a lot within language/action approaches to communication modeling (c.f. Dietz, 1999; Medina-Mora et al, 1992). The strength of the language/action perspective is that it is based on the idea that communication is not just transfer of information. When you communicate you also act (Searle, 1969).

The typical platform used for community-based communication is the whiteboard. A whiteboard is essentially a two-way storage where senders can store their messages and receivers can retrieve them. By its nature a whiteboard is therefore usually a platform for many-to-many communication. Direct one-to-one communication is hardly supported. For this type of communication Email is the preferred platform. Between these two extremes there is a range of communicative structures that is supported by neither platform in a direct way, e.g. a set of people wants to set up a communication link with another set of people for a limited time or purpose. Such coalitions might form spontaneously in a co-design situation for the purpose of discussing a certain design aspect or functionality between the users requiring this feature and the developers concerned in implementing it.

As indicated above part of the co-design process is the work of design. Such design work revolves around models. Architects and engineers draw blueprints, software developers build UML diagrams, fashion designer draw clothes designs and so on. Modeling is the language of design and design can hardly be done without modeling. The model serves as an artifact in itself that can be discussed and modified, but also as a blueprint for building prototypes and eventually products. This is especially true for a co-design process where a number of designers are involved that need some instrument for communicating design ideas. A large part of the co-design process is therefore a collaborative modeling process. We therefore conclude that tools for collaborative modeling are potentially useful for supporting some parts of the co-design process. Such tools would fulfill the needs of giving structure to such part of the co-design process in a better way than unspecific collaboration tools such as community whiteboards. A promising tool in that area is the COMA tool (COllaborative Modeling Architecture) that addresses many of the relevant concerns (see www.coma.nu). Using such a tool in the future development of e-Me would be interesting to explore as a complement to used processes (such as face-to-face meetings and the virtual community).

While COMA is suitable for structured collaboration, mainly negotiation of models, another tool, Compendium, has been devised for ill-structured problems, so-called wicked problems (Conklin et al, 2003). Compendium combines three different areas: meeting facilitation, graphical hypertext and conceptual frameworks. To make them work, facilitation is viewed as essential to remove the cognitive overhead for the group members, i.e., the necessity to develop hypertext literacy, which cannot be assumed in all participants. On the technology side, the critical elements are question-based templates, metadata and maps. They allow participants to move freely between different levels of abstraction and formalization as the need dictates. The question-based templates guide the process by supplying relevant questions, the answers to which will lead the group towards a better understanding of the problem and towards the development of appropriate solutions (e.g., models). The metadata is used to provide additional information that is also considered relevant but was not anticipated in the templates or lies at the intersection of templates. The maps have a hierarchical structure and the same concept can appear in different maps so that its use in different contexts can be understood. This feature is called transclusion.

CONCLUSION

This paper has been about exploring experiences derived by different users in the work of developing and trying out a personalized artifact acting as a filter and an agent in information society. The artifact as such is to be seen as a socio-technical instruments and the process as such has been embedded with both technical and social dimensions. Technical in the sense that the artifact has been the topic for ongoing discussions and that the process has been supported by IT-based tools for enhancing the collaboration among different stakeholders. We understand the term social in the sense that the process of development, use, learning, and evaluation has been highly influenced by the interaction between different stakeholders.

A central issue in socio-technical system has been the involvement of the users in the development process of information systems. One of the pioneers of this field, Enid Mumford, introduced 3 levels of user participation: Consultative, representative and consensus participation (Mumford, 1983). Co-design strives for consensus participation but goes beyond that in addressing also the issue of how this consensus can be reached.

The analysis performed in this paper has made us identify some challenges associated with involving several people in co-design processes. These are:

- How to ensure that users of premature artifacts keep up their interest in continuously trying out the artifact in the design process?
- How to find a good balance between satisfying desires by users and priorities needed to make in order to meet financial conditions?
- How to ensure a mindset as co-designers among the different stakeholders?
- How to ensure that different users support themselves in identifying different usage situations based on available functionality of an artifact?
- How can the involvement of a potentially large number of co-designers be organized in an effective and efficient way?
- In which phases of the co-design process should users be involved / engaged?
- How do we determine a reasonable composition of the co-design team for the latter phases of the co-design process such as design and implementation?

As one part of the result is a proposal for further research concerns the exploration of the use of different tools for collaboration in such processes involving several stakeholders. One important step was made in the e-Me project in which a share-point server based community was set up. For some parts of the co-design process aiming towards collaborative modeling it seems that such open community is not enough. In this paper we have therefore explored the possibility to complement the co-design process, such as the continuous deployment of an innovative artifact such as e-Me, with tools for collaborative modeling. This is especially important if the ambitions of deploying e-Me in a more open environment also giving users the possibility to develop and deploy user-generated services.

ACKNOWLEDGMENT

The authors would like to thank VINNOVA as well as all e-Me related stakeholders for making this research possible. Especially we owe our gratitude to the students participating in the project. We also want to acknowledge Lars Albinsson, Sören Berglund, Olov Forsgren and Madeleine Åkesson, all in the core-team of the e-Me project.

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KEY TERMS

e-Me: An electronic self that acts on behalf of the user and provides him or her with desired services and information, i.e. pull instead of push.

Co-Design: A method for system development that takes into account the multiple viewpoints of different stakeholders and tries to create a system that balances these partially conflicting views by enhancing mutual understanding and facilitating consensus achievement.

Scenario: A description of a potential usage situation of an information system on a general level in natural language, possibly supported by graphical means (e.g. comics) to facilitate communication about requirements between all types of stakeholders.

Community: A group of people that share a common problem or interest and that use an appropriate forum to discuss it, maybe supported by IT (blogs, newsgroups, etc.).

(User) Involvement: The active participation of the user in the system development process to ensure that the system design meets the users' needs.

Collaborative Modeling Tool: A tool that supports a group of people in jointly elaborating a model of a prospective IT system.

Communication Tool: A tool that supports a community in discussing topics of common interest.

Chapter XX
Formal Analysis of Workflows in Software Development

Harry S. Delugach
University of Alabama in Huntsville, USA

ABSTRACT

Automated tools are often used to support software development workflows. Many of these tools are aimed toward a development workflow that relies implicitly on particular supported roles and activities. Developers may already understand how a tool operates; however, developers do not always understand or adhere to a development process supported (or implied) by the tools, nor adhere to prescribed processes when they are explicit. This chapter is aimed at helping both developers and their managers understand and manage workflows by describing a preliminary formal model of roles and activities in software development. Using this purely descriptive model as a starting point, the authors evaluate some existing tools with respect to their description of roles in their processes, and finally show one application where process modeling was helpful to managers. We also introduce an extended model of problem status as an example of how formal models can enrich understanding of the software development process, based on the analysis of process roles.

People sometimes make errors. The problem here was not the error, it was the failure of NASA's systems engineering, and the checks and balances in our processes to detect the error. That's why we lost the spacecraft.

Edward Weiler,
NASA's Associate Administrator on the loss
of the $327 million Mars Climate Orbiter.

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INTRODUCTION

Many automated tools are available to support software development. There are two main reasons for an organization to use these tools:

- Much of software development takes place in distributed environments, or at least where the participants have difficulty meeting regularly face-to-face. Automated (often web-based) tools allow them to collaborate in a generally cost-effective way compared to travel and shipping costs.
- Software development workflows prescribe various *activities* to be tracked and *artifacts* to be created and maintained. Even when developers are able to collaborate in person, the number of these can become large and therefore requires organizing tools and a central repository.

As with all tools, their effectiveness is determined by how well participants understand how to use them. There is ample evidence that mere use of tools is not sufficient to support an effective workflow. Even if developers understand a tool's basic operation, they often do not understand or adhere to any development process supported (or implied) by the tool. This chapter examines some popular web-based software engineering tools from a pragmatic role-oriented perspective. That is, we intend to focus on the roles and purposes within the context of the development process, rather than characteristics of artifacts or products.

Our ultimate goals in developing these models is the following:

1. To better describe and analyze the processes themselves.
2. To formally analyze and evaluate tools with respect to generally accepted process models, and
3. To formally compare and contrast the models with each other.
4. To provide formal definitions based on process models.

The approach in this chapter illustrates all four of these goals. First we motivate the general value of formal models in analyzing process, and then provide some background on workflow modeling with respect to the software development process. The main body of the chapter applies this approach to one particular sub-process (namely bug tracking). Each of the four goals is discussed in turn, using examples to illustrate the approach.

This work continues in the spirit of previous work in modeling development processes (Delugach, 2007) (de Moor & Delugach, 2006) and in using conceptual graphs for modeling communication (Delugach, 2006) and software development (Delugach, 1996) (Delugach, 1992). In this chapter, we use conceptual graphs—a well-known knowledge representation—as a clear and effective way of formally representing the parts of a workflow. In future work, some automated analysis may use conceptual graphs' formal basis in logical reasoning and inference; however, this chapter does not exploit those capabilities for these illustrations.

The Value of Formal Modeling

At this point, it is useful to evaluate the role of formal modeling in software system development. While nearly all developers acknowledge the value of formally modeling the software system itself, there is less agreement on the role of formal modeling of the *process* of software development. Resistance to this idea is usually caused by "horror stories" of:

- Incorrect or incomplete models of a process, which initially give the impression of soundness but then later reveal themselves to be inappropriate
- Models that have been imposed on a development team by either upper management without proper evaluation, or by contractual obligations that are included as "boiler plate" requirements without any evaluation as their appropriateness

- Models that are perceived as reducing someone's power or control, infringing on their "turf" or responsibilities to the overall project.

In short, using the wrong model is probably worse than having none at all. Many (most?) of these bad experiences stem from misunderstanding the proper role of a model. This chapter promotes descriptive models: these do *not* impose or require a particular structure or process, but serve as a template for evaluating processes and comparing them with each other.

One feature of the formal models proposed in this chapter is to describe roles and define them in terms of responsibilities with respect to the workflow. As the reader will see, one such role is the responsibility for fixing a software problem that has been previously identified. Many tools exist for dealing with defects in software, but organizations often do not have a repeatable process for applying them. That doesn't mean organizations can't succeed without them, but it does suggest that the personnel may not always know how they were able to succeed. Use of a formal model can help them understand.

Here is a typical response when such a model is proposed for an organization's evaluation:

It's a waste of time to define roles and responsibilities. There's no formal way to decide who fixes a bug—the matching of an individual to a problem is dependent upon the nature of the defect. A well-established team avoids that issue as that allocation process happens informally. What's the problem?

This attitude deserves a detailed response.

First of all, the "waste of time" idea deserves further study. Formal modeling takes time and resources, like any other software development support activity. Certainly tracking those resources will help over time to determine whether such approaches are cost-effective—such studies must be performed and their conclusions verified. Such studies are outside the scope of this chapter, however.

Next, the models shown in this chapter do *not* describe a formal way to decide who fixes a defect. Since a defect is usually characterized by some general attributes, these might be formally matched up to known developer skills. (Some of these skills might not in fact be generally known; "did you know that person Y used to work on demographic databases?") We would never propose that developers blindly or arbitrarily follow a model, any more than a taxi driver with a GPS navigator should drive through a "road closed" barrier. We do, however, propose that the model can provide guidance to managers and developers if they choose to be guided.

The last claim about "a well established team" is an interesting one. Over the long term, intact teams of experienced people tend toward informality – either their once-formal procedures have become internalized or else they depend upon trust and past experience to guide their (informal) interactions. This is effective in some groups, and thus provides seeming counter-examples to the claim of formality's usefulness; however, trust and past experience usually require long periods of interaction that not all teams are fortunate enough to possess. In many distributed development environments, developers have not ever met face to face. Personnel may come and go, further interfering with the effect of experience and trust. In short, formal models of a process can help current and future participants to understand what their responsibilities are, as well as understanding others' responsibilities as well.

We are familiar with this last claim. In fact, in one of our studies, we formally modeled a team process in consultation with the manager of the team (de Moor & Delugach, 2006). This was a "well established" team, some of whom had been working together for a few years. The model revealed that in a small team, when personnel fulfill more than one role, it is possible for checks and balances to be circumvented if the same person fulfills both the executing role and the evaluating role. This situation represented a potential conflict of interest in the team (see below) that the manager didn't realize and responded with "I think I want to look into that one."

Failures in software system development (an important group of technical systems in general) are well documented. Here we are not talking about defects in the software itself, but shortcomings in the development processes themselves. Spectacular failures appear in public news reports from time to time. One well-documented failure was the NASA's Mars Climate Orbiter in 1999 in the United States (MCO-MIB-I, 1999). The spacecraft flew too close to Mars and was permanently lost, a cost of $327.5 million. The spacecraft's trajectory was wrong because software teams in two different locations made different implicit assumptions about which measurement units were used. Although each team's calculations were completely correct (presumably to a number of decimal places), one team assumed metric (SI) units, while the other team assumed English units.

The point of this failure is not that simple mistakes can have profound effects. The investigation of the failure showed that the error was evident every time the spacecraft did a course correction with its rocket engine, but the personnel monitoring the spacecraft simply expected another correction to fix it. There were thus two project failures—the first committed by the distributed development team in its inability to detect the inconsistency, and the second committed by the monitoring team in not understanding that they were observing unexpected behavior and not knowing where or how to report it.

Both of the failures could have been detected by modeling, if the distributed teams had been able to share each other's model of both the software's development itself and the management of the project during flight; however, no such modeling occurred. This chapter argues that the modeling approach supports analysis of such possible errors before they happen. Of course, there is no guarantee that any approach will solve this problem, but without doing something, the problem will persist. One prominent software engineer writes about "... the difficulty of technology transition and the cultural change that accompanies it. Even though most of us appreciate the need for an engineering discipline for software, we struggle against the inertia of past practice and face new application domains (and the developers who work in them) that appear ready to repeat the mistakes of the past." (Pressman, 2001, p. 870).

The next section describes the approach for workflow modeling.

Workflow Modeling

This chapter is intended to provide an approach for describing and evaluating software development processes, while focusing on two particular examples. It is important to emphasize the purpose of modeling is not to impose structure on an existing process, but to help understand what the structure is. Our position is therefore neutral with respect to being either normative or descriptive (i.e., neither "to-be" or "as-is" in the sense discussed by Scacchi (Scacchi, 2002)). While the discussion in (Scacchi, 2002) gives valuable insight into an environment (namely, open-source) where prescriptive models may not be viable or useful, this chapter takes the position that one must first have a model of a workflow in order to effectively understand, evaluate and ultimately improve that workflow. There are probably many uses of the model once an organization has produced them.

It is useful at this point to briefly mention some other processes for general problem-solving, both for comparison purposes as well as a reminder that process modeling (especially for problem solving) is not new; considering it from the general point of view may provide some insight. Some techniques are described in (Levinson & Rerick, 2002). Among some well-known problem solving processes are the Team-Oriented Problem Solving (TOPS) process pioneered by Ford Motor Company in the USA. This approach is sometimes called the "8-D" approach because of the eight "dimensions" it is intended to address; these are described simply as steps in the process.

Figure 1 is a typical description of the process (verbs italicized for emphasis).

An important point, which will be made several times during this chapter, is that the process focus is usually on particular activities or tools, without a clear delineation or definition of roles. For example, it is often useful to have independent (or at least different) personnel do the monitoring and validating of another group's constructive activities. Though there are several activities identified (e.g., *define*, *implement*, etc.) that are required to be performed by a TOPS team as a whole, there is no particular guidance (at this level of the description) for *who* on the team will perform those activities, even given in D1 that someone is presumed to have the knowledge, time, authority or skill. There is also no clear idea of how the process should be monitored or audited for being carried out correctly or effectively.

Some may argue that each organization should prescribe its own process for assigning these roles, monitoring, auditing, etc. We agree that organizations should do that; our approach does not prescribe any particular process development methodology. Their own methodology must answer the question: what's the right process for a given organization? Our approach is meant only to (i) alert organizations to possible omissions in their process descriptions (whether they choose to fill them in or not), (ii) suggest some typical roles if they do choose to specify them and (iii) suggest the value of being able to analyze and improve processes that are supported by explicit models.

(Levinson & Rerick, 2002) mentions other problem solving techniques (e.g., the "Deming wheel" of Plan-Do-Check-Act (PDCA) and Six Sigma's DMAIC) whose descriptions similarly omit a clear description of roles at the top level. Of course, refinements of these techniques have provided more guidance about the roles needed, but again they are considered secondary to the primary process framework.

Being "informal" does not render a process incapable of being modeled; on the contrary, most formal processes have their origins as informal activities that underwent successive refinement. We begin with the assumption that developing any model of a process is generally more useful than not modeling it at all. That being said, this chapter does not propose imposing any particular model on any software development environment; rather

Figure 1. TOPS problem-solving process

D1 - Use Team Approach: *Establish* a team (with an effective team leader) that has the knowledge, time, authority and skill to solve the problem and implement corrective actions.

D2 - Describe the Problem: Fully *describe* the specific problem in measurable terms.

D3 - Contain the Problem: *Define* and *implement* intermediate actions that will protect the customer from the problem until permanent corrective action can be implemented. *Verify* the effectiveness of these actions.

D4 - Identify/Define and Verify Root Causes: *Identify* all potential causes that could explain why the problem occurred. *Test* each potential cause against the problem description and data. *Identify* alternative corrective actions to *eliminate* the root cause.

D5 - Choose Corrective Actions: *Choose* corrective actions that will permanently resolve the problem for the customer and will not cause undesirable side effects. *Define* other actions, if necessary, based on the potential severity of the problem.

D6 - Implement/Validate Corrective Actions: *Implement* and *validate* the permanent corrective actions that have been identified. *Choose* ongoing controls to ensure that the root cause has been eliminated. Once in production, *monitor* the long-term effects and implement additional controls as necessary.

D7 - Prevent Recurrence: *Identify* and *implement* steps that need to be taken to prevent the same or a similar problem from occurring in the future.

D8 - Reward the Team: *Recognize* the collective efforts of the team and *take the appropriate steps* to make sure that the organization learns from what they did.

it is an attempt to establish a framework for modeling and thence understanding one's own software development environment, especially with respect to the roles that necessarily appear in any human-supported workflow. As the range of environments becomes more diverse (e.g., open source, agile methods, etc.) it becomes even more important to develop models and then to validate them.

Workflow modeling, as used in this chapter, is taken from the workflow specification definitions used in (de Moor & Jeusfeld, 2001), and based on the RENISYS model of organizational roles (de Moor, 1997). One key feature of those models is the notion of organizational actors, each of whom has particular obligations with respect to their roles in various activities. We use conceptual graphs (Sowa, 1984) as a convenient formalism and easily understood visual aid to represent the models. Conceptual graphs are well described elsewhere (Sowa, 1984) (Polovina & Heaton, 1992).A simple model of a workflow activity is shown in Figure 2, adapted from (de Moor & Delugach, 2006).

The graph in Figure 2 may appear simple; in fact, we consider this one of the strengths of conceptual graphs. This chapter proposes some modifications and additions to this model, based on some shortcomings in its power to express some important pragmatic relationships in the bug tracking process.

We will focus on the workflow involved in two different software development activities: problem reporting (often called "bug tracking") and requirements change. Software problem tracking is one portion of a much large set of processes belonging to software configuration management (SCM) which has been extensively studied; for a summary, see (Pressman, 2001). The motivation for a controlled SCM process comes from the observation that software systems constantly change while under development, either through additional requirements or business needs, or through the natural process of successively refining artifacts from inception to deployment. Because this process has many purposes, there are often many people involved.

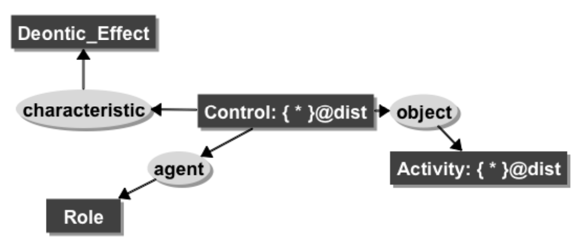
Another software activity is the process of making a change to the formal requirements in a software project. Along with de Moor, we conducted an experiment in modeling such a process in an industrial software development setting (de Moor & Delugach, 2006). This process is important because of the large lifecycle costs that result from erroneous requirements, a well-documented phenomenon (Pressman, 2001). Although requirements change is likewise subject to the control of SCM, we do not specifically address that feature in this chapter.

This chapter is focused on modeling software engineering processes with respect to its role- and purpose-oriented human aspects: who is involved, what are stakeholders' roles in the process's success, what responsibilities do they hold with respect to the system and what goals are they expected to pursue. The intent is that developers will better understand the processes they are using, perhaps finding omissions and mistakes along the way. We have applied these techniques in a production-level environment and as a result were able to suggest improvements to an organization's activities within a specified process.

Modeling Software Development Workflows

The main emphasis of this chapter is to formally capture software development workflows so that

Figure 2. Workflow step represented by conceptual graphs



There is a set of control concepts, each of which is characterized by a deontic effect (see below) and each performed by a particular role. For each control concept, there is a set of activities, each of which is operated upon by that control.

they may be better understood and analyzed. This section suggests the main area where current workflow descriptions are lacking. We will restrict our current attention to one task in software engineering; namely, bug tracking. The goal of this section (and of this chapter) is not restricted to this particular process, however; it is our way of illustrating the various uses of formal models in general.

This section illustrates the four goals given in the introduction. First we show how models can be used to describe software engineering processes. Next we show how models can be used to analyze particular software engineering processes and tools for their completeness and understandability. Then we show how models can be used to compare models to one another, in this case a prescribed process model vs. a model of the actual practice. Finally we offer an example of how definitions can be created from formal process models.

Describing Software Engineering Workflows

This section illustrates how formal models are used to describe software engineering workflows. We chose bug tracking as a typical activity in software engineering.

Bug tracking can be viewed as one kind of *problem resolution process.* The software engineering community has established standards for such processes, as exemplified in ISO/IEC 12207 (ISO/IEC, 1996). In this section of the chapter, we first describe some generic problem resolution process steps using the workflow models developed previously, then we briefly describe the 12207 process, and summarize the bug tracking processes supported by Bugzilla, a well-known software development tool set. Although primarily known as a tool (not a methodology), its description implies a process to be followed when using the tool's bug tracking features. In this section, formal models are shown for the ISO/IEC 12207 process and Bugzilla.

The first thing that one notices in studying the bug tracking capabilities of existing tools and processes is that there is generally no explicit set of roles which are defined in the process. Of course, the mere existence or use of a tool never guarantees that it will be used effectively or even correctly; however, most tools seem implicitly geared toward a particular change control process. Some of them appear to imply certain roles, while others appear role-neutral.

Requirements modification may also be seen as a problem resolution process, but of a different sort. In bug tracking, problems are explicitly identified by testers or users; in requirements modification, problems are usually identified through analysis. In either case, once the problem is identified, certain steps are performed in the resolution of the problem. In most descriptions of workflows, some key pragmatic knowledge is either left implicit or not even considered. This chapter's approach models the workflow so that some of that implicit pragmatic knowledge can be filled in.

First we will illustrate the kind of knowledge that is often omitted in descriptions of workflows, even when they appear to be well defined. The tools in sourceforge, for example, include a bug tracker. A tracked bug using sourceforge's tracker has the following attributes: assignee, status, category, group and description. Note that few of the attributes have any reference to persons or roles' responsibilities in software development.

- **Assignee:** The project administrator to which a tracker item is assigned. Can be chosen from one of the administrators registered in this project.
- **Status:** This is the (potentially changing) current status of a bug. The online help says:
  You can set the status to 'Pending' if you are waiting for a response from the tracker item author. When the author responds the status is automatically reset to that of 'Open'. Otherwise, if the author doesn't respond within an admin-defined amount of time (default is 14 days) then the item is given a status of 'Deleted'.
  This provides the beginnings of a primitive set of definitions for the possible status values,

and perhaps implies a particular workflow, however unstated.

- **Priority:** a nine-level scale.
- **Category:** "project-specific".
- **Group:** "project-specific".

The list of sourceforge's bug attributes clearly illustrates one of the major hurdles for practitioners in developing systems using existing tools: there is no structure or process guidance provided! To be sure, sourceforge's organizational goal is not to develop or impose specific processes, so one of its goals is to ensure as much flexibility as possible. Our approach likewise does not *require* completeness or assess quality; our main purpose here is to show how the approach can be used to analyze and evaluate different specified processes.

The attributes of "category" and "group" are good examples of this: each project administrator can choose them based on their own preferences. The downside of this approach is that the automated bug tracker has no capability to relate them to each other, to accommodate constraints between particular categories, groups or values of the other attributes (except for the ability to search each list by value). For example, are "category" and "group" orthogonal to each other, or is a group a sub-category, etc.?

We point out that software development is not alone in lacking clear organizational responsibilities for various activities in a process. This section describes our model of an organizational process (including an ontology) and later we will show how to model roles in a formal way. As an illustration, we give general models for two bug-tracking activities: reporting and repairing.

We adopt Figure 8 as a description of a general *workflow step* with some pragmatic knowledge. Note the inclusion of the concept **Intention** with respect to a role in the process. This concept is lacking in previous models, which simply showed the obligations (required, allowed, prohibited) as the deontic effect assigned to a particular role. Previous models therefore did not give any indication as to *why* a particular role would be given a particular assignment.

For example, why would a program manager be required to review a change, or why would a developer be allowed (but not required) to make a change? For our future goals, if we want to reason automatically about roles and their appropriateness or legitimacy, we must start to model their purpose and relationship to the system's development as a whole. Figure 8 shows a more complete model of a workflow step. While the language is not great prose, it captures the essential elements of what the graph says. More importantly, the graph itself is formal and we can therefore reason about it automatically.

The model in Figure 3 is meant to emphasize that a participant's intentions need to be captured for each activity in a workflow model, as well as the status intended for the result(s) of that activity. (Later, we will propose a more formal idea of what "status" really means.)

Figure 4 shows a basic ontology for the bug-tracking domain. Arrows represent the supertype-of or is-a-kind-of relationship, in the taxonomic sense. For example, an **Activity** is a kind of **Process**, **Approve** is a kind of **Activity**, and so on. The "QA" role represents that of Quality Assurance, whose duties include (among other things) verifying that processes have been followed. This ontology is taken from (Delugach, 2007). This constitutes a summary of the full ontology's description; all of the types require definitions, which can be represented using conceptual graphs. One important point of such an ontology is to make a clear distinction between roles, intentions and obligations (deontic effects). In some organizations, these are lumped together in such a way that they are difficult to understand and therefore difficult to adapt for new workflows and situations.

Figure 5 and Figure 6 illustrate how to model two typical bug-tracking steps. The point here is that a formal model can help developers visualize their process, remind them of their obligations and also allow process analysts to compare different models to each other, process vs. practice models, etc.

Note in Figure 5 that the bug report is both a result of the initiated request and a goal of the developer's report activity. This may seem obvious:

why would the developer start something if they didn't have its result as a goal? Our point in this chapter is that process descriptions may implicitly assume this, but they either omit the goal, or the role, or both. Models can help identify "obvious" omissions, leaving it to the organization as to what to do with them.

Figure 6 shows a general template for the process of fixing a bug.

Our motivation for establishing basic graph models for these workflows stems from a belief that by analyzing them, we can identify potential missing or incorrect elements in existing workflows. Once the graphs are established, it is necessary to validate them. One avenue of validation would be to use conceptual graph tools to scan the wealth of existing data as advocated in (Ripoche & Sansonnet, 2006). Examples of natural language sources are emails, forum posts, program source code comments (Etzkorn, Davis, & Bowen, 2001), and even identifier names in programs (Etzkorn & Delugach, 2000). The task of validating graphs linguistically is a significant one, but beyond the scope of this chapter. We confine ourselves to providing simple English paraphrases of the graphs as an aid to understanding and potential validation.

Analyzing Particular Software Engineering Workflows and Tools

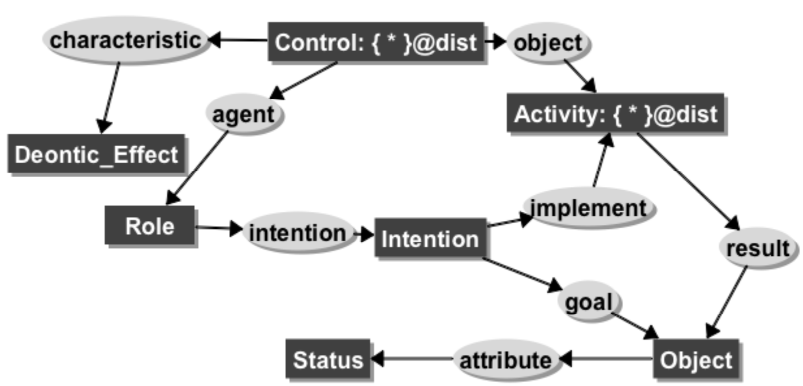
We have already suggested some important omissions in typical process models. This section illustrates those omissions by showing models of two bug-tracking processes using the conceptual graph representation already introduced. We then lead into a discussion of sourceforge's *status* indicator, as a typical example of an underspecified attribute for the purposes of process support.

ISO/IEC 12207 Problem Resolution Process

The problem resolution process of the ISO/IEC 12207 standard is reprinted in Figure 7.

This standard's process description is shown so that the reader can note one striking omission: nowhere does it prescribe *who* is tasked with any of the steps or activities! For example, the standard says "analysis shall be performed" but it does not state who will perform the analysis. This lack of specified roles weakens an organization's ability to provide appropriate process descriptions, including specifying who does what and also providing reasonable checks and balances for management. (Incidentally, some technical writers recommend using "passive voice" which ends up encouraging the lack of role knowledge.)

Figure 3. Workflow model incorporating intention



There is a role with some level of control ("deontic effect") over some activity that the role intends to implement. The activity's result is an object that is the goal of the role's intention. The object has a status.

Figure 4. Ontology for a role-based analysis of bug tracking

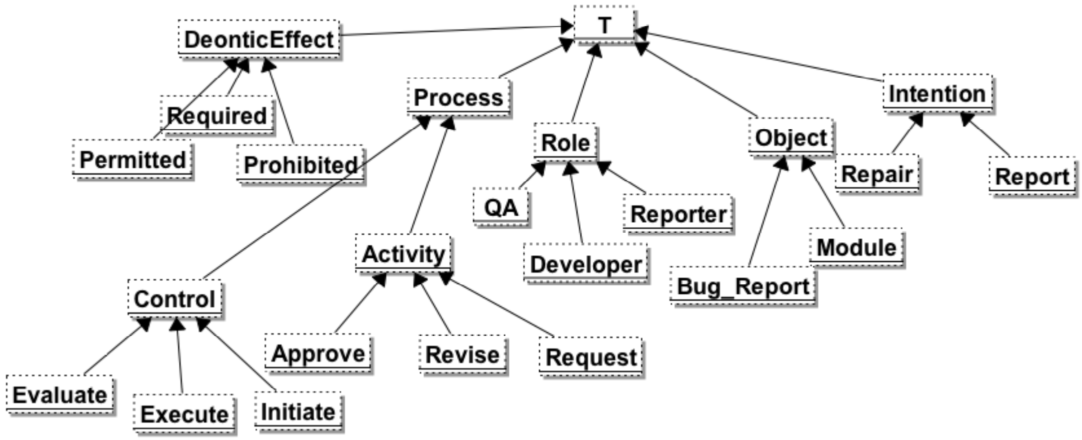
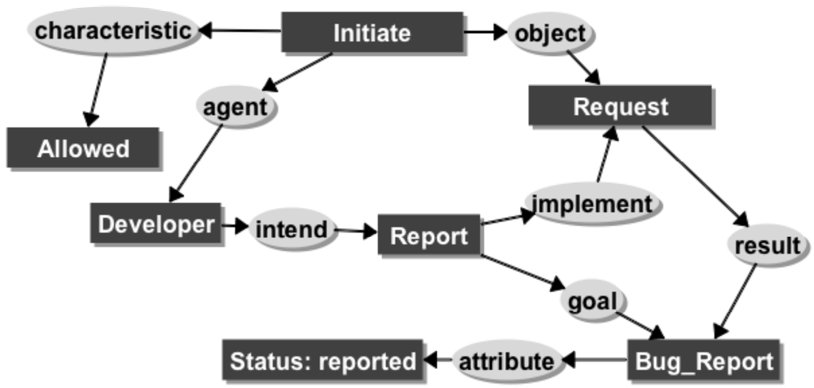
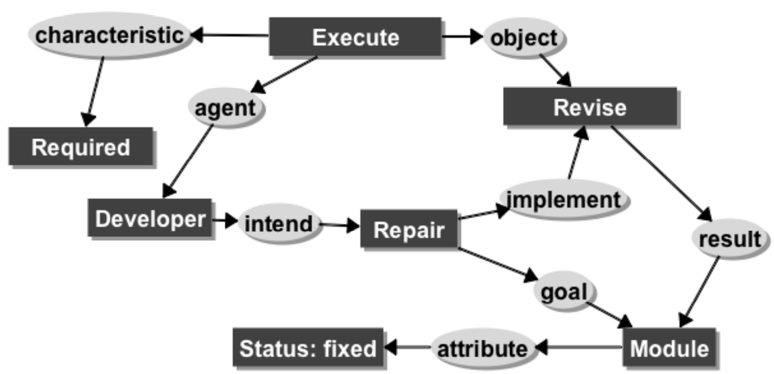


Figure 5. Generic model for reporting a bug



There is a developer who is allowed to initiate a request whose result is a bug report with status "reported". The same developer intends to report the bug report using the request.

Figure 6. Generic model for fixing a bug



There is a developer who is required to execute a revision whose result is a module with status "fixed". The same developer intends to repair the module using the revision.

The ISO/IEC 12207 process's model of problem resolution is shown in Figure 8. Compare this graph to the one in Figure 3. Note that while the deontic effect of "Required" is present (meaning initiation is required), there is no role shown that is responsible for that initiation, nor is there any indication of the purpose of the problem report or the goal in "handling" it. In short, the model is clearly incomplete, in ways that could directly impact an organization's ability to understand the process and therefore to implement it reliably in their workflow or audit its correct implementation.

Bugzilla

The Bugzilla bug tracking process is described in Figure 14 (taken from Figure 6-1 of the Bugzilla Guide at http://www.bugzilla.org/docs/3.0/html/). Note that several of the transitions have no labels, indicating that while it is possible for a bug to follow that transition, there are no constraints on when or how that transition is permitted. As in most other descriptions of these kinds of workflows, there is little guidance as to *who* is authorized to change the status of a bug. One might assume that the "owner" of a bug is authorized to change its state, but even in that case there is little organizational support for the reasons or circumstances under which the change is legitimate. For example, what does "unconfirmed" mean? The owner could simply mark a bug as "unconfirmed" if they did not want to deal with it at the moment, or the owner could engage in a detailed exploration and be unable to reproduce the bug, or perhaps the owner just hasn't had time to check out the bug yet.

In short, participants in a given software development workflow need a set of guidelines, constraints, operating procedures, etc. that govern what these status values mean. In a more sophisticated process, there would be procedures for changing/augmenting the set of status values as the team gains more experience.

The Bugzilla process is somewhat more completely defined than in the ISO/IEC 12207 process. Using Figure 9 as a basis, we can describe the model formally as shown in Figure 10. Again compare this graph to the one in Figure 3.

Note that the Bugzilla model, while still rather informal, does in fact include much of the vital pragmatic knowledge needed for an organization to implement the process. Roles are shown in several places, and verbs indicated activities are also shown. "Ownership" and "possession" are not specifically represented in the process models, but does seem to suggest a "required" obligation of some sort. In summary, Bugzilla's process appears more complete than the ISO/IEC one in.

This section showed clearly the lack of role and goal knowledge in workflow descriptions, as well as illustrating the need for such knowledge. Again, it is not the purpose of this chapter to prescribe particular roles or to tell organizations how to assign them; the purpose is merely to call attention to the need for a clear set of roles and descriptions.

Comparing Software Engineering Workflows

Models can be also be used to compare prescribed process descriptions and observed practice descriptions. This section describes an earlier study performed by Aldo de Moor and myself using a conceptual model to evaluate an existing industrial development process. The study itself was described in (Delugach & de Moor, 2005) and (de Moor & Delugach, 2006); the results are summarized here to illustrate some of the benefits of formal process modeling. This example is different from the previous ones in that the developers were cognizant of the roles involved in their processes and used the above framework to specify two models: (i) their prescribed process from their development guidelines, and (ii) their actual practice instantiated with the names of their actual developers. As we will see, there were some significant differences between them.

Our example was based on a detailed study of a small-sized internal software development group that develops and maintains aerospace software. This particular group is characterized as small (10-20 persons), necessitating multiple roles per

Figure 7. ISO/IEC 12207 problem resolution process

6.8 Problem resolution process

The Problem Resolution Process is a process for analyzing and resolving the problems (including nonconformances), whatever their nature or source, that are discovered during the execution of development, operation, maintenance, or other processes. The objective is to provide a timely, responsible, and documented means to ensure that all discovered problems are analyzed and resolved and trends are recognized.

List of activities. This process consists of the following activities:

1) Process implementation;
2) Problem resolution.

6.8.1 Process implementation. This activity consists of the following task:

6.8.1.1 A problem resolution process shall be established for handling all problems (including nonconformances) detected in the software products and activities. The process shall comply with the following requirements:

a) The process shall be closed-loop, ensuring that: all detected problems are promptly reported and entered into the Problem Resolution Process; action is initiated on them; relevant parties are advised of the existence of the problem as appropriate; causes are identified, analyzed, and, where possible, eliminated; resolution and disposition are achieved; status is tracked and reported; and records of the problems are maintained as stipulated in the contract.

b) The process should contain a scheme for categorizing and prioritizing the problems. Each problem should be classified by the category and priority to facilitate trend analysis and problem resolution.

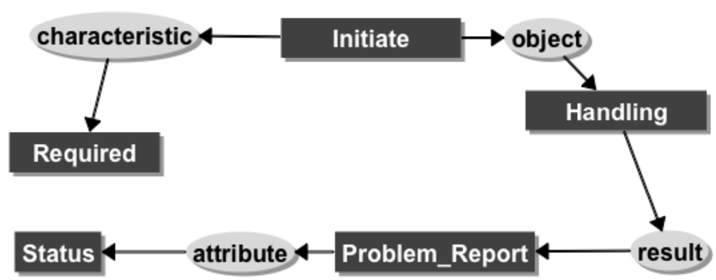
c) Analysis shall be performed to detect trends in the problems reported.

d) Problem resolutions and dispositions shall be evaluated: to evaluate that problems have been resolved, adverse trends have been reversed, and changes have been correctly implemented in the appropriate software products and activities; and to determine whether additional problems have been introduced.

6.8.2 Problem resolution. This activity consists of the following task:

6.8.2.1 When problems (including nonconformances) have been detected in a software product or an activity, a problem report shall be prepared to describe each problem detected. The problem report shall be used as part of the closed-loop process described above: from detection of the problem, through investigation, analysis and resolution of the problem and its cause, and onto trend detection across problems.

Figure 8. Model for standard problem resolution process



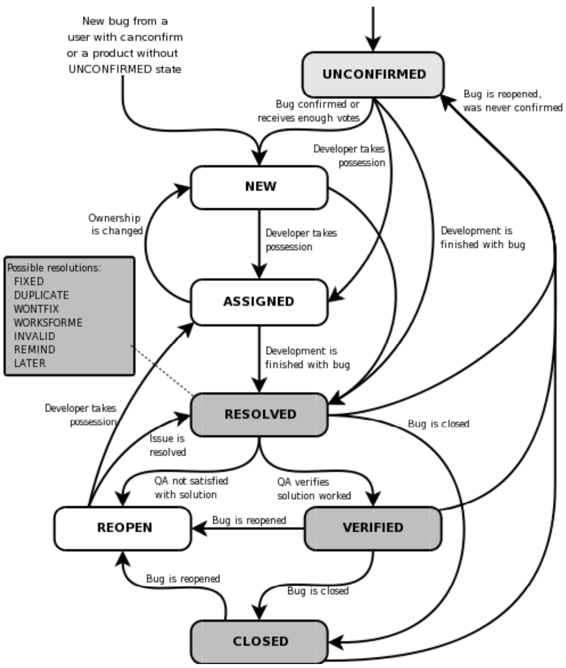
There is an initiate process that is required for handling a problem report which has a status.

person, with little duplication or cross training of roles, some occasional role re-assignment, and (we discovered) implicit accumulating adaptations of the official process in practice.

Software development in this group is project-based; we compared its prescribed process and actual practice models. Space does not permit us to show our complete model of a software process; we focused on one small part: namely, this organization's activity of creating and approving changes to the requirements.

The graphs resulting from this study consisted of a few dozen nodes each. One of them is reproduced here to show the practicality of these models as well as to illustrate the complexity that can arise in even a short process with simple steps. Figure 11 shows the instantiated model of a particular small team's software requirements change process. Each step has an **Initiate**, **Execute** or **Evaluate** activity, with its accompanying role(s), objects and results. There is a new feature of conceptual graphs shown in the model of Figure 11—a dashed line connects

Figure 9. Bugzilla bug tracking process



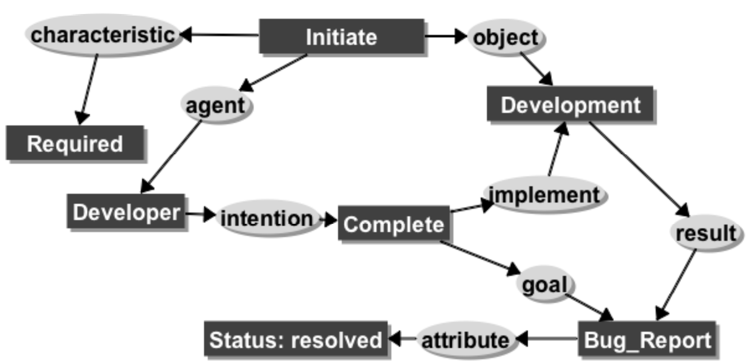
several concepts to each other. This dashed line is called a "co-referent link" or a "line of identity" indicating that the joined concepts refer to the same individual. (This gives the ability to identify individuals without necessarily using exact names.) This is especially important when considering roles, since the lines indicate that the same person serves multiple roles.

Figure 11 shows several steps in sequence, each with a resulting artifact (e.g., **Change_Request**) that is then used by succeeding steps (e.g., relations "**uses**" and "**object**"). For example in the first step, a software engineer "**Jerry**" is permitted to initiate a **MakeRequest** activity and also to execute that same activity, which results in an "**Evaluate**" activity which the software lead "**Terry**" evaluates, and so on. The purpose of this (large) example is twofold: it is a good example of a usable conceptual graph and it shows the large number of relationships in a typical process.

Note that this process model appears more complete than the previous ones in that it does show both roles and their deontic effects. This is an intentional result of the acquisition process by which the model was obtained. A manager was interviewed, with the purpose of explicitly recording roles. For each step, therefore, the manager was asked who did what and what was their deontic role. It is worth noting that the mere asking of these questions would occasionally provoke some thought in the manager about the precision of his process description. Once the prescribed process and actual practice graphs were manually obtained, an automated comparison produced a small list of differences, but those differences were significant from a process-oriented viewpoint.

Figure 12 highlights a key difference between the workflow models. The highlighted portions are

Figure 10. Bugzilla bug tracking process model

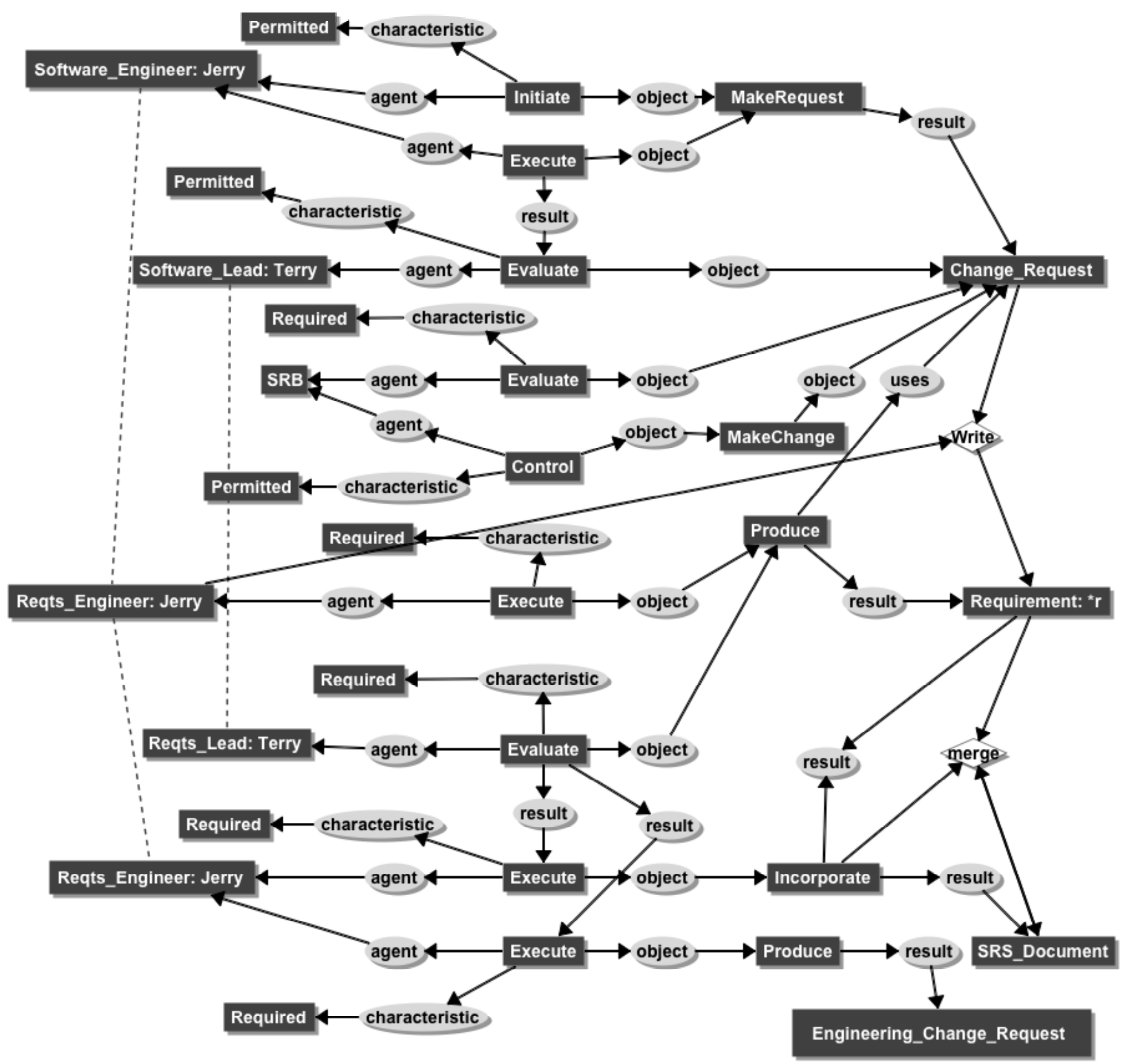


There is a developer who is required to initiate a development that will implement their intention to complete a bug report. The development's result is a bug report with status "resolved".

in white, with the rest of the graph "grayed out". Differences are apparent between how requirements engineers (RE's) are modeled. The prescribed process model on the left—Figure 17(a)—shows a **notEqual** relation between the RE who writes the requirement and the RE who incorporates the requirement into the formal requirements document. This represents the prescribed process constraint that the RE who writes the requirement and the one who incorporates the requirement into the document should be two different people. In the actual practice model on the right—Figure 12(b), however, the RE who produced the requirement (we name them ***r**) is also the same person (referred to as ***s**) who incorporated the requirement into the formal software requirements, a situation that is disallowed due to the **notEqual** relation in the process model.

The point here is that the separation of roles (i.e., the explicit **notEqual** relation) specified in the prescribed process model represents an explicit prohibition, whereas in practice this separation of roles did not occur. This occurred because the

Figure 11. A requirements modification process model instantiated with individuals



same developer ("Jerry") had more multiple roles in the (small) team that happened to coincide for this particular workflow.

Whenever comparisons between models are made, there is always a question about how to proceed: if there is a discrepancy, something is wrong, but what? Which model should be changed? Or should both be changed? Our technique does not prescribe a definitive answer solely from the models; it is up to actual participants such as the software managers and developers to interpret and analyze the comparisons.

Forming Definitions Based on Formal Models

This section of the chapter describes another value in using a model; namely, developing definitions of concepts based on their process relationships. We consider the concept of "status" which often appears in tracking and management artifacts. The particular notion of a bug's status is an interesting one. As one educator reported using the sourceforge tools, "if the phrases describing subtask status are not defined, different student teams often give different meanings to the same phrase. Even worse, sometimes, different members in the same team would interpret the same phrase differently." (Liu, 2005). They identified the need to define status phrases indicating which role and workflow are involved; e.g., the status "Ready for Review" meant ready to be reviewed by the quality assurance (QA) role on the team. A better way to name this would be an explicit "Ready for Review by QA" status.

Another way to envision *status* as a working concept is to approach it from the perspective of its relationships to the concepts in a given workflow: an item's status reflects the process that produced it, not some arbitrary choice from a pull-down menu. So a more accurate and useful definition of status would look something like Figure 13.

This representation shows *status* not as an independent attribute but instead as a dependent attribute—dependent on the process that produced it. This example illustrates another power of conceptual graphs—the graph contains a *context* that allows the modeling of feature clusters. In this case, a definition is described in terms of workflow step features. One can easily envision that, given adequate definitions in a formal model, some characteristics of a process (e.g., "status") would not have to be explicitly stated by participants—they could be derived by observing the current workflow step. This one example is meant to suggest one clear advantage of formal models in their being able to support automatic logical inferences, which is a subject of future research.

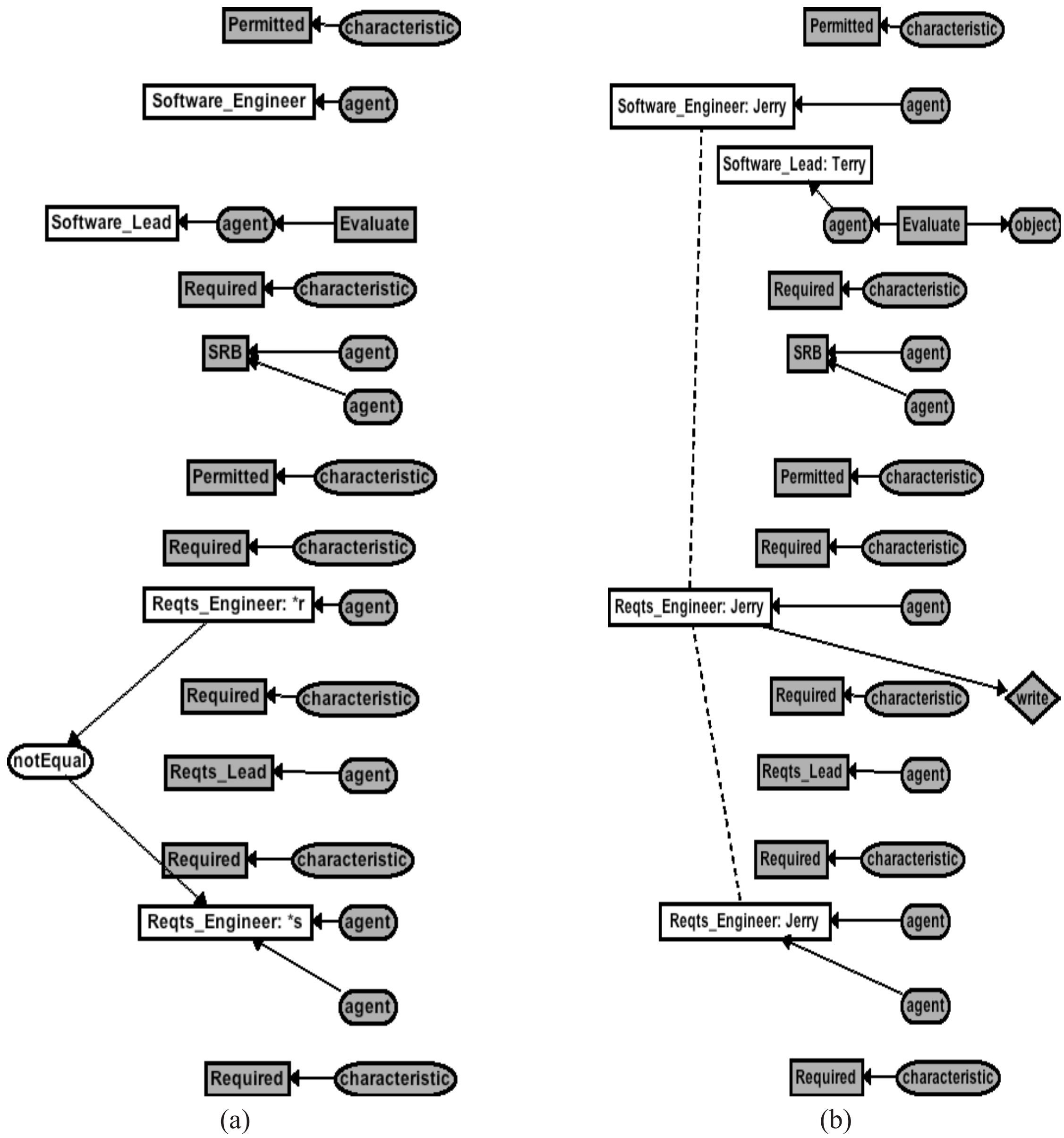
Summary

This chapter was intended as an illustration using formal models of process concepts to describe, analyze, compare and reason about some software development processes. Because most workflow definitions provide only vague (or absent) roles, responsibilities and managerial duties may also be vague. For example, most existing tools do not address the issues of why someone is authorized (or not) to make a change to an item's status, so it is possible for the status of items to be inconsistent with whatever process the software's developers are supposed to follow.

The advantages of using conceptual graphs to represent the workflows are (i) conceptual graphs have the potential to be formally manipulated and compared, and (ii) they provide an easily understood visual description of the process for developers and analysts. In one requirements modification exercise based on this approach, the models' comparison led to a specific potential weakness in the current workflow, toward which a manager was able to focus effort to correct.

For bug-tracking in particular, the subsequent process of how to actually correcting the defects identified during the process, with duties and responsibilities assigned to appropriate roles, is an interesting area to study further, since it involves a superset of the same roles involved in problem tracking. Obviously it will be useful to compare different

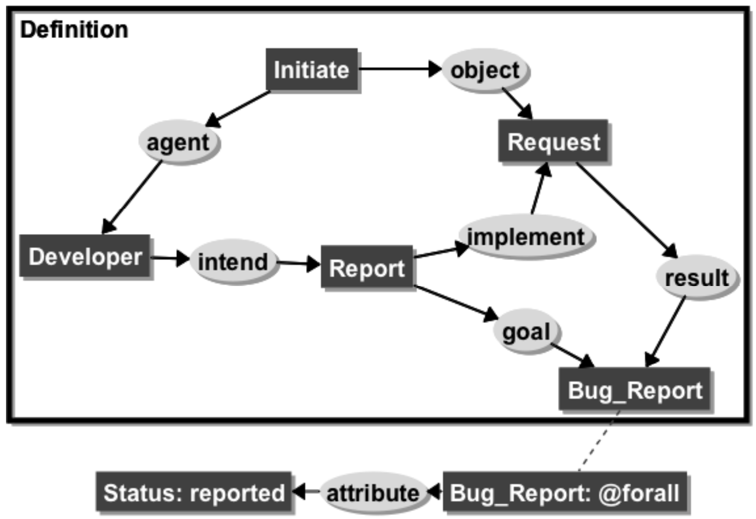
Figure 12. Comparing a prescribed process (a) and an observed process (b) model



organizations' processes to find common features, and (likely) missing features; this is a natural next step. It will also be useful to identify where the processes actually conflict with each other. This last issue becomes quite relevant as companies' products and personnel are merged with other companies' products and personnel.

Using formal models is an important aspect in workflows: models help us conceive, develop, describe, evaluate and compare workflows in system development. This chapter described one technique for representing workflows that is capable of accomplishing all these purposes, with the hope that researchers and practitioners will ultimately benefit.

Figure 13. Status defined as a derived concept



A bug report with status "reported" is defined to be a bug report where a developer has imitated a request for the bug report, and that same developer intends that request to report a bug.

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KEY TERMS

Conceptual Graphs: A knowledge modeling approach based on semantic networks and first-order logic, first introduced by Sowa, whereby knowledge is represented by concepts and relations linked together in a bipartite graph.

Deontic Effect: A feature of an activity assigning to it some role's obligations, such as whether the role is required to perform the activity, permitted (but not required) to perform it, or prohibited from performing it.

Formal Model: Any model with well-formed syntax and semantics, such that it is amenable to systematic (usually automatable) processing and analysis subject to logical rules.

Process Model: Any description of a process (not necessarily formal), that shows a series of steps aimed at accomplishing some goal.

Requirements Change Process: A systematic series of steps by which changes to formal software requirements are identified, evaluated, approved and incorporated.

Software Development Process: The overall process of software development, from initial inception through analysis, design, implementation, test and deployment.

Software Issue Tracking: Also called "bug tracking"; a process by which issues (errors, defects, faults, problems) in some software component are identified, evaluated, analyzed, authorized and implemented.

Workflow Model: A process model specifically aimed at representing a development process, as opposed to an algorithm or program.

Chapter XXI
The Role of Expectations in Information Systems Development

Dorit Nevo
York University, Canada

Brent Furneaux
York University, Canada

ABSTRACT

This chapter reviews the significance of expectations to information systems development with particular emphasis on the process of requirements analysis. In accordance with a socio-technical perspective, it argues that the expectations of key stakeholders involved in this process impact the emerging technology solution while the emergent technology simultaneously impacts stakeholder expectations for the solution that is ultimately developed. The primary aim of the chapter is to synthesize the relevant literature to provide insights to those seeking to improve their requirements analysis capabilities and to highlight potential avenues for future research that stem from a consideration of the role of expectations in the information systems development process.

For [a product] to surprise me, it must be satisfying expectations I didn't know I had. No focus group is going to discover those. Only a great designer can.

—Paul Graham, Made in USA

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INTRODUCTION

The information systems (IS) literature identifies incomplete requirements, changing requirements, misunderstood requirements, and inadequate management of user expectations during the requirements analysis process as significant threats to the successful development of information systems (Hansen, Berente, & Lyytinen, 2007; Keil, Cule, Lyytinen, & Schmidt, 1998). The significance of these threats has resulted in considerable attention being directed toward tools and techniques of potential utility to the analysis of both functional and non-functional requirements (Mathiassen, Saarinen, Tuunanen, & Rossi, 2007). Despite these initiatives, recent research has reported the presence of notable dissatisfaction with the requirements analysis efforts of many organizations (Neill & Laplante, 2003) that suggests a need for further work aimed at better understanding and improving the effectiveness of this process. Toward this end we adopt a socio-technical perspective (Thomas, Gupta, & Bostrom, 2008), emphasizing process over outcome, in an exploration of how the interactions between people, processes, tasks, and technology during the course of requirements analysis can impact the expectations of key stakeholders. We also consider some of the potential implications of these expectations for user satisfaction and system success.

Grounding our analysis in expectation confirmation theory (ECT) (Oliver, 1977, 1980), we explore how user expectations are created and evolve as a result of the information exchanges that occur among various stakeholders as requirements are developed and refined. These exchanges are seen as being essential to system success and as occurring over a significant portion of any given project, particularly in environments based on agile development methods (Sommerville, 2007). In addition to examining the process of expectations transfer from prospective users to analysts, that is analogous to the transfer of requirements that occurs during requirements elicitation, we consider the implications that the expectations of designers and other stakeholders have for understanding and influencing users' requirements and for the effectiveness of the requirements analysis process as a whole. Improving our understanding of stakeholder expectations and how they evolve is seen as making a potentially important contribution to efforts to ensure that systems remain well-grounded in the real human needs that they are intended to meet (Whitworth, 2008).

We begin with a description of expectations confirmation theory which is then followed by an analysis of the implications of expectations for information systems design. Our analysis builds primarily on the theoretical foundations that we present and is augmented with examples provided by three design managers at a large software development company.[1] The anecdotal evidence that these examples provide is intended to give real life context to our theoretical arguments. We incorporate the insights derived from the interviews throughout our theoretical analysis to concretely illustrate the points that we are making and lend preliminary support to our analysis. Finally, we conclude with thoughts on future opportunities including some questions raised by the literature and our analysis.

Theoretical Foundations

Expectation Confirmation Theory

Marketing researchers have long recognized the impact that expectations can have on the ultimate success of products and services. Consumer reactions to a movie can, for example, vary widely depending on whether *a priori* expectations were low ("what a pleasant surprise!") or high ("what a disappointment!"). This understanding has been formalized in expectation confirmation theory which seeks to account for satisfaction with a product or service by positing that the level of satisfaction experienced depends on the magnitude and direction of the gap between the perceived performance of a product or service and a consumer's expectations for its performance (Oliver, 1977, 1980). This gap is referred to as *disconfirmation* and its significance is based on Helson's (1964) adaptation-level theory which argues that stimuli are perceived primarily in relation to past stimuli that are judged to be similar. Positive disconfirmation occurs when performance exceeds expectations and, as such, is hypothesized to result in high levels of satisfaction. In contrast, negative disconfirmation arises when performance falls below expectations and is posited to lead to reduced levels of satisfaction (Figure 1). In other words, if a product is perceived to outperform expectations (positive disconfirmation) then post-use satisfaction will result, while post-use dissatisfaction will result when perceived performance falls short of expectations (negative disconfirmation) (Oliver, 1980; Spreng et al., 1996).

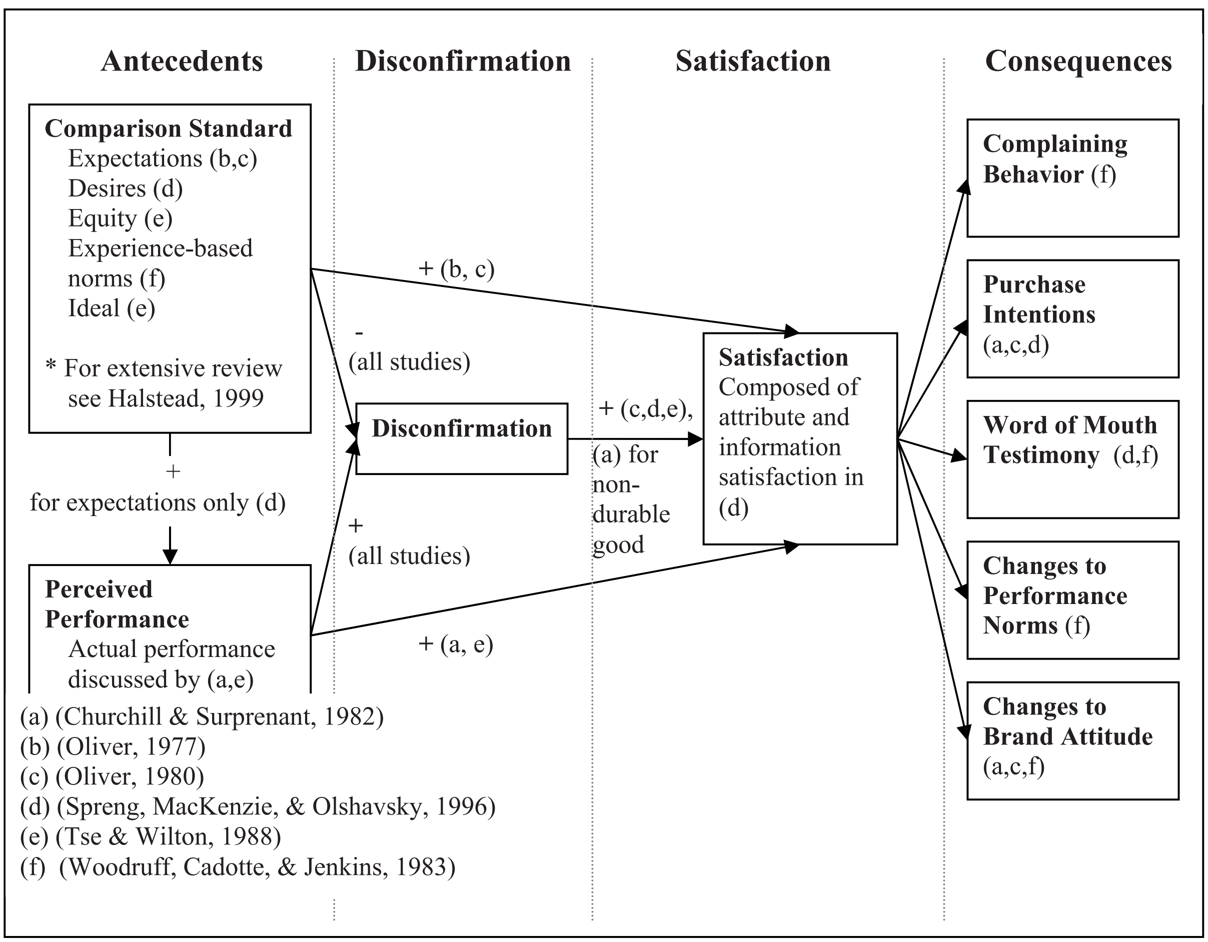
Satisfaction is characterized by ECT as either an outcome state following the consumption experience or more widely as an evaluative process encompassing the entire consumption experience (Yi, 1990). For example, Tse and Wilton (1988) define satisfaction as "the consumer's response to the evaluation of the perceived discrepancy between prior expectations (or some other norm of performance) and the actual performance of the product as perceived after its consumption" (p204). Satisfaction is generally measured at the individual level and can be measured in relation to a variety of dimensions including an entire product, an attribute of the product, an experience, a salesperson, or a purchase environment (Yi, 1990).

The ECT literature defines expectations very broadly as anticipated outcomes (Churchill & Surprenant, 1982). They can be evaluative, incorporating the desirability of different outcomes, or they can be predictive, representing only what is objectively expected at some point in the future (Spreng et al., 1996). Expectations can also be characterized on a continuum of standards that ranges from the worst imaginable outcome through to minimum tolerable and adequate outcomes and on up to predicted, desired, and ideal outcomes (Santos & Boote, 2003). The literature surrounding ECT suggests that expectations in general can affect satisfaction in three ways. First, expectations serve as the comparison standard against which consumers evaluate actual performance to form a disconfirmation judgment (see review by Halstead (1999) and meta-analysis by Szymanski and Henard (2001) for more details). Secondly, expectations can have a direct impact on satisfaction as consumers adjust their sense of satisfaction toward the level of their expectations in order to avoid the experience of dissonance that arises when there is a discrepancy between expectations and satisfaction level (Szajna & Scamell, 1993; Szymanski & Henard, 2001). Direct impacts of this kind have been reported by numerous studies (e.g. Bearden & Teel, 1983; Oliver & DeSarbo, 1988; Oliver & Linda, 1981; Swan & Trawick, 1981) though evidence to the contrary also exists (e.g. Churchill & Surprenant, 1982; Spreng et al., 1996). The third mechanism by which expectations can impact satisfaction is through their influence on perceptions of performance with a number of researchers having shown how these perceptions can be influenced by expectations (e.g. Anderson & Sullivan, 1993; Spreng et al., 1996).

The potential for expectations to impact perceived performance was anticipated by literature suggestions that performance perceptions, like satisfaction, tend to adjust toward expectations (Yi, 1990). This suggests that higher expectations can lead to higher levels of perceived performance irrespective of the objective performance of a product or service. In contrast with objective performance, the perceived performance of a product can therefore vary significantly between individuals and over time (Yi, 1990). Perceived performance is, however, generally considered the standard against which expectations are compared to derive disconfirmation in the ECT literature. In addition, most studies suggest that performance (objective or perceived) impacts satisfaction only through its impact on disconfirmation (e.g. Cadotte, Woodruff, & Jenkins, 1987; Oliver & DeSarbo, 1988; Spreng et al., 1996) and thus, direct manipulation of performance may have little or no influence on satisfaction except to the extent that such changes impact the gap between performance and expectations.

Disconfirmation can be measured directly by asking respondents to evaluate performance relative to their expectations ("better than/worse than expected") or by calculating the difference between a measure of perceived performance and a measure of expected performance with the former approach being more prevalent in the literature (Spreng & Page, 2003; Tse & Wilton, 1988). Two main issues have been raised with respect to the impact of disconfirmation on satisfaction. The first issue centers on the question of whether simply meeting expectations will lead to satisfaction while the second is the question of what level of satisfaction results when negative expectations are met. For example, will satisfaction result when a user finds that a system that was expected to be difficult to use is, in fact, difficult to use? Santos and Boote (2003) suggest that both issues are related to the standard against which performance is compared. Thus, while Oliver (1980) used predictive expectations ('what will be') as the comparison standard, others have proposed using different standards such as ideal expectations, desires ('what should be'), equity, and past product or brand experience (Halstead, 1999; Tse & Wilton, 1988; Woodruff et al., 1983; Yi, 1990). While most of these standards have been proposed as substitutes for predictive expectations, there has been some suggestion that desires operate in conjunction with predictive expectations to drive satisfaction (Spreng et al., 1996). This view sees the perceived performance of a product or service as being compared to both expectations and desires to yield expectations disconfirmation and desires disconfirmation which, together determine the level

Figure 1. The ECT model



of satisfaction experienced. The desires used in these comparisons can either be relatively abstract desires such as the desire to make an organization more cost efficient or more concrete desires that are aimed at achieving abstract desires (Spreng et al., 1996).

Figure 1 provides a graphical summary of the preceding discussion as well as an indication of some of the consequences of consumer satisfaction that have been explored in the literature. In the interests of conceptual clarity the remainder of this chapter will distinguish between expectations and desires though it will adopt a broad understanding of expectations and desires that includes any expectation or desire considered relevant. For instance, consideration is given to both cognitive and emotional expectations as recent research suggests that expectations of an emotional nature may be as or more important than those of a cognitive nature (e.g. Lin, Wu, & Tsai, 2005; van der Heijden, 2004).

ECT in Information Systems Research

IS researchers have made notable use of expectation confirmation theory in an effort to better understand end-user satisfaction with information systems and related services. Although a full review is beyond the scope of this chapter, we highlight here three salient research streams. One such stream is the direct application of the theory to assess end user satisfaction in a manner that is analogous to use of the theory in consumer research. Examples from this stream include the study of satisfaction with Internet Service Providers (Erevelles, Srinivasan, & Rangel, 2003), Internet-based services (Khalifa & Liu, 2002), and end-user computing (Suh, Kim, & Lee, 1994). A second stream of research uses ECT to explain the adoption and continued use of information systems and relies on the premise that these behaviors are the result of user satisfaction. For example, Wixom and Todd (2005) applied ECT to the study of usage intentions in the context of data warehousing while Bhattacherjee (2001) used ECT to study continuance intentions among online banking users. Finally, while the preceding research streams have focused primarily on how expectations impact outcomes such as satisfaction and system use, a third stream focuses on expectations and how these can be managed (e.g. Nevo & Wade, 2007; Staples, Wong, & Seddon, 2002). For example, focus group discussions with IS managers led Nevo and Wade (2007) to suggest that expectations should be carefully managed to ensure a better match between the actual capabilities of a system and how these capabilities are perceived by its intended users.

Chapter Objective

Extending the last of the three preceding research streams back in the system life cycle to the requirements analysis stage, this chapter explores the opportunities and constraints that expectations present for the requirements analysis process and for those involved in this process. It is built on the understanding provided by ECT that gaps between expectations and performance impact satisfaction and on literature demonstrating that satisfaction is important to the adoption, success, and continued use of information systems. Differing from prior studies on expectations in IS projects, this chapter adopts a socio-technical perspective which emphasizes the interactions among relevant actors and their role in the creation and adaptation of expectations over the course of a development project.

Fluid Expectations and System Design

While ECT provides a useful theoretical lens upon which to study expectation disconfirmation, the theory is only partly suited to an analysis of the expectations which figure prominently in information systems development. ECT typically views expectations as being predetermined prior to the purchase experience. In contrast, we view expectations as being fluid and subject to change as users interact with various actors and the technical characteristics of an emerging system. Thus, we aim to integrate a socio-technical perspective with its focus on the interactions between people, processes, tasks, and technology (Thomas et al., 2008) with ECT insights on how expectations impact satisfaction. We assert that adequate understanding of these interactions is crucial to system success as it is these interactions that shape expectations throughout the development process, ultimately leading to (dis)satisfaction with the resulting system.

We see two types of interactions, people to people and people to process, as being particularly relevant to an examination of the significance of expectations to system requirements since it is these interactions that are most likely to figure prominently in the creation of the socio-technical solution. We therefore focus primarily on these interactions in the following discussion.

People to People Interactions

The main interactions among people during requirements analysis are the frequent interactions that occur between users and designers as well as the various interactions that occur between the members of the design team.

From User to Designer: Understanding User Expectations

As suggested by ECT, user expectations can be strongly influenced by past experience with similar systems. Users often come with preconceived notions of a system, its uses, and its expected features and performance (Khalifa & Liu, 2004; Nevo & Chan, 2007; Nevo & Wade, 2007). Given the role of comparison standards in determining satisfaction, it becomes important for designers to fully explore the standards that users are relying upon to form their evaluations of a system in order to better understand users' expectations and to identify the factors that will be most likely to contribute to disconfirmation. For example, is the prospective user of a new collaboration tool basing his or her expectations on prior experience with email, prior experience with instant messaging, or a combination of both? Such differences can have significant implications for the expectations and desires that a user will express and the satisfaction that he or she will ultimately experience from using the system. Understanding the standards upon which users' expectations are based can thus greatly facilitate the requirements gathering process.

Although users may hold very clear, concrete expectations based on prior experience with similar systems, they are also likely to hold *implicit* expectations and expectations that are relatively *fuzzy* (Ojasalo, 2001). Fuzzy expectations are particularly likely to arise under circumstances of ambiguity such as when a system is complex or belongs to a newly emerging class of systems (Khalifa & Liu, 2004). In these cases limited or non-existent prior experience can make it difficult to form accurate expectations:

When it comes to things like databases, systems that have been around for a long time, people have those numbers and they have performance expectations in hand. You know, they know what they want to see from the database… but with new applications, I don't think that can be the case.

Khalifa and Liu (2004) suggest that under circumstances where expectations are fuzzy users may be more likely to rely on desires rather than predictive expectations for their comparison standards. Preferential reliance on desires creates further challenges including the need to translate what are generally quite abstract notions into concrete product attributes. Recent research has highlighted this challenge, finding that users of knowledge management systems have difficulty translating their abstract product desires (e.g. the desire for improved knowledge sharing or the desire to empower employees) into concrete product attributes (e.g. strong information retrieval capabilities, collaboration features, etc.) (Nevo & Chan, 2007). In addition, comments made by our informants suggest that the ability of users to adequately express desires may be contingent on at least some experience with the proposed system such as through the use of a prototype.

Desires are something that are probably derived after a piece of software has been experienced and it either doesn't do the things you expect or the things you need and you formulate the desire for certain things, or if it does everything you need, you formulate additional desires that are over and above what the product does.

These remarks highlight some of the potential value surrounding the use of agile development methods under circumstances where expectations are initially vague (Sommerville, 2007). Agile methods call for frequent incremental product releases that can provide users with numerous opportunities to establish and refine their expectations over the course of a development project. It must, however, be recognized that not all expectations are ambiguous, even for projects characterized by a high degree of ambiguity. Users can have very clear but implicit expectations for a system and these expectations may, in fact, be so clear that they seem self-evident and are therefore not expressed (Ojasalo, 2001; Utterback, 1994). Although users may not express implicit expectations, failure to consider them during system development can fundamentally impede adoption and subsequent use.

I think certain things are nonstarters, so, if say you delivered the system and there was no security on it, well, then we can't deploy it, I mean that's just, it's expected that it's there…

The dramatic threats associated with a failure to account for implicit expectations may even lead system designers to introduce what they believe are implicit expectations into system requirements without adequate verification. For example, although the preceding quote seems to indicate that the inclusion of security features is fundamental to many systems, it was observed that for a new social computing technology:

Security wasn't a concern; they got, you know, millions of people using their system without it.

Thus, it is essential that system designers ensure that they are documenting requirements based on the expectations of users rather than based on their own (implicit) expectations.

From Designer to User: Creating and Altering User Expectations

Evidence from the vast body of advertising literature indicates that information generated by vendors can significantly impact consumer expectations. For example, Oliver (1979) found that advertising a product with superlatives and exaggerations is likely to result in over-appraisal of the product's attributes and its value. As a result, consumers will experience more positive affect toward the product and this positive affect will tend to persist over time. Similarly, Burke et al. (1988) studied the impact of implicitly misleading advertising claims, finding that such claims can lead consumers to hold false beliefs concerning a product. In the context of systems development, we note that information flowing from designers to users is likely to foster initial user expectations for a product and to impact the subsequent evolution of these expectations over the course of the requirements analysis process (Nevo & Chan, 2007; Nevo & Wade, 2005). As our informants note:

It depends how you present it to them so that you don't give them a false sense… if you go and you say, we have this product, we want to know what you think about it, well, then, you know, it's hit or miss. They might think, oh, it's an early version of a product or this is a final product they're trying to sell me on…

The work that we do sets the stage for that expectation and so having a set of templates that are well designed and reusable across all of those products will set us up in the future.

Views such as these are also supported by reports that the failure of a new product to meet expectations can impact future expectations as well as demand for subsequent product releases (Ho & Yu-Sheng, 2004)

User Heterogeneity and Conflicting Expectations

The need to consider and include multiple users in the requirements analysis process is almost certain to result in expectation discrepancies and conflicts (Nevo & Wade, 2007). The risk of such discrepancies may be particularly salient in the context of systems such as social computing technologies which are, by their nature, intended for use by a very wide group of individuals. In such cases, certain groups of users may not be adequately represented by those who are actively involved in system design activities.

The people who are paying attention to blogs like that are probably very experienced users who have some stake in watching the development of a product.

Significant challenges have been noted in efforts to incorporate the needs of users who are inaccessible to the organization developing a system and it has been suggested that the gap between users and developers is increasing with the increasing importance of external stakeholders to the requirements development effort (Mathiassen et al., 2007). It has been further suggested that the risk of inadequate requirements definition also increases with increased physical, conceptual, and cultural distance between developers and potential users (Mathiassen et al., 2007). Under such circumstances, analysts face numerous challenges in integrating the diverse and often conflicting expectations of a wide range of stakeholders as they seek to establish a set of requirements that can be feasibly delivered to provide maximum benefit at minimum cost (Bergman, Lyytinen, & Mark, 2007; Mathiassen et al., 2007).

I'll get conflicting reports, you know: one person wants this done in this way, another person wants it that way… someone wants this done simpler, someone else wants more flexibility. Well, simplicity and flexibility naturally oppose each other.

Discrepancies among users can also vary in terms of disconfirmation and user sensitivity to unmet expectations:

I think a lot of this depends on personality… certain people are just, you know, perfectionists or they just expect that everything is going to work perfectly. You either do it right or you don't do it, and other people are very forgiving and know that software is imperfect and are very happy with what it is that you're doing.

Socio-technical complexity of this sort is likely to be particularly salient as the number of system users and other stakeholders increases. In managing user heterogeneity and resolving requirements related conflicts, ECT offers a perspective that is not generally captured by traditional requirements analysis techniques. In particular, it has been noted that time and other resource constraints can limit the extent to which detailed requirements are reviewed by all relevant stakeholders with the result being projects that proceed with significant requirements errors (Hansen et al., 2007). Focusing, however, on the more succinct and readily understood expectations that underlie these requirements might help to mitigate such risks. Serving as high level objectives, expectations may also prove easier to prioritize. In addition, operating at the level of expectations is likely to improve the chances that stakeholders from distinct fields of practice (Levina & Vaast, 2005) will be able to understand each other and effectively compromise toward an acceptable system.

Finally, research indicates that it is important to focus attention on expectations for those aspects of a system that will cause users to incur the greatest costs as a consequence of disconfirmation (Griffith & Northcraft, 1996). For example, the absence of capabilities that allow a user to adequately fulfill requests from superiors can impose significant reputation costs and ECT suggests that this is likely to be particularly problematic if the limitation was unexpected. In contrast, negative disconfirmation related to capabilities that are not associated with such reputational costs may simply encourage a user to explore alternative means by which the system can meet his or her needs. Further research in this area appears warranted in order to better clarify what factors impact the significance of user expectations.

People to Process Interactions

The methodologies and tools that are used to support the requirements analysis process, the extent to which designers and/or users engage in expectations management, and the degree of transparency in the process can all play a role in shaping user expectations for both the process and the resulting system.

Impact of Methodologies and Tools Used

The methodologies and tools used in the requirements analysis process can have a significant impact on the development and refinement of expectations. In the previous section we discussed some challenges surrounding the existence of fuzzy and implicit expectations. The use of specific methods during the design process may help both users and designers gain a better understanding of such expectations. For example, prototyping and other incremental or iterative approaches to understanding user requirements have been found to be useful in obtaining user feedback and they might therefore facilitate incremental refinement of expectations (Mathiassen et al., 2007). The risk of using such methods is, however, that they can anchor user expectations to an initial impression and thus impede subsequent design changes (Hansen et al., 2007). Similarly, techniques such as interviews have been found to bias requirements documents toward expressing designer preferences over user needs (Hansen et al., 2007).

Support tools used in the design process can also influence the formation and evolution of expectations. For example, social computing tools offer the potential to facilitate the design process by connecting stakeholders from different social worlds. This can improve understanding of the expectations of heterogeneous, widely distributed user groups and facilitate ongoing communication of the development process to prospective users:

Throughout the development of the product [a colleague] *was blogging consistently about different features they were developing and asking customers about what they were doing, how did they feel about this feature*

Given their potential to facilitate sharing and reflection, such tools could, in effect, serve as forums for the creation and management of boundary objects (Bergman et al., 2007; Levina, 2005) which have been defined as artifacts or concepts "with enough structure to support activities within separate social worlds" (Bergman et al., 2007, p. 550). The effective management of boundary objects through the use of tools such as those offered by social computing could serve to mitigate the risk of negative disconfirmation surrounding a system. This possibility does, however, raise some questions. For instance, can these tools be used to better enable users to reach a shared understanding of the key expectations for a new system and the detailed requirements that would deliver these expectations? Also, what changes to the capabilities of these technologies would be required to most effectively support such initiatives?

Meta Expectations

Meta expectations are expectations held in regard to such things as the development process itself, the organization developing the system, and the general class of technology to which the developed system belongs. For example:

Some people will give you requirements, you know, two weeks before the next major release of the software… so those have to get rolled over to the next one. That's, again, managing expectations and then explaining how the life cycle works and how the schedules work and when the best time to suggest these is…

It defines a larger expectation for customers that [study company]*, okay, you have* [study company] *products, they're going to be reliable.*

The literature on agility and agile development methods highlights the importance of managing meta-expectations and the challenges associated with such efforts. This literature argues that many traditional requirements engineering practices and system development methodologies are too inflexible for use when developing systems in contexts characterized by rapidly changing user requirements (Cao & Ramesh, 2008; Surendra, 2008). Traditional methods have, for instance, been reported to present some significant limitations in highly turbulent environments (Erickson, Lyytinen, & Keng, 2005; Tallon, 2008). In these environments expectations can frequently and unexpectedly emerge from the external context in which a development project is situated. For example, it has been suggested that users develop unrealistic expectations as a result of exposure to the generally rapid pace of progress in the IT industry (Doll & Ahmed, 1983). Although some attempts can be made to manage these expectations, in many cases it may be more appropriate to simply recognize them and adapt to ensure that they are met.

The product that was being worked on hadn't planned for that so, of course, we had to generate a requirement for it in order to be concurrent with what's happening out there.

This remark suggests that attempting to manage against such expectations would be unlikely to be particularly effective. Rather than attempting to manage against change, agile development methods such as Extreme Programming and Adaptive Software Development emphasize iterative requirements development processes, greater communication with users, and prioritization of requirements to adapt to fast paced environments (Cao & Ramesh, 2008). These methods may therefore be of considerable utility in addressing development contexts characterized by rapidly changing expectations. As noted by an industry expert: "Writing a detailed requirement spec up front is a worst practice, despite being considered a best practice for the longest time. When you do this, you are building to specs as opposed to building to what people actually need." [Scott Ambler, IBM[2]]

External and Internal Expectations Management

In the previous section we focused on understanding the role of interactions among people and process in shaping expectations throughout the process of requirements development. The fluidity of expectations over the course of system development projects suggests the importance of proper expectations management to the success of these projects. Hence, in this final section we discuss two types of expectations management and offer some practical guidance on managing expectations.

External Expectations Management

External expectations management refers to the deliberate effort of an actor or group of actors to adjust the expectation level of some other actor or group of actors. The following discussion focuses on two dimensions of external expectations management. These are the manipulation of users' expectations concerning the system and efforts to clearly convey project purpose and objectives.

Manipulating Users' Expectations

Two opposing perspectives on the manipulation of user expectations can be identified in the literature. On the one hand, ECT suggests that the lower one's expectations, the lower the experienced disappointment that arises from negative outcomes and the higher the satisfaction that is achieved as a consequence of positive outcomes (van Dijk, Zeelenberg, & van der Pligt, 2003). Thus, it would seem reasonable to ensure that user expectations for a product are initially quite low, a view that is in accord with some of the remarks made by our informants.

[study company] *had developed one product and the product was rejected by customers: too complex, it didn't meet their needs at all. So we had a pretty big awareness of their requirements and so we went into the development of another product with a different development team and developed a different experience based on the same requirements plus additional ones that came out of the rejection of that product. And customers weren't expecting too much at all, so when they received the product they were almost exuberant in their praise of it.*

In contrast, some literature suggests that managing development projects by establishing minimal expectations can have significant collateral consequences including a probable reduction in the effort that users will put into the requirements analysis process (van Dijk et al., 2003) and a significantly reduced likelihood of initial adoption (Venkatesh, Morris, Davis, & Davis, 2003). Furthermore, Szajna and Scamell (1993) suggest, based on cognitive dissonance theory, that unrealistically low expectations may actually result in lower levels of satisfaction as users endeavor to minimize the gap between their expectations and their satisfaction level. Thus, there is a need to actively manage expectations within the unique context of each development initiative, giving suitable consideration to the subtleties that such management entails. Further research would also be helpful in resolving some of the conflict that is suggested by these two opposing perspectives on the management of expectations.

It is important to recognize that in some situations efforts to rationally manage expectations may prove futile as a consequence of these expectations being emotionally based. For instance, it has been reported that consumers will be more likely to buy a familiar product when, prior to making the purchase decision, they are asked to imagine purchasing an unfamiliar product and having it fail (Simonson, 1992). Hence, emotions such as anticipated regret can lead users to continue to insist on the inclusion of obsolete capabilities for fear that they might, at some point, be needed. Recognizing the emotional basis for such expectations can facilitate designer efforts to address the challenges that they present. A related risk can be identified from research indicating that the level of disappointment experienced by a user increases with the level of effort invested (van Dijk et al., 2003). As a result, those involved in the design process may reduce their effort on a project to avoid the possibility of experiencing such disappointment. This reduction in effort has clear negative implications for the ultimate success of a project and it is therefore suggested that designers work to recognize these situations and to explore the reasons for anticipated disappointment.

Conveying Project Purpose and Process Transparency

Our analysis of the literature and discussion with informants highlight the importance of establishing a clear, overarching purpose for a system. This purpose serves to broadly frame user expectations, helps to manage expectations that appear to drift too far from this purpose, and guides designers in making choices when user expectations appear to conflict with each other. As efforts are undertaken to extend a system to accommodate the expectations of a wider user base, developers need to remain cognizant of the broad purpose of a system and focus efforts on managing the expectations of those users whose expectations do not align with this purpose. Managing expectations in this way helps to ensure that revisions do not have negative implications for the expectations of the existing user base.

In addition to suitably targeting expectation management efforts, establishing and maintaining a transparent and widely accessible development process can further assist with expectations management.

I would say transparency is, again, it's something that I mentioned before but I think this is pretty important with a lot of projects… I think people react better when they understand what's happening throughout *the life cycle or they feel like they're in control of that, to have access to that information.*

Internal Expectations Management

In contrast with external expectations management, internal expectations management refers to the self-regulation process that prospective users can engage in to avoid future disappointment. Users may, for example, intentionally lower their expectations when it is felt that they will exceed actual outcomes (Kopalle & Lehmann, 2001; van Dijk et al., 2003). The activation of this self-regulation process might, however, be limited when users participate in the design process as part of a large group, when a project is perceived as irrelevant or unimportant, or when the temporal proximity of outcomes is distant (van Dijk et al., 2003). Furthermore, Kopalle and Lehmann (2001) suggest two opposing influences on this self-regulation process. First, users whose satisfaction level is more strongly impacted by disconfirmation (disconfirmation sensitivity) will generally aim to lower their expectations while perfectionists will aim to have more realistic expectations. Linking back to our previous discussion regarding interactions among people, we maintain that an important role of the designer involves identifying those situations in which users self-regulate expectations and exploring the reasons why these expectations are being regulated.

CONCLUSION

This chapter focused on the role of expectations in the requirements analysis process based on the premise that these expectations underlie user satisfaction and therefore impact system success. Building on the theoretical foundation provided by expectation confirmation theory, we have focused on expectations formation and evolution through interactions between users, designers, and the requirements analysis process.

The socio-technical lens used in this chapter and its integration with the insights provided by ECT have served to yield a richer understanding of the role of expectations in shaping technology and the role of technology and process in shaping expectations. It is altogether too easy to ignore or misunderstand the significance of expectations to satisfaction with a system, focusing instead on concrete product features. We have therefore sought to highlight this possibility, identify some of its consequences, and offer some guidance for improvement.

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KEY TERMS

Needs: Any outcome that an individual or group of individuals believes must occur

Predictive expectations: Any outcome that an individual or group of individuals believes will occur

Desires: Any outcome that an individual or group of individuals would like to occur

Disconfimation: The gap between expectations for the performance of a product or service and perceptions of its actual performance. Disconfirmation can be either positive or negative.

Satisfaction: An evaluative response to perceptions of the discrepancy between expected and actual outcomes

Perceived Performance: A subjective understanding of how well a product or service functions

Expectation Confirmation Theory: A theory of consumer behavior that seeks to explain consumer satisfaction as being based on the gap between some performance standard and the actual performance of a product or service as perceived by its consumer

ENDNOTES

1 These examples are based on the development projects of numerous systems by the organization. Projects in both corporate and open source contexts ranged from tools for developing enterprise web applications and web services products to portfolio management systems and the development of user interfaces for a range of products.

2 http://www.itworldcanada.com/Pages/Docbase/ViewArticle.aspx?id=idgml-ff988788-a178-430c&sub=1521555

Chapter XXII
Building a Path for Future Communities

Jeff Axup
Mobile Community Design Consulting, USA

ABSTRACT

With mobile technologies increasingly weaving themselves into the fabric of our communities, it would be beneficial to increase our understanding of how these devices will affect our quality of life. This chapter presents a case study where a set of prototypes of future social technology concepts were generated and used by groups of backpackers in a mobile community. One of these concepts, which facilitated viewing the locations of other group members, is evaluated with regard to how it might affect community development. This and other examples illustrate that communication technologies form a social path which guides individual and emergent behavior of societies. Determination of where these paths lead can be accomplished through the creation of development projects with positive social aims. Using collaborative research methods, considering design outcome spectra, and adding features with implicit cultural values are promising strategies for influencing future communities.

Technology. That's always been your Achilles heel in this part of the world.

—Obadiah Stane to Raza, *Iron Man*, 2008

INTRODUCTION

Mobile technologies are rapidly becoming a permanent part of the social fabric of our society. Common interactions such as maintaining family relationships, getting directions to meet up, seeking guidance on the quality of a restaurant, or rating political candidates, are all increasingly being accomplished via mobile phones. It is these minutiae of daily social interactions which give rise to culture and greatly affect our quality of life. Consequently, there is a valid concern that if these technologies

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are developed without regard to facilitating positive, democratic and humane social environments, they may actually reduce the quality of life of large numbers of people. If it is agreed that positive socio-technical systems are a desired goal for technology developers, there remains the question of how to attain it.

This chapter provides a case study demonstrating a process whereby the complex interactions between groups, technologies and emergent socio-technical systems can be explored. The study evaluated a number of social technology concepts in the context of a mobile community of backpackers. The research method used enabled us to understand more about the social structure which new devices would be introduced into and record requirements. Outcomes of the studies included over 57 product concepts, 67 user requirements, and a rich description of the social and physical context. The results of the study also provide a glimpse into how a future community of backpackers with new social tools might operate. It is through this type of exploration that we can start to envision building tools which provide a constructive path for individuals to follow in creating their own future communities.

Social Goals for Compelling Products

It is increasingly common to find software and Internet companies building creative business models around community-based products with charitable and socially responsible goals. For example, Google has expressed an interest in building platforms and APIs which empower local communities to rapidly build technologies to help themselves. During the 2007 wildfires in and around San Diego, CA, several organizations utilized the Google Maps API to communicate which areas of the city were currently burning or where evacuation orders were in place (Wagner, 2007).

Similarly, several sites on the web help communities operate by providing forums for user participation and community interaction. These tools implicitly build in the ideals of free speech, satire, whistle-blowing, personal empowerment, and helping others. For example, YouTube has had Egyptian users post videos of police abuse which led to jail sentences for officers (Anderson, 2007).They are similarly facilitating education and debate around the 2008 US election process ("CNN/YouTube debate: Video streams," 2007). Another ratings site, Yelp, gives users a forum to rate and comment on everything from restaurants to religious organizations ("Yelp.com," 2007). They also have a section for Health and Medical to support rating doctors and other medical professionals. These sites help provide a degree of oversight and community advice which would otherwise be lost in the anonymity and complexity of large cities.

There are also non-profit corporations that produce mobile technology products with social aims; these indirectly compete with and influence profit-based corporations. For example, the non-profit OLPC project started with the goal of "providing children around the world with new opportunities to explore, experiment and express themselves." (Teletico, 2007) OLPC founder, Nicholas Negroponte stated that "It's an education project, not a laptop project." ("One Laptop Per Child," 2007).

These examples demonstrate that technology design has the potential to facilitate and thereby encourage certain values and behaviors amongst user communities. With Internet access becoming more widespread daily, it is possible for a web application to be rapidly used all around the planet shortly after development. This brings with it entirely new opportunities for the spread of cultural values.

Back Packers: A Distributed Mobile Community

Backpackers have been described as "travelers who exhibit a preference for budget accommodation; an emphasis on meeting other people (locals and travelers); an independently organized and flexible travel schedule; longer rather than brief holidays; and an emphasis on informal and participatory recreation activities." (Loker-Murphy & Pearce, 1995, p. 830-831). Backpackers in Australia primarily flow in a bi-directional North-South current along the East coast, where most of the tourist attractions and major conurbations are located (Loker-Murphy & Pearce, 1995).

Budget accommodation normally consists of hostels or inexpensive hotels, which typically offer some form of shared sleeping, eating and entertainment facilities. Estimates vary, but many backpackers to Australia do not make significant plans or bookings for their trips before arriving and advocate this to other backpackers. The primary exception to this is airline tickets which require bookings; nearly half of these are only booked 0-2 months in advance (TNT Magazine, 2003). Various researchers found the average time spent in Australia to range from 2-6 months (Slaughter, 2004) and trips to Australia are frequently a portion of larger trips to New Zealand, South East Asia, Indonesia and other countries. Backpackers often seek informal work as they travel and additionally engage in activities such as trekking, scuba diving or ridesharing outside of the time they spend working. Tourism Queensland estimates that backpackers represent 10% of all visitors to Australia and this percentage is increasing (Kjeldskov, Skov, Als, & Høegh, 2004; South Australian Tourism Commission, 2004).

Backpackers frequently stay 2-3 nights in a location, although some locations are a one night bed in-between stages of transportation, or a stop to work for up to several months (Ballen, 2004, personal correspondence with hostel owner). Frequent movement results in a lifestyle of continually meeting new people. A recent study indicated 42% of backpackers in Australia arrive alone (Ballen, 2004). Many others travel with a partner or friend. Larger groups are uncommon although backpackers occasionally travel with others they meet for brief periods. Organized backpacker bus services provide transportation between common backpacker destinations and cater to a younger, partying crowd. More independent travelers use standard bus services or other forms of travel such as planes, trains or shared cars.

The prototypical backpacker is open-minded, well travelled, able to travel frugally, knows how to have fun, and goes places other tourists do not. They are a bit daring, find locations only locals know about, and can travel for years at a time. Real purists do not plan anything, do not carry mobile phones or cameras, and enjoy being isolated from familiar people and cultures. The fact of the matter is that very few backpackers reach this ideal definition. Instead, a large percentage of backpackers are on university breaks or taking a year off between high-school and university (referred to as a gap-year) (Huxley, 2005). Many of them want to party, and hostels often have their own bars or have connections with local pubs to facilitate this. Many backpackers like companionship and safety, choosing to stick to the well-trodden paths and backpacker enclaves. They also rarely go to untraveled locations; good tourist locations are often well known and thus attract all types of tourists. Backpackers are increasingly older, and often have more money to spend on advanced technologies which they carry with them.

Field Trip Study

The following is a study of mobile information sharing and social network formation amongst backpackers engaged in a typical tourist activity. The study is named 'Mobile Information Sharing' (MIS), with iterations 1 and 2, which were conducted several months apart. More detail on the method and results is provided in several technical reports (Axup & Viller, 2005, 2006).

Method

In each iteration of the study, a group of six or seven backpackers was recruited from a hostel for each study. They participated in a day-long 'field trip' including the following activities: walking through the city, a boat cruise, and an animal park visit in Brisbane, Australia. In MIS-1 two observers accompanied the group, with one taking notes and the other using video. Three observers were used in MIS-2, with all observers taking notes and digital photographs. Digital audio-recorders (2 in MIS-1, 3 in MIS-2) were worn by volunteers in both studies for the duration of the field trip. In MIS-2, foam prototypes of mobile devices were carried and 'used' by backpackers during the trip (see Figure 19).

The fictional functions for the prototypes were as follows:

1. "You can leave a message at this location for other backpackers."
2. "I can tell you the cheapest way to do something."
3. "I can store any ID cards, tickets, or personal items and let you use them electronically."
4. "I can show you the location of other group members."
5. "I can identify any object."
6. "You can talk to the group using this device. I can show you where you are."
7. "I can let you talk to anyone in the world for free."

Each prototype was a piece of lightweight foam with an attached sticky-note describing one of these fictional functions. Prototype functions were chosen based in part on issues observed in the MIS-1 study. They were requested to carry their chosen "magic thing" (Iacucci, Kuutti, & Ranta, 2000) with them during the day and look for opportunities to use and modify it. A researcher demonstrated marking up a sample prototype with a pen and each participant was given a permanent marker to draw with. A researcher also demonstrated talking into the prototype and showed another experimenter how he was interacting with it. No other instructions were given about what the backpackers should do during the day.

We were primarily interested in what situations provoked usage of the devices and what requirements they had for it. To this end it was not suggested exactly how the prototypes should be used. It was hoped that the unpredictable environment and personal characteristics of the backpackers would challenge us with new proposed functions and situations. There is a subtle balance in the design of exploratory user studies: sufficient detail about the prototype needs to be given to the participant, so they know what is being built and what is desired of them (Houde & Hill, 1997). However, providing too much detail reduces the potential for exploring alternate design paths, and is not likely to produce results which challenge existing concepts. Thus it was concluded to provide high-level fictional functions in common language, simplistic objects to use as props, and basic instructions on how to play-act with the prototypes. It was hoped this would remove the need to consider technologies or detailed interfaces, and focus on situations, functionality and practical usage.

Workshops following the field trip debriefed the participants in both studies, and participants using prototypes had the opportunity to discuss modifications to them. The following sections cover highlights of the results including who the participants were and major themes coming out of observations of both studies.

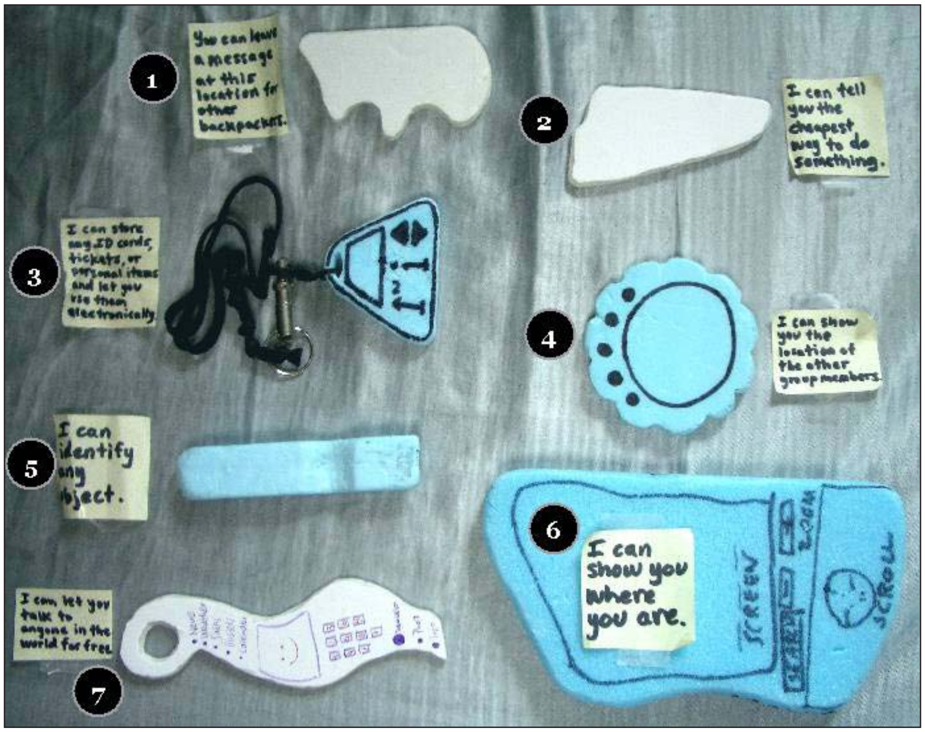
Participants

All of the participants in both study iterations were backpackers (BP), and are referred to using the syntax BP#(S), where # is their assigned identification number; if it is ambiguous, 'S' indicates the study iteration 1 or 2 (e.g. BP7(2)). Similarly, both iterations coincidentally had three subgroups (A,B,C) which again have the iteration number following them (e.g. subgroup A(1)).

In MIS-1 the participants formed three preexisting subgroups.

- **Subgroup A (1):** BP1 and BP2 were married, from Ireland and Holland, and in their mid-thirties. They were traveling for seven weeks with a moderate budget.
- **Subgroup B (1):** BP3 and BP6 were friends from England in their late teens. They had recently spent a month in New Zealand and were spending several weeks in Australia

Figure 1. Prototypes chosen by participants for use during the study. The drawings on the foam were made by participants during the study



on money borrowed from parents and credit cards.

- **Subgroup C (1):** BP4 and BP5 were acquaintances from the day before. BP4 was from Holland and in her late teens, working while traveling, and on a very tight budget. BP5 was from Korea, in his early twenties, and was traveling with a reasonable amount of savings.

In MIS-2, there were seven participants, forming three pre-existing subgroups.

- **Subgroup A (2):** Three English females (all under 21 years) were old friends from school, traveling together for a few weeks. One of them (BP7) had been traveling for longer than the other two (5.5 months) and had just joined up with the other two, who had been traveling for 5 weeks. They had known each other 8 years, were traveling South, and BP7 had recently been living in New Zealand.
- **Subgroup B (2):** A Swedish male and female couple (both 26-30 years) had known each other for 5 years. They had been traveling together for 8 weeks and were also traveling South.
- **Subgroup C (2):** Two English males (both under 21 years) had been friends for 11 years and were traveling North to Cairns. They had been traveling for 3 weeks.

The following sections cover results of the study particularly relevant to socio-technical design.

Mobile Phones and Remote Communications

Five of the backpackers in MIS-1 carried and owned their own mobile phones. The non-owning member (BP2) used her husband's (BP1) phone as they were traveling together. All five reported both voice and texting (SMS) usage. Family and friends at home were common contacts and two participants reported using their phones to contact friends met while traveling. In MIS-2, at least one member of all of the subgroups owned and carried a mobile phone while traveling. BP1 and BP2 (English males) each carried their own and used voice, SMS, GPRS, contacts and clock features. BP3 (Swedish female) carried a phone and used voice or SMS. BP7 (English female) carried a phone but said she barely used it. All the backpackers who carried phones said they contacted family, hostels or other travelers they met.

BP4 sent several text messages while on the boat and received an international phone call while at the park. She walked away from the group and trailed them while talking for approximately 15 minutes. She said "*I'm texting everybody all the time.*" BP5 also sent text messages to his girlfriend who lived in a nearby city. The experimenters also used both voice and SMS phone communications during the study to coordinate observations and inform external parties about the status of the study.

There were a number of situations where backpackers communicated with remote people outside the study group. BP7 was seen using her phone for SMS several times on the boat, and indicated she was texting a friend back in England. Several backpackers discussed sending group e-mails, indicating they were "*to those met, home friends, family, [and for] big events.*" BP7 also indicated she had a friend "*e-mailing me expectantly about when she will return*." BP5 jokingly indicated "*she's still e-mailing that [John]*", who was a love interest she had met in New Zealand.

Guidebooks, Journals and Maps

Guidebooks were discussed but not used during the field trip, and were a topic in the post-activity workshop. BP4 mentioned she had not brought her Lonely Planet guidebook with her. However, she had brought an iPod, a loaf of bread and carried a medium-size backpack. She indicated she was using the guidebook to keep notes in the margins about where she went. During the workshop backpackers mentioned the currency and accuracy of information obtained at their current location, as an alternative to guidebooks. They also discussed problems with outdated information, bias of individual authors, lack of detail for large regions, and insufficient emphasis on budget travel. The following quotes illustrate the range of opinions on guidebooks.

BP1: *The information centre, they have a lot more information* [than guidebooks].
BP3: *But it* [the guidebook] *is like really useful. It is right where you are, it is everywhere we want to go. And it is divided into sections. So like places to stay, backpackers and nightclubs.*
BP1: *Yeah but the best places…*
BP4: *Are not in the Lonely Planet.*
BP1: *But the places that are not there are more important to staying at.*

…

BP4: *The Lonely Planet says they're for backpackers, but there is expensive hotels in there as well. And we really do not need that. I think it'd be great if they said where the nearest supermarket is. Like Coles or Woolworth's, you do not want to go the 7-11. There was nothing in there about Surfer's Paradise.*

These excerpts show strong opinions surrounding guidebooks, ranging from those liking predictability and organized travel tips to those seeking unexplored areas and other sources of information. Maps were used fairly often during the day. Small handheld maps of the animal park were available and used to plan routes, see available activities and find the way out.

Some backpackers complained about the map and a few had trouble finding their current location on it; however, it was used effectively by many of the participants. One of the backpackers had obtained a free map of Brisbane city and others were looking at it and asking about getting one.

Several of the backpackers mentioned travel journals and BP7 wrote regularly in hers. She kept a smaller notepad for keeping track of daily events (see Figure 20), to help form a larger journal which she kept at the hostel. The larger journal contained clippings and memorabilia from her travels.

Problems and Difficulties

Backpackers discussed both difficulties experienced during the day, and problems they had on previous parts of their journeys. In both cases, backpackers sometimes expressed the issue as a problem, but sometimes it was simply related as an experience. We noted situations where difficulties could have been averted or where new tools or design changes could have made things easier or more enjoyable. Plato once said that "Necessity is the mother of invention." Categories and examples of problems our participants experienced are listed below; the reader is invited to invent potential solutions, or read a list of proposed products in Appendix C of my doctoral thesis (Axup, 2006).

Trouble Locating Products or Resources

At the animal park several backpackers wanted to find a water tap to fill up a water bottles, but did not know where to find one. BP3 wanted to find pants in an uncommon size and was not sure where in the city they could be purchased. This was complicated by different sizing standards and brands from her home country.

One backpacker was interested in sharing a ride to a city up the coast but was considering public transport. She was not sure about costs of bus tickets going North or if there were better methods of finding people going the same way. Cost was a critical factor in her decision.

BP4: *Maybe I'm gonna buy a bus pass from here to Cairns. If I can get it for $35, then I'll do it. But I hope I can get a lift to Hervey Bay, and from Hervey Bay to the Whitsundays, and Whitsundays to Cairns.*
BP2: [unclear]
BP4: *But, well, I often meet people...*

Figure 2. (Left) A prototype is placed in a large jacket pocket, while a magazine rests on her lap and the coffee cup is shared. Coffee could be spilled and her hands are not free to manipulate a device. (Right) Writing a quick outline of the day's events while on the boat, before writing a longer journal entry at the hostel. Paper journals might be used prior to digital journals in the future

BP2: *How do you find them?*
BP4: *Usually I just look at the message boards in hostels. It is safer.*

Social pairing technologies need to facilitate these kinds of activities while maintaining or improving the level of safety of existing methods.

Safety of Belongings, Trust, and Losing Important Items

BP3 gave her airline ticket to an airline worker as part of the process of finding a checked bag that had not arrived. When the bag finally did arrive BP3 & BP6 accidentally left without getting the ticket back. At a previous location she had also dropped her passport in a hostel lobby while drunk but had fortunately had it returned. BP4 had valuable items which she regularly left in her room with strangers. She said she "trusts them not to steal".

BP4: *Why did you bring all that?*
BP2: *I always carry my tickets with me.*
BP4: *Ya me too.*
[unclear]
BP2: *Never trust anybody.*
BP4: *You can trust me, you can trust [BP5]. I leave stuff in my room all the time, like my iPod, my telephone, and my passport, my tickets. I'm staying with five people, and one of them's my friend.*
Others: [laughter]

Phones or other electronics that require recharging from a wall electrical outlet often result in these items being left unprotected in rooms.

Accommodation

Backpackers discussed where to get cheaper rates and the quality of accommodation where they had stayed. They complained about noise outside the room windows, problems with other guests in the rooms, dirty sheets and other issues. Problems of competition for space and resources in busy hostels came up as an issue. For instance BP4 had not done her laundry because there had been a line waiting for washers. Getting access to showers, toilets, café seating, single rooms or other resources can be an issue in some hostels.

Technological Difficulties

The mobile phone used by BP4(1) went dead shortly after arriving at the park because of an insufficiently charged battery and a long phone call. Phone batteries do not last more than a day or two when under heavy use and charging phones in hostels is often inconvenient. Her iPod had also gotten visibly dirty during a job assignment where she was handing out newspapers on a street corner. She used it during the trip to relieve boredom during a lapse in conversation and indicated that she used it regularly. She also said fairly seriously that "If I lose this I'm going home." Personal music players provide entertainment, excuses to ignore others in the environment, protection from noisy environments and cures for homesickness. This is similar to issues that affected the original introduction of the walkman and other music players (Bull, 2000).

How a Community wants to Communicate

Early research into developmental sequences of small groups isolated the stages of forming, storming, norming, performing, and adjournment or transforming (Tuckman, 1965). Traditional technologies such as post mail or conference rooms have long affected these sequences of community development. More recently, technologies such as teleconferencing systems and mobile blogs are affecting them in different ways.

One of the prototypes in the MIS study was intended to explore whether a new community technology would be useful and how it might affect the social relationships of backpackers. The concept would enable backpackers to visualize the locations of other people, and determine who they would want it to track (Design 4: Visualize Group Members, see Figure 3, Figure 4). In MIS-1 there were situations where backpackers had been geographically distributed and wanted to contact each other, and this prototype was created for MIS-2 to evaluate a potential solution.

BP7 (female, under 21, from England) chose the prototype earlier in the day. When interviewed later she indicated there hadn't been many opportunities to use the device. "*Mine can show the location of other group members, which I didn't really use today. But I could see that it could be quite useful, if it worked all over the world, and didn't cost you any more. Like* [BP5] *and* [BP6] *have mobiles with them*." There was only one occasion where the three girls were out of sight of each other. This occurred when BP5 left to look at an exhibit a short distance away and a koala the other girls were watching became particularly animated. They called out to BP5, who eventually heard them. In this case the desire to contact and/or find someone is time-critical in that the event of interest might end quickly. Sharing special moments such as these is part of the development of stronger social ties.

In situations not immediately relevant to the prototype chosen, the interviewers tried to introduce recent travel history into the discussion. This resulted in the following exchange.

Interviewer: In terms of the last week, are there any situations where you've wanted to visualize the movement or location of others?
BP7: Ya. People that I've met in one place, that I knew were going to be in the same hostel. I'd want to find out what room they were in, or you know, if we don't have mobiles. [pause] I didn't know what time you two [gestures at BP6,7] were arriving yesterday. You didn't have mobiles. It would have been quite good to find out. I went out yesterday, and I didn't know what time they were going to be back.
Interviewer: Is this something you'd use just between the three of you while you're traveling or would you want to include other people you met or people at home?
BP5: Umm, more of the sort of wider network like mobiles, where you just add someone on.
Interviewer: How would you visualize the group? Would you want the group to just be the three of you, so you could see where you were, or would you like to see the people you met last week in a larger...
BP5: I would... I wouldn't want it to be limited, I'd want to be able to add new people.

It becomes clear through observed usage and this discussion that the backpackers speaking are not interested in visualizing all seven members of the study group. The social bond between her and the unfamiliar backpackers in the study group (BP 1,2,3,4) is not high; this is particularly true half-way through the study when she is considering usage of the device in-situ. She is interested in tracking her two other friends, and other people such as friends or family that are in other locations. She emphasizes the need to add (and presumably remove) people on a case-by-case basis.

There is a valid concern about how representative and predictive these results are since they come from a sample of 13 people. While this certainly isn't a large enough sample for statistical analysis,

Figure 3. A circular screen and buttons has been added by a backpacker

Figure 4. A backpacker thinking about potential uses for her device while standing in the middle of a field. Other people, animals, weather and current tasks probably affected what she chose to use it for

it should be remembered that design processes frequently have to take a “discount” approach and iterations of small studies can be informative and cost effective (Nielsen, 1993). Research in this area would certainly benefit from additional studies with different cultures, other locations, and larger sample sizes. However, the reality of typical rushed industry projects is that if useful data can be collected rapidly, it can be iteratively used to help keep projects on the right track. The behavior of the individuals in this study largely conformed to the norms of other backpackers, and thus provides reasonable insight into likely usage by the larger community. Grounding design decisions in this real observed behavior reduces the scope of potential theorized behavior and reduces the risk of designing the wrong product. While controlled studies with larger sample sizes and increased certainty are feasible in some contexts, they are frequently not a sound methodological choice for studies in natural social settings, on limited budgets, needing rapid turn-around times, or in explorative research stages where the net should initially be cast wide.

Taking this pragmatic approach, we can extrapolate from these findings and fast-forward to a hypothetical time when the device has been completed and is being widely used. Some possible socio-technical outcomes become apparent: the participants are now able to rapidly get the attention of nearby friends through a simple buzzer or vibration and call them to their present location. They also have the ability through a ubiquitous technology or communication standard to rapidly contact all of the people they already know. Additionally, they can rapidly add and remove people they meet from these systems.

This could have a wide range of consequences for both individuals and communities. Backpackers would probably feel less lonely, but more distracted by others they know. They might meet 20 people at a backpacker bar one night, rapidly get all of their contact details, and then remove all of them the following day when they can’t remember them. On the other hand, they might finish a three month trip in Australia with 300 active friends instead of a small number of dimly recalled email addresses that many backpackers leave with. In either case, it is likely such a device would affect the early forming and storming stages of groups, and possibly strengthen social ties used in the stable performing of later phases.

The Relationship Between Community and Technology

Social technologies are analogous to a path or sidewalk we take through a park or university. The path suggests a direction and location of travel. Many people follow it because it is easier, safer, and more socially acceptable. However, people are also free to deviate from the path to explore, challenge, or provide variety, and some do. The path itself was probably designed with some forethought and it greatly influences the majority of people who use the space. Communication technologies provide similar paths by which individuals get to the destination of forming groups and communities. The following sections explore how these *social paths* should be constructed and what factors affect how they are used.

Social Implications of Technology use in Backpacker Culture

As with all technologies, the tourism technologies proposed above would change the environments they are introduced into, and the behavior of the people using them. Some elements of this are reasonably predictable and others are not; however, it is usually possible to identify design outcome spectra (see Figure 5) to help plot a course (also see (Engeström, 1993)). For example, community authoring poses challenges for existing models of creating guidebooks. It could be that backpackers on the road will generate more current, accurate, and detailed information than professional authors have previously provided. This could easily result in the replacement of experienced paid authors with an inexperienced swarm of unpaid travel authors. It is also true that professional authors work hard and provide insightful, useful and comprehensive overviews, and this may not be matched by amateurs. This could result in a competition between the two authorship paradigms. This scenario would be likely to result in a shift in the focus of professional authors, or perhaps the gradual elimination of this job role.

Another example is the tradeoff between popular and largely unvisited destinations. There is a small portion of the backpacker population genuinely wanting to experience untainted foreign cultures, isolate themselves from home, travel without a guidebook, and use only the most basic travel equipment. Because of the increase in Internet cafes, backpackers carrying mobile phones, and the increasing number of backpackers, it is increasingly hard for these people to find the travel experience they are looking for (Huxley, 2005). This is analogous to the increasing difficulty of finding new species on a planet that does not hold many unexplored locations. The technologies I am proposing through this research would make it easier and safer to travel, which would probably increase travelers' confidence in going to more remote locations (and thus increase their impact on those destinations). The technology would enhance the group-formation abilities of backpackers traveling alone, which could result in more group activities and more partying. Contrarily, the ability to e-mail, call and instant message from a mobile device carried in a pocket could result in backpackers connecting more with people at home or from a similar culture, instead of actively engaging in the cultures in which they are traveling.

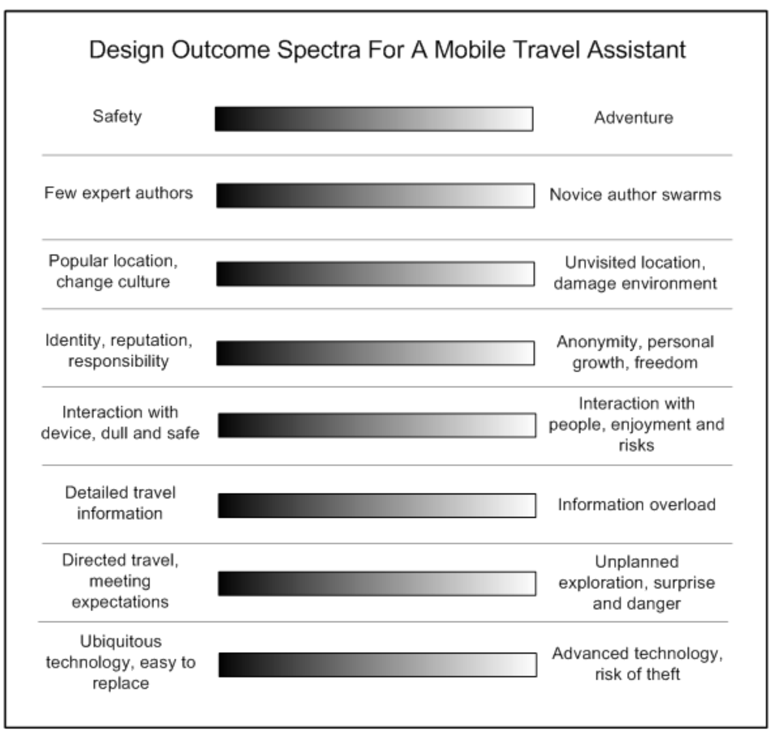
So what is the aim of our technology design? Should we follow the path of the Luddites (Darvall, 1969) and destroy the Internet cafes and mobile phones? Should we protect the guidebook authors and instead of replacing them with community authoring technologies, seek ways to improve the quality of their reportage? Should we design technologies to help *reduce* the ability for others to contact backpackers and guide a minority of backpackers to pristine unexplored locations? All of these options are theoretically possible, but it depends on what social aims we have, where sufficient markets are, and how much of the result we can predict. It may well be that guidebook authors will go the way of human traffic directors and telephone switchboard operators. Is this a natural evolutionary process, or is it a role respected in society to a degree that we wish to protect it when it is obsolete?

Is our Technology Leading us?

On a daily basis there are decisions being made about what work roles should be replaced, who has control over the creation of new technology, and what cultural values it will represent and propagate. The design processes we use also have a similar effect. Technological determinism is a term sometimes used to describe this relationship between technology and usage of it (Feenberg, 1999). This theory has weak and strong versions, with the latter advocating new technologies follow their own unquestionable evolutionary path and that humanity needs to adapt to the needs of scientific progress. The more commonly advocated weak version stipulates that while new technologies do influence behavior, there is also another significant effect of people deciding which technologies to create and how to use them. Some social science researchers are on the other end of the spectrum and believe that personal choice and environmental situations are the primary controlling factors of technology development and use (Arnold, 2003). This perspective dismisses the significant history of progressive technology advancement and successful predictive formulae such as Moore's Law (Fitts & Posner, 1967) which are based on the premise that new advancements in science will result in the predictable growth of new technologies. For example, some of the most stable predictions in technology design are that devices will get smaller, more powerful and more efficient; this of course changes what people are physically capable of. When these powerful handheld devices are delivered into the hands of customers by hardware and software vendors, they will certainly have some impact on employment roles, social relations and governments. People will make some decisions about how to use these devices, but they will largely be constrained by the physical limitations of the devices and tempted to use easy and inexpensive features more. Thus, it appears weak determinism is the demonstrable conclusion, and that we should seek to learn to guide it, not doubt it.

Accordingly, there is a balance in responsibility between those who are designing and selling devices, governments which regulate their practices, and users of these technologies deciding what is desired and socially acceptable. Clearly we do not want situations where the usage of new technologies results in members of the surrounding community living in inhumane conditions, as occurred in England during the Luddite rebellion (Darvall, 1969). However, we should also remember that the *introduction* of a new technology was not the significant factor in this case. Instead it was unethical business owners and a government which did not enact laws to support a healthy economic climate in which people could find quality work and be safely retrained. It is true, some technologies change workers' job roles more

Figure 5. Spectra between potentially opposing design goals and trade-offs



than others and will consequently be more disruptive. However, a more significant factor is the way business owners choose (or are regulated) to use available technologies and treat their employees, which greatly influences the quality of life of workers. Thus it is quite possible we as designers could use completely humane design theories to produce a mutually satisfactory product, which is then implemented in a profit-driven fashion by industry, resulting in the abuse of workers. Thus it must be remembered that design theory and methods are only a small part of the bigger picture of humane socio-technical systems.

Guiding Change in Communities

Three major factors bring an influence to bear on technology adoption: a) technology developers b) governmental legislation and c) users. Developers (or designers) have more control over their own behavior than that of the latter two. However, participatory design did have a stage where it was more concerned with political legislation than design (Helander, Landauer, & Prabhu, 1997, p. 303) and this is another possible avenue for designers interested in improving the quality of life of workers and users. Users themselves will ultimately choose to use technologies in a partially unpredictable and emergent fashion, so it may not always be possible to design humane environments for them. There are also other options for guiding adoption of products, such as boycotts or protests seeking to rally large numbers of users to change their behavior in unison to influence manufacturers and governments. However, developers typically have more control over the processes they use, the products produced, and the types of actions those products enable and encourage.

In addition to the socially charitable projects discussed in the introduction, it is clear certain social technology developers have more dubitable social agendas behind the products they are creating. Islamic, Christian and other religious groups are developing technologies which encourage regular prayer and conformity to established norms (Emily, 2003; Malone, 1989). On the other end of the spectrum is Craig's List which has a section for arranging casual sexual encounters between strangers (Bui & al, 1987). While developers can make these technologies widely available and easy to use, consumers still exercise a vote in what they choose to use or purchase. In his autobiography, Alan Greenspan talks about the tendency to naively attempt to regulate and centrally plan market economies (Greenspan, 2007). He argues that if markets are large and free to make their own decisions, they are often stable and self-regulating. When applied to technology markets, one would expect technologies which best fit the market's perceived need to be chosen. However, consumers can only choose from available technologies – so technology developers exercise a great deal of power through their choice of what to create and distribute.

There is also an unofficial class of products known as 'subversive technologies', which either by design or not, have the ability to change power structures in societies. These products often contain highly adaptable, generally applicable, high-level functions. They often offer new forms of communication, and frequently are inexpensive and difficult to censor and regulate. Primary examples of subversive technologies include mobile phones, e-mail, the Internet, camera phones and peer-to-peer networks. It may be, it is the *type of activities which the device enables and simplifies*, which is more socially important than the design process used or the intended use of the technology, although these are certainly related. It may be better to give users technologies which enable them to *organize, analyze situations, form strategies, and represent and defend themselves* than to attempt to prescribe future humane usage situations. These basic tasks carry the cultural ideals of free speech, non-discrimination, and democracy with them. Making tools freely available to support these tasks may be enough to encourage these social ideals to take root in societies that would benefit from them. Designers should not be timid when advancing social agendas they believe the world would benefit from, and the opportunity is ripe for doing so.

CONCLUSION

The determination of reasonable social paths is a combination of more thoughtful technology development, humanist social policies regulating technology deployments, and self-regulation by users through choice in usage and purchasing power. By virtue of being first in the process, designers lay the path which users tend to follow, and have the resulting responsibility to guide them to a prosperous destination. The study above has shown how creating and evaluating social technology concepts with communities of users can help designers more positively predict and influence community development.

ACKNOWLEDGMENT

Thanks to Dan Nicolau, Dave Nichols, Jason Shugg, Roslyn Cooper, Stacey Lamb of Palace Backpackers, Lone-Pine Koala Sanctuary, Mirimar Cruises and the anonymous participants for helping plan and conduct the study. Also many thanks to numerous technical report reviews and guidance by my advisor Stephen Viller, and to the University of Queensland and the Australasian CRC for Interaction Design (ACID) for funding and research opportunities.

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KEY TERMS

Social Path: A technology, which, regardless of intent, embodies political, cultural, and moral ideals in its design, and encourages or enables certain resulting behavior by large numbers of people.

Socio-technical Systems: Networks of people and technological components which interact in the course of usage or deployment of designed processes or products.

Mobile Community: A group of mobile, and often distributed, people with social ties which can be used by members to obtain various kinds of resources.

Social Networks: Groups of people who communicate with each other, and who often have shared interests and stronger social ties.

Mobile Ethnography: The detailed study of small numbers of subjects who frequently move, which typically requires novel methods of recording observations, tracking subjects, and analyzing data.

Low-fidelity Prototyping: Creatively iterating on design concepts, typically using paper, whiteboards or other artifacts which permit rapid creation and modification.

Community Planning: Social networks come into existence and some point, and typically go through various stages of development. Vision statements, guidelines, tools used, and environment greatly affect how the community develops and how it acts.

Section IV
Socio-Technical Design

This section concerns issues regarding the design of socio-technical systems that succeed. It addresses questions like:

1) What is new about socio-technical design?
2) How does it differ from other forms of design?
3) How does it derive from other forms of computing design?
4) How do different methods of socio-technical design connect to each other?
5) Are there common principles in socio-technical design?
6) What are the issues socio-technical designers face?
7) What value does socio-technical design add?

Prologue
Socio-Technical Design

Thomas Erickson
IBM T. J. Watson Research Center, USA

What is socio-technical design? How does it differ from 'ordinary' design? Or does it? Are we simply dressing up a well-understood practice with a fancy new name? I think not. I believe that we are seeing a gradual shift in design methods that is a consequence of the increasingly complex nature of the systems with which we are working. To consider the nature of this shift, let's begin with 'ordinary' design.

Design has both an end and a means. The end of design is to make something that serves a purpose, usually many purposes. The means by which design achieves its end is a cycle of making and reflecting. This sounds simple, but as with many simple things there are hidden complexities.

The elemental act of design is casting an idea into a material form and then using *that* as an aid to thinking about the idea. Thus we have the archetype of the crude napkin sketch that serves as a focus of pointing hands and excited talk. Or an interactive mock up of a user interface. Or a 3-D model that can be rotated and viewed from different directions.

When we take an idea and translate it into what I will call a design artifact, we are able to think about it differently. Embodying it in a material form—whether physical or digital—enables us to see things in it that weren't evident when it was only in our heads. The philosopher Donald Schön referred to this as having "a reflective conversation with the materials of the situation" (Schön, 1987). I like this notion: When you cast an idea into a material form it takes on a life of its own—you can talk to it, and it will talk back! This quasi-magical act is the core of what it means to be a designer.

Another advantage of casting an idea into material form is that it makes it easy to talk about it with others. Talking with others—that's really another form of reflective conversation. Not only do I think about something differently when I have cast it into a material form, but when I show it to you, you too will think of it differently, and differently from me. Then we talk, argue, joke about or mull over our differences, and as we do so the idea becomes richer.

The process of casting an idea into material form and reflecting on it occurs repeatedly, a cycle of making and reflecting. As this cycle plays out over time, it generates an expanding array of design artifacts that embody various aspects of the idea. The napkin sketch begets drawings, the drawings beget models, the models beget specifications (though the path is rarely that linear). Furthermore, as the cycle plays out, the idea changes—it grows more complex, mutates, diverges, converges and so on—generating a veritable cloud of design artifacts which can

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themselves be combined to create new variants of the idea. Under the right conditions, which usually involve an increasingly intense convergence of temporal, organizational and financial pressures, a product (or service or organization or whatever is being designed) will precipitate.

But as we move into the socio-technical realm, things become more complicated. As I laid out the account of design above, you may have imagined various objects of design: a cell phone, a photo browser, a house. For it is (comparatively) simple things like these, things used by an individual or a small group, towards which our current design practices are oriented.

But socio-technical design is not just about designing things, it is about designing things that participate in complex systems that have both social and technical aspects. Furthermore, these systems and the activities they support are distributed across time and space. One consequence of this is that the systems that are the sites for which we are designing are in constant flux. And even if we were to ignore the flux, the distributed nature of the systems means that they surface in different contexts, and are used by different people for different (and sometimes conflicting) purposes.

Thus, if we examine the design process from the vantage point of the socio-technical, this complexity raises a number of general questions that socio-technical systems designers will need to address.

First of all, how do we represent such systems? How do we cast a complex system into a material form in such a way that we can reflect on it? In particular, how do we create design artifacts that capture a system's distributed nature and the fact that, Rashomon-like, it may appear quite different depending on the context in which it is used and the characteristics of those who use it? An example of one approach to this end involves the use of pattern languages, first developed for use in architecture and urban design (Alexander, et al. 1977).

Second, whatever set of design artifacts we end up with—and it seems likely that the set will be much larger and more complex than those we are accustomed to—how do we carry out reflective conversations with them? If our design artifacts have evolved to accommodate increased complexity, will our existing reflective practices suffice? How will we go about ensuring that we ask the right questions, from the right perspectives, in the right contexts? Perhaps, taking a cue from participatory design (e.g., Greenbaum and Kyng, 1991), we will need to greatly expand the range of participants involved in the reflective processes, which in turn may require developing new sorts of design artifacts to aid in participatory reflection.

Third, as we move through the cycles of representation and reflection, how do we ensure that eventually we converge? Or do we? Perhaps the notion that the end result of a design process is a stable product is old-fashioned. Perhaps we're headed towards a future of 'permanent beta,' in which things are designed so that their design may continue during use, where the leading edge of design resides not with the producers but with the users This resonates with current ideas about open innovation communities (Von Hippel, 2005).

However things turn out, it seems clear that socio-technical design will require new methods, new tools, new participants, and new practices. This section—and indeed, much of this volume—provide views of the new vistas open before us.

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Chapter XXIII
Systems Design with the Socio-Technical Walkthrough

Thomas Herrmann
University of Bochum, Germany

ABSTRACT

Socio-technical systems integrate technical and organizational structures and are related to various stakeholders and their perspectives. The design of socio-technical systems has to support this integration and to take the differing perspectives into account. To support this goal, the design concepts have to be represented with appropriate documentation methods, which combine formal and informal aspects. Communication processes have to be facilitated which systematically refer to these kinds of documentation. Therefore a socio-technical, semi-structured modeling method (SeeMe) is introduced. It represents socio-technical concepts with diagrams which can be developed, evaluated and improved by the socio-technical walkthrough (STWT). This facilitation method—together with a corresponding software-tool—has proven to be suitable for socio-technical design in complex, practical projects.

A maximum of explicitness leads to a minimum of understandability

—Ungeheuer, 1982
(translated from the German p. 328)

INTRODUCTION

Socio-technical systems comprise the interaction and dependencies between aspects such as human actors, organizational units, communication processes, documented information, work procedures and processes, technical units, human-computer interactions, and competencies. They are characterized by continuous evolution which is influenced by interests, conflicts and power relations. The socio-technical walkthrough ("STWT," Herrmann, Kunau, Loser and Menold, 2004a; Herrmann, Loser

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and Jahnke, 2007) is a methodological approach to take this multitude of aspects into account and to make them the subject of communication, negotiation and decisions in the course of the development of socio-technical systems. The documents which accompany the STWT mirror these aspects and build bridges between the developing competencies, organizational change, programming or configuration of software and identification of appropriate hardware. We suggest that the expectations of the various stakeholders being involved are better met:

- the more technical and organizational structures as well as relevant competencies are integrated and aligned to each other, and
- the more the different perspectives of the stakeholders are taken into consideration, valued and integrated during the discourse which accompanies the participatory design and evolution of socio-technical systems.

Systematical support of socio-technical system design can be based on a wealth of methods, guidelines and principles, for example design principles according to Eason (1988) Cherns (1976) and (1987); "ETHICS," Mumford, (1995); "scenario-based design," Carroll, (1995); or "socio-technical requirements-engineering," Jones & Maiden, (2005). The background of Participatory Design (e.g. "MUST," Kensing, Simonsen and Bødker, 1996) provides guidance on how to integrate the experience of different stakeholders. However, the documentation of the requirements and concepts which accompany the design process do not usually sufficiently support an integrated view on varying aspects such as technical and organizational structures. The experience within a series of practical projects reveals that the available approaches, like prototyping, diagrams of use cases, story boards, mock-ups as well as a set of different visualizations (e.g. for contextual design Holtzblatt, 2002) do not sufficiently support an integrated (over-)view of the interrelationships between the aspects of socio-technical systems. For example, prototypes direct the feedback of evaluators on issues of screen design and lead to a neglect of issues concerning work processes and cooperation between users.

A central problem of socio-technical design is the integration of technical functions with social structures and perspectives. This problem can be overcome by appropriate guidance for conducting workshops and by means of documentation. We propose the socio-technical walkthrough (STWT) as a documentation and facilitation method. It has been gradually developed, evaluated and incrementally improved during the course of several practical cases (Herrmann, Hoffmann, Kunau and Loser, 2004b) in the field of Computer Supported Cooperative Work (CSCW). A set of workplaces where several people's cooperation and communication is supported by CSCW-software is a typical example of a socio-technical system. The STWT combines two parts: the **s**ocio-technical, s**e**mi-structured modeling **me**thod SeeMe with which diagrams can be developed to document the concept of the socio-technical system, and a facilitation method for workshops where walkthroughs are applied to the SeeMe-diagrams to inspect and improve them step-by-step by asking certain questions. For example, the STWT helped to develop a solution for improving the coordination between dispatchers and truck drivers with mobile handhelds (cf. the CASE-STUDY section below). Both roles as well as software-engineers and a project manager were involved to discuss and improve diagrams step-by-step. They clarified the technical functionality needed and the accompanying organizational change. After deliberate analyses and negotiations in four workshops the participants agreed upon more than 10 comprehensive diagrams which described the projected solution. The series of STWT-workshops can serve as a scaffold which sustains projects where software-development, organizational change and development of competencies are parallely pursued.

The theoretical background of socio-technical systems—as referred to by the STWT—is outlined in the following section. A further substantiation of the STWT is given by describing our research approach. The following sections describe the modeling method SeeMe, the particularities of the

STWT and how they are technically supported. The conclusion quotes some reactions to the STWT from different standpoints and elucidates further research questions.

Background and Theory

Starting from the historical development of the term "socio-technical" (Emery & Trist, 1960) we saw the necessity to adopt elements of newer systems theory (especially Luhmann, 1995; Maturana & Varela, 1980) to achieve a better understanding of how a social system and a technical system can become integrated. The early socio-technical concepts mainly referred to the advantages achieved if "... work organizations were envisaged as socio-technical systems rather than simply as social systems. (Trist, 1993, p. 39 referring to Trist, 1950)" and if the management recognizes "... that the success of an enterprise depends upon how it works as a socio-technical system, not simply as a technical system with replaceable individuals added to fit (Emery & Thorsrud, 2001, orig. 1969, p. 85)". Consequently „Socio-technical design is an approach that aims to give equal weight to social and technical issues when new work systems are being designed. (Mumford, 2000, p. 125)."

The design-oriented approaches in the field of socio-technical research (Mumford, 1995; Checkland, 1981; Eason, 1988) mainly adhere to the early concepts of systems theory and therefore cannot sufficiently explain the central characteristics of social systems such as contingency and the limited predictability of the systems' evolution. These approaches are related to the concept of "open systems" to explain the intense interaction between the socio-technical system and its environment. However, this concept fails to explain why the system cannot be deterministically controlled from outside and therefore in general reacts differently to identical stimuli in its environment. To overcome this deficit we refer to Luhman's theory of social systems who combines the closed-system perspective of living systems developed by Maturana and Varela (1987) with Parson's (1967) concept of contingency.

Luhmann (1995) defines a social system as a web of communication acts which develops and reproduces itself on the basis of rules which are communicatively made by this web itself. From this viewpoint, organizational units can be understood as a web of communications that negotiates, defines, maintains and adapts a set of conventions, which characterizes the identity of the organization. The strength of this approach is that social systems are analyzed and understood with respect to the particularities and properties of its communicational interactions. Luhmann considers communication as contingent: a communicational utterance cannot determine how receivers react to it but can only influence their reaction. Therefore social systems cannot be programmed; they develop a certain strength (with respect to learning and adaptation) through their inherent possibilities for freedom of decision and build a contrast to technical systems which are designed to be programmable and controllable from outside and are intended to be reliable due to their constancy. Contingency "... is opposed to necessity and universality, contingency refers to variability and particularity; unlike constancy and certainty, contingency refers to mutability and uncertainty ..." (Pedersen, 2000, p. 413). On the one hand, contingency means that the reactions of a system to events in its environment are not predetermined, but that each reaction is one of many options. However, on the other hand, the system creates its own necessity in its pattern of reactions towards these events (Kirkeby, 2000, p. 11).

Luhmann's theory cannot explain all kinds of socio-technical phenomena such as the emergence of virtual communities. Yet, emphasizing the relevance of communicational relationships gives a deeper understanding of socio-technical systems: The degree of integration between organisational and technical structures is closely interrelated to the extent of:

- communication about the technical system and about the ways of using, maintaining and adapting it,
- communication which is mediated with the technical system,

- the reciprocal mirroring of—on the one hand—knowledge about the technical structures in the social communication and, on the other hand, representations of social structures within the technical system (e.g. via access rights).

These aspects emphasize that a socio-technical system is more than the coincidental connectedness of technical components and human beings. Furthermore, we conclude that a socio-technical system can be considered as a combination of controllable structures and contingent structures. This contraposition can also be related to other differentiations such as plans vs. situated actions (Suchman, 1987), anticipatable vs. non-anticipated changes (Orlikowski, 1996), informal vs. formal communication (Kraut, Fish, Root and Chalfonte, 1990), maps vs. scripts (Schmidt, 1999). An appropriate method to model socio-technical systems and to make them a subject of deliberate, participatory discourses has to be able to cover the whole scope of these differences. The success and efficiency of a socio-technical system depends on its balance of contingent and controllable structures, and on an appropriate understanding of the dynamics of its context. In accordance with an activity-theory perspective, the *developmental dimension of work activity* is to be taken into account as well as the question of *how transformations in the collective organization of work are accomplished* (Engeström, 1999, p. 64).

Empirical Background and Related Work

The STWT-approach for socio-technical design has been incrementally developed since 1997 (cf. Herrmann et al., 2004b). We first developed the modeling method SeeMe to represent concepts of socio-technical systems with graphical diagrams. For this purpose, we analyzed a set of common modeling methods for their appropriateness in modeling socio-technical systems (Green & Benyon, 1996; Harel, 1987; Oberquelle, Kupka and Maass, 1983; Rational Software Corp., 1997; Yourdon, 1989; Moody, 1996). SeeMe is inspired by the extended-event-process-chain (eEPC) developed by Scheer (1992), by use-case diagrams (Rational Software Corp., 1997) and by State-Charts (Harel, 1987). We have combined aspects of these methods and extended them with possibilities to express vagueness which includes incompleteness and uncertainty. Vagueness in SeeMe is related to a qualitative lack of information and not to quantitative probabilities.

SeeMe was applied in several practical projects (cf. Table 1) where socio-technical systems were analyzed or conceived. Within these projects we were involved as researchers as well as consultants and were guided by an action research approach (Avison, Lau, Myers and Nielsen, 1999) that included a cyclic process: knowledge is applied in practical problem solving, becomes refined step-by-step, and is scientifically reflected. The studies took place in practical fields where they were focused on qualitative data and on singular temporal events, which cannot be repeated. With respect to practical problem solving we were involved as the facilitators of workshops and as the modellers who translated the contributions of the participants into graphical diagrams with SeeMe. During the phases of scientific reflection, the modeling method was improved on an empirical basis. The sceptical views on the usage of diagrammatic modeling (Bannon, 1995; Bowers, 1992; Ehn, 1988; Robinson & Bannon, 1991; Suchman, 1995) were taken into account. The first projects revealed that it mainly depends on the facilitation of the workshops as to whether the problems which are stated by these authors occur. Therefore, we used the successive phases of critical reflection to understand the challenges which could be observed during the facilitation of workshops. This reflection (Herrmann et al., 2004a; Herrmann et al., 2007) deals with questions of how

- to prepare the workshops and present the SeeMe-diagrams to the participants,
- to ask proper questions which refer to the diagrams,

- to intertwine the facilitation with the modeling,
- to improve the technical support for developing, presenting and modifying the diagrams,
- to deal with conflicts and focus attention etc.

The improvement of the STWT-method was also supported by an intensive comparison with other approaches of participatory design, documentation and workshop facilitation. The comparison is explicitly documented in Kunau (2006).

In the context of university classes, we (Carell, Herrmann, Kienle and Menold, 2005) conducted a controlled experiment where we compared four groups of three students each who used traditional facilitation support (pin boards and flip charts) with four other groups using SeeMe-diagrams. It became significant that using SeeMe increases the number of commitments to the technology usage that was planned during the workshop. And afterwards, the usage was significantly more intensive than was the case with the control groups. These results can be related to the effect of applying the walkthrough to the diagrams, a process which promotes a very detailed consideration of the technical functions and of the commitments underlying the planned cooperation.

A Socio-Technical, Semi-Structured Modeling Method

The modeling method SeeMe (cf. Herrrmann et al., 2007) is based on communication theory which suggests that communicators only make explicit what is not already obvious by their context (Kienle & Herrmann, 2003) or common ground. A design-oriented notation must not enforce the depiction of all details as they are needed for tasks such as programming or configuration. It must be possible to represent incomplete or uncertain information and to indicate those aspects of a model which are only incompletely specified. If misunderstandings occur because of this incompleteness it can be gradually reduced by making the diagrams more explicit and formal.

For the early phases of designing socio-technical systems or processes it is reasonable to use a modeling notation which can:

- Visualize the complex interdependencies between different people, between humans and computers, and between technical components.
- Integrate overview sketches of the planned solution with the representation of rich details, should a contributor want to introduce them.
- Integrate formal and informal structures as well as technical and social aspects.
- Indicate vagueness (for example if it is not clear which sub-activities are part of a task or under which conditions these sub-activities are carried out).
- Represent conventions, interests, and multiple perspectives.

SeeMe helps to describe the interaction between people and physical or technical objects of the world, and therefore differentiates between three basic elements (see Figure 1):

- ***Roles*** (e.g. end-user, STWT-Team) which represent a set of rights, duties and responsibilities as they can be assigned to individuals, teams or organizations by reciprocal expectations. Roles represent the social aspects and relations.
- ***Activities*** (e.g. running a workshop) which are carried out by roles or characterize the transitions between states of machines. They stand for the dynamic aspects which represent change, such as the completing of tasks, functions etc.
- ***Entities*** (e.g. SeeMe-diagram) representing resources used or modified by activities, such as documents, tools, computer systems, programs, items from the physical world.

Table 1. Practical projects as a basis of the continuous development of the STWT-Method

Case	Maximum number of Participants	Workshops	Diagrams**	from-to	Results
Knowledge management for a training company	4 + 2* (trainers and office assistants)	4	8	04/99 -07/99	complete requirements specification + new software (SW)
Development of a training concept for a print workflow	6 + 2* (print-technicians)	5	18	07/99 -01/00	training was conducted
Introduction of library software	8 + 1* (members of a university library team)	10	35	11/00 -05/01	organizational change instead of SW-replacement
Knowledge management for consumer counselling	4 + 1* (incl. IT-specialist and job steward)	4	5	02/01 -10/02	software role out but less usage than expected
Mobile communication system for a logistics services company	10 + 3* (incl. 3 dispatchers, 2 drivers, 2 SW-Engineers)	4	10	12/02 -03/04	explicit concept, complete prototype but no sw-introduction (due to management strategy)
Groupware for collaborative ordering of scientific journal papers	10 + 2* (incl. 2 student workers from library team, 1 software-engineer)	5	17	07/03 -08/05	SW usage and continuous improvement for three years
Software for the exchange of radiographies	5+1* (incl. 1SW-engineer, 2specialists, 1job steward)	25	31	01/05 -05/05	new SW introduced, ensuring high reliability
Knowledge management for steel pipe manufacturing	17 + 2* (incl. 8 technicians of pipe welding team, 1 job steward, 1 IT-specialist)	8	4	05/06 -11/06	new SW introduced, need for more explicit quality improvement activities was accepted
Knowledge management for switch-housing contract manufacturing	11 + 2* (incl. 2 welding engineers, 2 IT-specialists)	8	7	04/07 -12/07	new software introduced, knowledge sharing and work processes improved
Knowledge management for a prop-shafts assembly plant	10 + 2* (incl. 2 quality assurance, 2 assembly men)	6	5	08/07 -12/07	No software introduction but increased mutual knowledge base
Analysis of IT-based production of digital air photo maps	3 + 3* (incl. 1 manager, 2 technicians)	8	8	10/07 -02/08	Preparation of establishing a new branch in a new country

* facilitator, researcher, assistants or SeeMe-Modeller;
** only diagrams with more than 20 elements

Elements can be embedded into other elements: a sub-element is part of a super-element. Sub-roles can represent parts of the organizational structure of a more complex role as shown in Figure 1; entities can contain their components as sub-entities. Sub-elements can contain further sub-elements.

It is useful to differentiate between whether a super-element is completely described by its sub-elements or only partially. In the latter case, incompleteness is indicated by a semi-circle. It is *empty* if the incompleteness is intentional; *three dots* indicate that we do not know enough to complete the specification and that further research is required. A *question mark* indicates doubts about the correctness of the used sub-elements.

SeeMe offers nine standard relations represented by arrows. Their meaning depends on the types of elements being connected and on the arrow's direction. The most used relations are (Figure 1):

- The role ***carries out*** [1] the activity.
- The activity ***influences*** [2] the role (e.g. end-user).
- An activity produces *or **modifies*** [3] an entity (diagram).
- An entity (editor) ***is used by*** [4] the activity.
- An activity ***is followed by*** [5] another one.

Relations can be connected to super-elements or to one of its sub-elements (that means crossing the border of the super-element). If a relation is connected with a super-element, it also refers to all of its sub-elements. Relations can be **incompletely anchored to elements**: If it is not clear whether a relation refers to the whole super-element or only to a subset of its sub-elements (and to which of them), the **relation crosses the super-element** (STWT-team in Figure 1) and is not connected to a distinctive sub-element. In figure 1, the facilitator is responsible for the entire activity while the other team members only carry out an unspecified set of sub-activities.

Relations **can be left out**, for instance between sub-activities if it is not clear in which sequence they occur. Figure 1 displays two perspectives: in the lower one, the activities of running a workshop are strictly sequenced with the relations, while the upper case (without arcs) indicates that they can be freely combined. The two perspectives are separated by a **segment line**. With segments, the modeler can juxtapose different views of a phenomenon within the same element. The two perspectives are also an example of how the degree of structuring can vary in a diagram.

Relations can be combined with logical **connectors** (depicted as rhomboids). Typical logical constellations are "or", "xor" or "and". However, the **logical type** of a connector can be left **unspecified** if its meaning is clear from the context of a diagram, or if it is not reasonable to be more precise.

If relations are logically connected with "OR" or "XOR" (Figure 2), it depends on **conditions** or events whether a certain relation is instantiated. In many cases, this decision can be clearly derived from the context. If not, so called **modifiers can be annotated** (hexagons in Figure 2). **Modifiers can** also **be incomplete**: they can be empty if we only know that the instantiation of an element or relation depends on a condition but the condition is unknown or unstable. Unspecified conditions (empty hexagons) can be used to express **freedom of decision** as shown by case b) of Figure 2. Case a) is controlled by the explicit specification that all contracts with a value higher than 5000 are checked by a supervisor. Including a check can then be en-

Figure 1. Basic elements of SeeMe

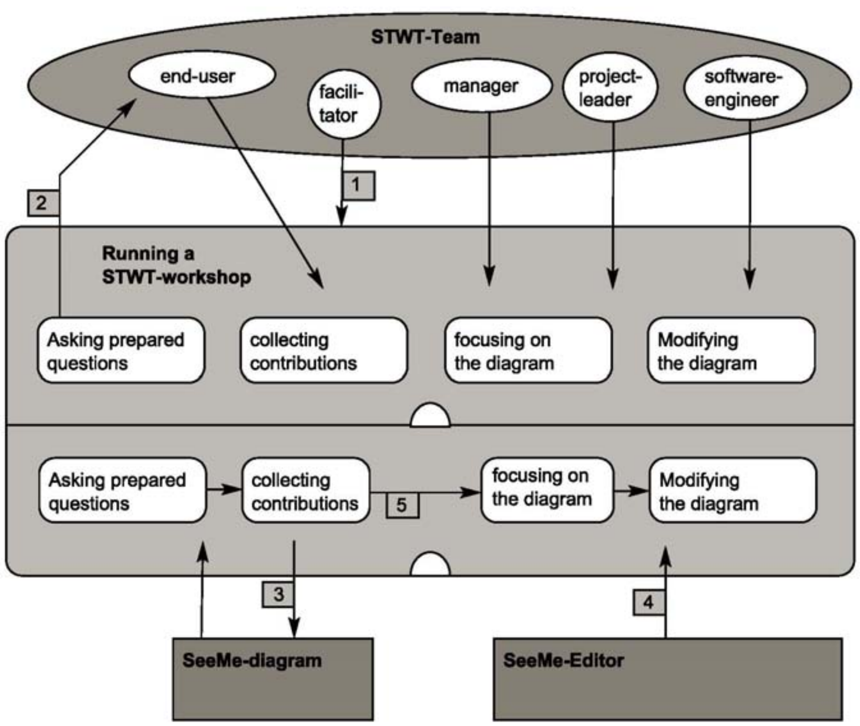
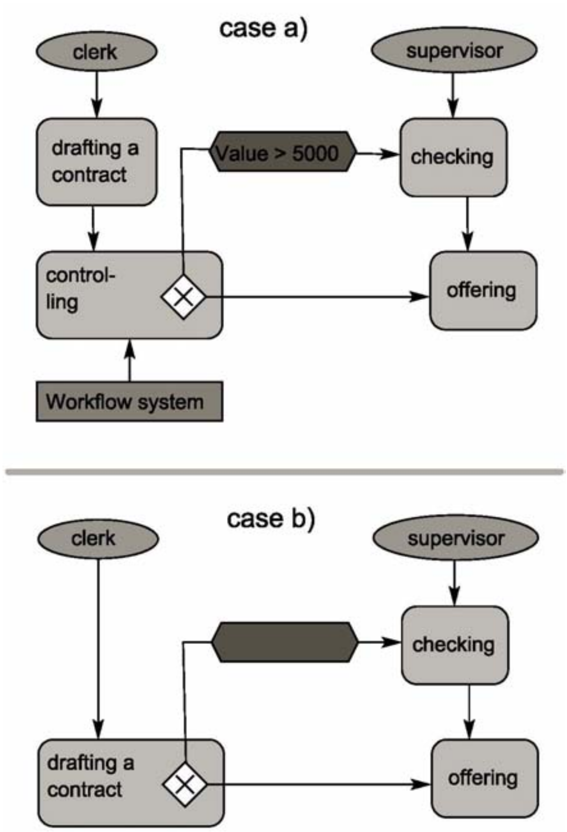


Figure 2. Control vs. freedom of decision



forced by a workflow system. By contrast, in case b) the condition is empty and the meaning of the empty hexagon is that the clerk decides ad-hoc whether a checking of the contract is necessary.

SeeMe is constructed in a way that it is flexible in both directions: it can be used to express vague, informal structures and it can support formal specifications which are similar to UML-activity diagrams, flow charts, eEPC (Scheer, 1992) or entity-relation-diagrams (Moody, 1996). The strength of SeeMe—if it is compared with other methods—is the possibility to express and indicate vagueness. Furthermore, it is not exclusively focused on the interaction with the technical system, as is the case with use-case diagrams in UML which can also be considered as a means to support informal drafts. By contrast, SeeMe supports the presentation of entire processes and work settings. Compared with methods which are similar to flowcharts, SeeMe has been extended by adding the possibilities for embedding sub-elements. Furthermore, SeeMe is not restricted to only presenting a view on selected aspects such as functionality, data, organization or flows, but can also integrate these views. SeeMe is compatible with other, more formal methods, since it can mimic structures as they can be found in activity diagrams, eEPCs or in flow charts; it can represent many structures which are needed for programming.

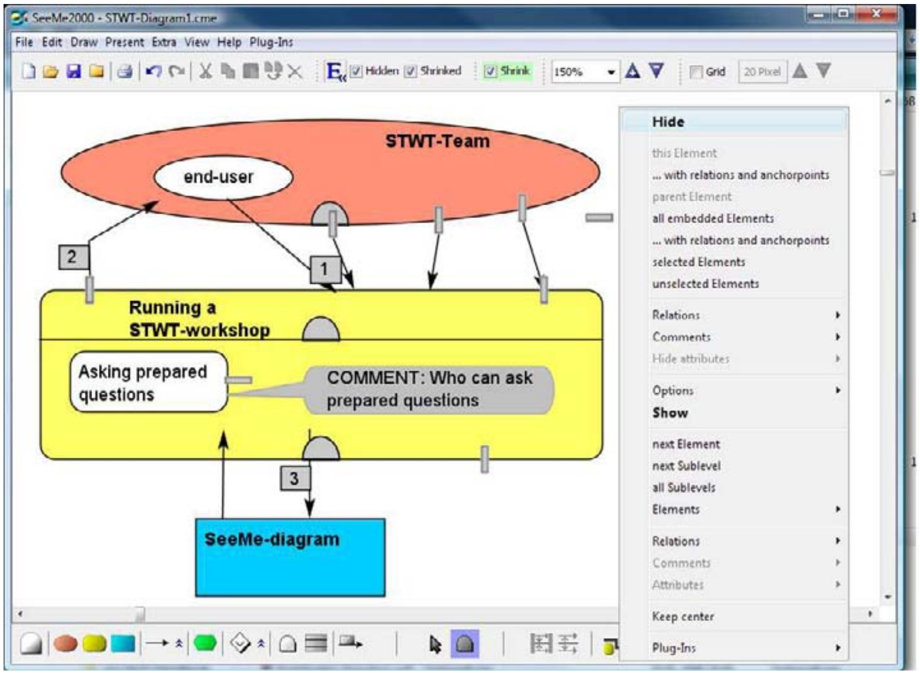
Vagueness can either be retained or gradually eliminated in the course of socio-technical design when the concepts mature. Those parts of the diagrams where all involved stakeholders know how they could be completed can remain incomplete. If the context and conditions of the software usage vary from case to case so that no persistent decision can be made of how to overcome the vagueness, incompleteness is also sustained.

The Socio-Technical Walkthrough (STWT)

STWT supports a series of workshops which are the basis of a participatory design process. It is mainly used to design concepts for the development and usage of systems which support cooperation and coordination.

The outcome of the participatory design is a concept or an outline of a socio-technical system which is represented by a set of diagrammatic models. These models are either developed from scratch or derived from existing work processes by gradually modifying a diagram with respect to the technology to be introduced. A model has to be inspected step by step before it is considered as the final solution. Therefore the model of the socio-technical system is incrementally modified at every workshop. The STWT can be compared with, and is partially inspired by, the “Cognitive Walkthrough” (Polson, Lewis, Riemann and Wharton, 1992). However, these two methods mainly support the tasks of a single evaluator while the STWT includes several participants and combines evaluation with design. The selection of the STWT-participants is a critical factor: end-users, project-leaders, representatives of

Figure 3. Hide mechanisms applied to Figure 1: The SeeMe-Editor with context-menu



the software-developers or other technical experts, and possibly members of the management board have to be included.

The participatory development of a socio-technical system usually needs a whole series of workshops. The first walkthrough has to be prepared by deliberately eliciting the characteristics and achieving an understanding of the field where the socio-technical system is to be established or adapted. The preparation includes the decision of how the whole participatory process should start and with whom. Since all types of participants must easily become familiar with the diagrams, SeeMe is constructed in accordance with the principle of "low threshold high ceiling": The three basic elements and some elementary types of relations are usually sufficient to start; afterwards, more complex notation elements can be introduced to express specific concepts.

The first workshop may start with the task of achieving a mutual understanding of the work procedures. Further walkthroughs collect information about relevant aspects such as documents being used and produced, types of current technical support and possibilities for improvement. In a follow-up workshop it is asked for the needs and possibilities for supporting the work with information technology. This phase of repeated questioning is decisive for maximizing the requirements gathering. Finally, the evaluation of prototypes can be guided by the diagrams which depict the interactive relations between work and the IT-system. The series of walkthroughs should be concluded by ensuring that the participants agree on the consolidated models. There can be a fluent transition to the training phases which are needed to adopt the socio-technical system—especially by those who were not able to take part in the participatory process. "Walking through the models" is a suitable means of conducting training.

STWT-workshops are characterized by the following facilitation activities (cf. Figure 1):

- **Getting started:** The facilitator usually prepares a diagram representing the results of the previous work. It is reasonable to begin with an overview diagram and to proceed with a strategy of how to inspect the complete diagram step by step.

- **Asking prepared questions:** The facilitator discloses some parts of the diagram by using hide-and-show mechanisms (cf. Figure 3). Each phase of such a disclosure is one step (of about 7-15 per workshop) which is accompanied by one or two prepared questions such as: "What is the next sensible activity?", "Which information support is needed for this activity?".
- **Collecting contributions:** The facilitator collects the answers, hints, proposals, comments, references to further documents etc. It is important that the stakeholders contribute their varying—and potentially conflicting—viewpoints and make comments.
- **Focusing on the diagram:** The diagram serves as a "boundary object" (Star, 1989) which integrates the varying perspectives of the participants into a larger picture. Therefore, the facilitator makes sure that the collected contributions are inserted into the diagram, which is used to focus the participants' discussion and attention.
- **Dealing with conflicts:** Making differing *positions comparable* and visible helps to deal with conflicts and to "*support congruence"* (cf. Cherns, 1987, p. 158*)*. The possibility of intentional vagueness allows the participants to express "*several routes to the same goal*" (Cherns, 1976, p. 788), or as Coakes (2002, p. 7) writes the "*...same function can be performed in different ways"*. Depending on the social context, the eventual solution to a conflict is found by negotiation or by a decision of the management. These decisions can also be postponed until first practical experience with the socio-technical solution has been made.
- **Modifying the diagram:** Inserting the contributions into the diagram leads to a continuous documentation of the incrementally developed concept and provides the opportunity to represent the different requests for change. The incremental development is made visible so that all the participants can check whether their proposals are documented or not.

The socio-technical project continues between the STWT workshops when the diagrams, which include all the comments, have to be aesthetically improved, checked against the audio-recording of the workshops, and linked to additional documents. The coordination with the software-engineers goes on. They usually explain their needs for further specifications and reduction of impreciseness.

It became apparent during the case studies that certain technical features, which support the editing and presenting of the diagrams, are indispensable. With the SeeMe-editor, sub-elements and/or relations can be temporally hidden and then shown again step-by-step to support the walkthrough. An invisible sub-element is indicated by a grey semicircle; a hidden relation appears as a grey, thickened residue of the arc. Fig. 3 shows a version of Figure 1 after the hide-function has been applied. The hiding of sub-elements can be used to shrink the diagram. Varying appearances of a diagram can be stored in snapshots and can then be displayed like a slideshow. Furthermore, the SeeMe-editor provides features to add free text and comments to the diagrams, to draw geometrical dividers into a diagram (e.g. to depict 'swim lanes'), and to insert hyperlinks which allow the facilitator to show additional information or illustration. Initially we started with paper and pen material which may invite the participants to a more direct modification of the representations. However, electronic support offers more flexibility: "*Unlike passive design materials, such as pen and paper, computational design materials are able to interpret the work of designers and actively talk back to them*. (Fischer, 2004, p. 158)".

Case Study

In a case study we (Herrmann et al., 2004a) accompanied a company which planned to improve the communication and coordination processes between dispatchers and truck drivers with mobile information technology. The company, which offers logistics services, also intended to improve its business processes.[1] The unit that is involved in the case study is called “steel-delivery”. “Steel-delivery” is a team of seven dispatchers working in offices in three different towns, 17 drivers and a team-leader who also used to work as a dispatcher. Two managers from the logistics-company’s head office have advisory functions for the team. They are responsible for the complete delivery logistics of a large steel trading company. The dispatchers of “steel-delivery” receive purchase orders from the steel trading company and assign them to delivery-tours for the drivers who load their trucks according to the pile of purchase orders. They are on the road for between 4 and 10 hours a day. Only in the case of irregular events do they communicate with the dispatchers during the tour. Before and after their daily tour, the drivers come into the office to hand in the documentation from their last tour and to receive the paperwork and additional information for their next tour.

The project’s main goal was to design, implement and test a technical infrastructure which supports the communication and coordination between drivers and dispatchers. The research goal was to apply and to improve the STWT method. The project had four phases (Kunau, 2006):

In phase 1) ethnographic methods were used to understand “steel-delivery” and to develop a starting point for the STWT workshops. This included 9 days of accompanying and observing the work of dispatchers and drivers. Additionally, interviews and analysis of documents were conducted. The results of the first analysis were documented in written notes, on tape, as photos and in one large diagram.

STWT-workshops started in phase 2) in order to receive feedback on the analysis of the status quo, and began by eliciting the requirements for the software prototypes from a socio-technical viewpoint. In phase 3) we combined socio-technical diagrams with a work-oriented evaluation of GUI-prototypes. In phase 4), STWT-workshops were used for training purposes.

All in all we conducted 4 STWT-workshops. Because of organizational restrictions, not always the same participants could take part; but we usually had two people representing the drivers and up to three representing the dispatchers. In addition, a software developer, a manager of the head office and the local team leader were present at almost all workshops.

Figure 4 and 5 mirror the development of the technical solution. They both refer to the so-called “daily-report” which has to be continuously updated by the drivers during their tour. For example they have to note the name and town, times of arrival and departure, the mileage etc. for each customer. Originally, the “Daily-Report” was solely paper work for the driver. During the elicitation of the requirements in phase 2), the diagram shown in Figure 4 emerged. It includes the idea that the system could automatically read data such as the mileage from the truck’s data interface. The drivers have to complete the data by entering whether a delivery has been successful or was disturbed by problems. Subsequently, the dispatcher can access the data at any time. Fig. 5 is then taken from phase 3) and shows the screenshot with which the drivers can enter remarks about their jobs into the system. The drivers working steps during the process of delivery are refined in Figure 5 and related to the screenshots of the mobile devices. This refinement was triggered by the question: “How could SpiW-Com support this working step?”

In the original workshop setting the diagram and the screenshot were not integrated in an overlapping mode as shown in Figure 5. However, it became apparent that this is a useful feature which is now available with the SeeMe-editor. Since about 10 of the diagrams became very complex it became clear that the facilitator should be supported by an extra person who modifies the diagrams.

A problem within this case study was the coordination with the software developers who had expected more formally specified requirements and preferred software engineering oriented modeling methods, such as UML. It is important that a representative of the software developers takes part in every STWT-workshop. During the workshops the usage of indicators for vagueness proved as being necessary and helpful. The semi-circle in the “data”-entity in Figure 4 is only one example.

Figure 4. New work process at the customer's site (Herrmann et al., 2004a, p. 135)

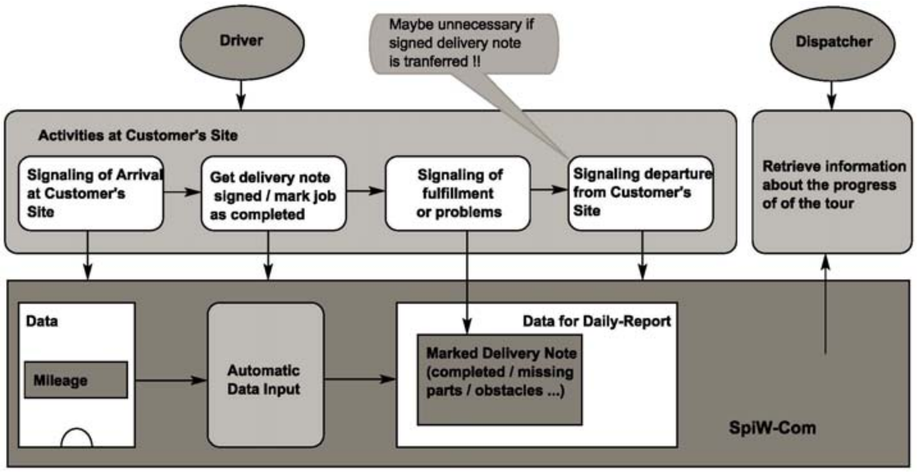
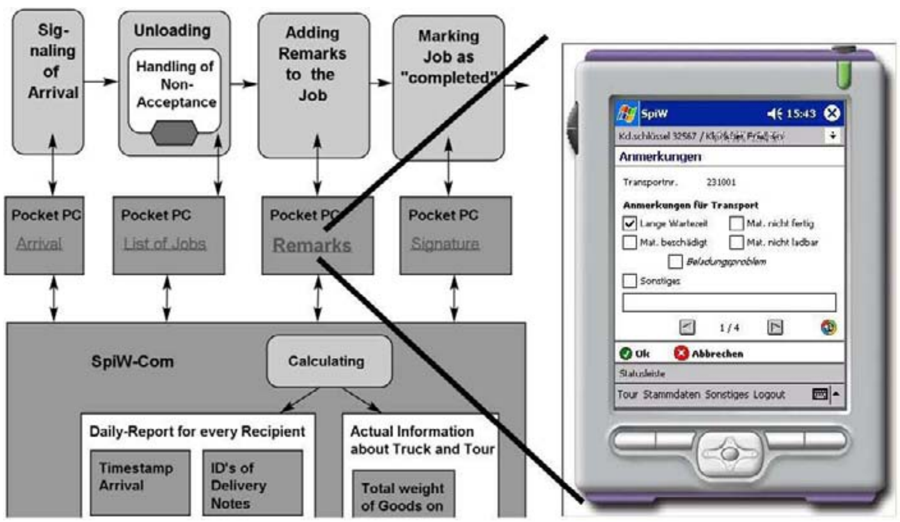


Figure 5. Relating activities to prototypical screen shots (Herrmann et al., 2004a, p. 135)



It indicates that "mileage" is only one type of data which is automatically retrieved and that it remains an open question as to whether other types of date could be automatically entered.

The findings of the case study are repeatedly challenged by the question whether the participants were really able to understand the diagrams. It became apparent that they comprehended the models, since they related their statements to the diagram, pointed to its details, expressed doubts about its appropriateness, or made proposals for changing it.

Lessons Learned and Directions for Further Research

The STWT and the semi-structured modeling with SeeMe proved useful to develop concepts for socio-technical systems in several practical cases. It can be considered as a success factor that the design teams were inspired to project their thoughts into real as well as planned work processes to consider the interaction with technical components step-by-step. The following quotes from participants characterize the impact of the STWT:

Comments with respect to the modeling method (Kunau, 2006, p.222):

- **Project-Leader:** "When I look at it after a workshop, the systematics of the models is much easier to understand; the same would be true for an outsider …"
- **Software engineer:** "… the modeling is helpful.… For each method there are advantages and disadvantages. … The advantage [for SeeMe] is that the notation can describe weakly structured work procedures - that is obvious. But that also creates the disadvantage: certain analyses that are based on certain formalisms cannot be made."
- **Driver 1:** "I quite liked that [documentation]; it was helpful for me to get a better, even better picture of the system, to become more familiar with it. Because it became more complicated, ..."

Answers to the question (Kunau, 2006, p. 200): "Now, after the workshop, do you consider it necessary and sensible that dispatchers and drivers establish rules for their cooperation with the new software?"

- **Project-leader:** "I regard it as very necessary because otherwise everybody would interpret and use the system differently."
- **Manager:** "I find it quite sensible because by doing it we have cleared controversial issues in advance."
- **Driver 2:** "That is very important because otherwise the whole system would not work."

From the perspective of the case studies, the main questions which are left for further research deal with the appropriate selection and involvement of the participants, in particular if there are more stakeholders than can reasonably take part in the STWT-workshops. Furthermore, the interaction with the software-developers needs to be improved. Although it was an advantage during the workshops that a modeling method which helped all kinds of participants to express more complex structures and interdependencies was used, a transformation into more software-engineering-related representations has to be supported. Therefore, it is a reasonable goal to provide a semi-automatic transformation of SeeMe into other modeling concepts which are more directly related to the support of programming. Such a transformation has to include dialogue features which help to complete unspecified parts of the diagrams by asking for missing information.

Besides these problems it can be advantageous to extend the STWT-method to the phases of maintenance and continuous improvement of socio-technical systems. SeeMe diagrams can become a means to support design in use (Henderson & Kyng, 1991) or meta-design (Fischer & Giaccardi, 2006). The need for modifications, can be documented within SeeMe diagrams, as well as the changes which have been made. Furthermore, a collection of SeeMe-diagrams and the history of their adaptation during use could form a basis to extract useful patterns of socio-technical constellations and dynamics which have been successful in previous projects.

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KEY TERMS

Contingency: Characterizes those relations between a stimulus and a system's reaction which are possible but not necessary.

Semi-Structured Modeling: Systematic description of a socio-technical system which combines context-free specifications which vague descriptions.

Socio-Technical Diagram: Graphical representation of a system which can be based on a predefined modeling notation.

Socio-Technical Documentation: All kinds of representations, including diagrams, which describe the structures and processes of the interplay and integration between a social system and its technical components.

Stakeholder: all roles which are affected by or have an interest in a socio-technical system

Vagueness: Incomplete specifications within the documentation of a socio-technical system which are either incomplete or possibly, but not necessarily, incorrect under certain conditions.

Walkthrough: Deliberate inspection of the documentation of a system which applies step-by-step a selected set of prepared questions.

ENDNOTE

[1] The case study was funded by the German Government (grant 01HT0143) in the context of "work in the e-business".

Chapter XXIV
Applied Pragmatism and Interaction Design

Anders I. Mørch
InterMedia, University of Oslo, Norway

ABSTRACT

This chapter presents a translational approach to socio-technical design, as a new approach to the theory-based design of user interfaces, supported by a multi-stage process. A survey of the early work on theory-based design in HCI identifies the strengths and limitations of this approach. This new approach extends HCI with a socio-cultural perspective, and adopts creative practices from the fields of architecture and furniture design. The process consists of three stages: selection, appropriation, and translation that "map" elements from the socio-cultural domain to the HCI domain. Two interactive systems are used to illustrate the process, informed by ideas of American pragmatism. The chapter ends by discussing the strengths and limitations of the translational approach, and points out directions for further work.

The "Copy Principle" accounts for the origin of all ideas.

—David Hume

Which is why "originary" must be understood as having been crossed out.

—Jacques Derrida

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INTRODUCTION

In the fields of Human Computer Interaction (HCI) and Computer Supported Collaborative Learning (CSCL), theory-informed design has been influential but under-articulated. Two examples will illustrate the intimate connection between theoretical ideas and interaction design to argue for the importance of further research on theory-informed design. *Affordance* (Gibson, 1977; Norman, 1988) and *scaffolding* (Vygotsky, 1978; Wood, Bruner & Ross, 1976) are two ideas that have developed over a long time in psychology and education respectively, starting before computer applications become fashionable. In spite of a lack of direct connection between these ideas and computer applications, they have had an enormous influence on the design of human-computer interfaces in HCI and CSCL. However, there have been few attempts to map these two domains in terms of a multistage design process. Previous attempts at theory-based design of user interfaces took a different direction (e.g. Card, Moran & Newell, 1983; Polson & Lewis, 1990), which I return to later in this chapter.

Gibson (1977) defined affordances as all "action possibilities" latent in objects in the environment. They are independent of the individual's ability to recognize them and can be "objectively" measured. In order to be useful for interaction with users, the objects provide a subset of their affordances each time they are used. This is a result of different users interacting differently with the environment. For instance, a chair in a winter cottage might be used to sit on, to stand on to reach items on the wall, or as firewood when it is cold and there is shortage of dry wood in the vicinity. Norman (1988) appropriated the term "affordances" in the context of HCI to refer to just those action possibilities that are readily perceivable by a user (i.e., having a relational rather than dualistic meaning). It is Norman's adaptation that has been adopted by interaction designers. This is probably as a result of his emphasis on the cognitive capabilities of the user, which is the dominant perspective in HCI. It makes the concept dependent not only on the physical features of the objects and the perceptive and reactive capabilities of users, but also on their goals, plans, values, beliefs, memories, and past experience.

Vygotsky developed a theory of how children learn and develop in the context of interacting with more capable persons. His idea is that the potential for cognitive development is limited to certain stages of development, which he calls the Zone of Proximal Development (ZPD). This refers to the gap between what a given child can achieve alone—i.e., their potential development as determined by independent problem solving—and what they can achieve through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978).

Several authors have pointed out the connection between the notion of scaffolding and Vygotsky's ZPD concept. It was Wood, Bruner and Ross (1976) who first coined the term "scaffolding" to describe the tutorial interaction between an adult and a child. The term was used as a metaphor to explore the nature of the support provided by an adult for children learning how to carry out a task they cannot perform alone. A result of this was a method for effective tutoring in terms of instructional techniques aimed at engaging and keeping the learner on task—for instance, to reduce the degree of freedom when the design space is large, provide direction towards a solution, highlight critical features, and give examples and demonstrations of partial solutions (Wood, Bruner & Ross, 1976). This approach has stimulated the design of computational scaffolds for educational technology, ranging from intelligent tutoring systems to web-based learning environments.

A goal of this chapter is to harness the under-articulated process of theory-informed interaction design, and to incorporate this as part of the first version of a process model of *socio-technical interaction design* (STID). Academically, this is situated in the intersection of HCI and the socio-cultural approach to research (Wertsch, 1991), thus extending the previous work in theory-informed design in HCI through a broader theory domain (social sciences rather than cognitive sciences). The sub-goals are to express socio-cultural theories in everyday artifacts, and to enhance communication of significant ideas of the past to students of today through interaction with technology.

This interest of mine was prompted by a retrospective analysis of two interactive systems I have been involved in designing over a number of years (a design environment and a collaboration interface). These systems were inspired by the ideas of Pragmatism, a branch of early American social science that began in the late 19th century and is associated with the works of Pierce, James, Dewey, Mead, and Schön, among others. Pragmatism is characterized by an interdisciplinary approach, i.e., many of the early contributors were associated with multiple disciplines such as philosophy, psychology, sociology, education, and urban design. Within each discipline and their intersections, these contributors developed far-reaching insights.

Pragmatism has implications for practical action, collaboration, learning and design, which are equally valid today as when the ideas were first introduced. These theories contain insights that are useful to interaction designers in HCI and CSCL, and there is plenty of room for more research. I use the phrase "applied pragmatism" in the title of the chapter. By this I mean the subset of ideas developed in the tradition of American pragmatism, and by later followers like Donald Schön, with the potential for technology application. In particular, we (the author with collaborators and students) have "operationalized" two of these ideas into interaction design (user interfaces for computer applications). The ideas are generalized-other (Mead, 1934) and reflection-in-action (Schön, 1983). Whereas these ideas have numerous sociological, psychological, and educational *implications* (as judged by a large amount of secondary literature), they are not often thought of in terms of technological *applications*.

Socio-technical systems (STS) can be interpreted in many ways. It is beyond the scope of this chapter to do a complete survey of past work on STS. In the context of this chapter STS is understood as the evolutionary creation of shared environments with a focus on the interaction between social and technical components, as seen from the perspective of participation by multiple stakeholders in systems development, such as developers and users (Ye & Fischer, 2007), and how theories from the applied social sciences can inform the design of computer-based tools (Mørch, 2007). The latter interpretation of STS is developed in this chapter in the form of a multistage process cast within a sociotechnical design space. This space is marked by a source (theory) domain and target (technical systems) domain. Separate stages are *selection*, *appropriation* and *translation*. Selection is the location of the source domain, appropriation is the adoption of ideas from the source domain into the target domain (Dittrich *et al.*, 2005), and translation is the step-by-step work to build a concrete instantiation in the technical domain (interaction design). See Table 1.

In sum, by socio-technical systems design I mean the appropriation of ideas from the applied social sciences to motivate and guide (with affordances and constraints) interaction design. The ultimate success criterion is to be able to communicate complex ideas to end users through the resulting designs.

The following research questions guide the work reported in this chapter:

- How can we trace the development of abstract objects (theoretical ideas) into concrete artifacts in terms of evolution and participation?
- What methodological support (guidance, model) is needed during the early (creative) stages of design before designers start to think in terms of technical (software) objects? What other fields of design can we learn from in this regard?

The rest of the chapter is organized as follows. It starts by giving a survey of theory-based design in HCI. Next, it presents the design process behind an award-winning chair in the Nordic design tradition to provide an example of creative appropriation in the early phases of the design process. This is followed by an example of "externalized design,"

Table 1. Generic translation table for three-stage socio-technical interaction design process

Stage	System
Selection (theoretical idea)	Name of idea (name of author)
Appropriation (design context)	Interpretation of idea and breakdown into smaller units
Translation (GUI objects; configuration)	Creation of user interface based on idea units

a technique from postmodern architecture, which provides a model for how to incorporate external (non-computational) objects into user interfaces. Based on this, a three-stage process is suggested (selection, appropriation, translation). This process is applied to the retrospective analyses of two interactive systems (Janus and FLE-Assistant). The analysis reveals the strengths and limitations of the approach. Finally, lessons learned and directions for further work are discussed.

Theory-Based Design

Theory-based design (TBD) of interactive systems is a design approach first proposed in HCI (e.g. Card, Moran & Newell, 1983). The basic idea is that a theory, theoretical idea, conceptual model or a set of related concepts provides the starting point for a design process. What makes this controversial (and challenging) is that the theory should originate in a field outside of computer science, often in the human (psychological) sciences (the source domain of early HCI), or the social sciences, which is more common today with, for example, Activity Theory (Kaptelinin & Nardi, 2006). The phrase "theory-informed design" is sometimes used instead of theory-based design. I do not make a distinction between the two phrases here. The survey below focuses on the development of theory-based design principles for user interfaces.

Design Principles for User Interfaces

A branch of theory-based design in HCI can be traced to work done at IBM and the University of Colorado in the mid 1980s. Polson and Lewis (1990) proposed a design based on psychological theories and cognitive models. The goal was to build a formal theory of exploratory learning that could assist in the design of easy-to-use interfaces. From the theory, Polson and Lewis derived a list of design principles they could employ to design user interfaces (Lewis *et al*., 1990). Four of the seven design principles derived from this theory are:

- Make the repertoire of available actions salient
- Provide an obvious way to undo actions
- Offer few alternatives (to prevent wrong moves)
- Model tasks that require as few choices as possible (Lewis *et al*., 1990)

The success of these and related design principles has made them useful for specific platforms. For example, Apple Computer and IBM created similar guidelines for supporting user interfaces within their GUI frameworks. These guidelines tended to be either too general and open-ended, like those used in IBM's 1984 Olympic Message System (Gould *et al*., 1987), or, like the Macintosh Human Interface Guidelines (Apple Computer, 1987), they gave very detailed specifications for how to select (GUI) components, how components should look on the screen, and what behavior they should exhibit in applications. Critics at that time considered these design principles severely limited in applicability and a passing fad in research, favoring consistency over exploration (Grudin, 1989).

When looking back at the evolution of the field, the design principles movement in HCI gradually turned into research on *evaluation criteria*. The application of Polson and Lewis' work is a good example of this. Their frequently cited cognitive walkthrough methodology is an evaluation technique, and it was developed on the basis of the above-mentioned theory and corresponding design principles (Lewis *et al.*, 1990). Another influential evaluation technique for user interfaces is heuristic evaluation. This can also be traced to the design principles developed in the late 1980s.

In sum, the strengths and limitations of design principles to support design of user interfaces are as follows:

- **Strength:** Design principles are useful for specific platforms and GUI frameworks when the action space is large and there are expectations that user interfaces are consistent with respect to given standards and conventions.
- **Limitation:** The same set of design principles can be derived from multiple sources, each of seemingly legitimate origin, e.g., psychological theories, empirical findings (user needs), and informed guessing based on design experience. The importance of theory to support design was not adequately demonstrated.

Externalized Design

In the work surveyed there is no explicit rationale for theory-based design in HCI (i.e. why theory-based design is important), except to build a scientific foundation for HCI, and the stages passed through when translating theoretical ideas into concrete designs were not elaborated or problematized. We address these two issues in the remainder of the chapter by developing an approach to theory-informed design based on an analogy to creative practices in two design fields that interaction design can be compared with—furniture design and architecture of buildings (Hooper, 1986; Norman, 1988; Ehn, 1999).

Furniture Design

The design process of chairs is characterized by integrating creativity with utility. Utility (usability, usefulness, and domain-specific needs) is as important to furniture designers as it is to interaction designers. For example, a chair that is uncomfortable will not be used, but one that is comfortable will be. More importantly, and as result of the abundance of comfortable chairs in the world, furniture designers have to bring innovation into their designs to succeed in competition with fellow designers. The Nordic designer Olav Eldøy explained the role of creativity as the first and most important step of the following three-step design process (simplified for illustration):

1. Find a recognizable idea that can be expressed in physical form
2. Balance creativity against utility when building prototypes
3. Provide a construction that affords production and export

All phases were essential in the design of his award-winning Peel chair. The inspiration for this chair was orange peels falling to the ground (Figure 1). This turned out to be a realizable idea. The result can be judged by the degree of resemblance between the inspirational idea and the physical form and color of the chair. In contrast, finding a recognizable idea that can be expressed in computational form (interaction design) is not commonly associated with our profession. However, there is no intrinsic reason why it should not also be expressed in interaction design. Another example of the same phenomenon is described in the next section by distinguishing notions of inner and outer language.

Postmodern Architecture

Postmodernism in architecture is associated with architects such as Michael Graves (Wheeler, 1982; Patton, 2004). One of the buildings he is known for is the Portland Building in Oregon, USA (Figure 2). This building is one of a few that instantly became an icon for postmodern architecture. It is distinguished from the nearby buildings by external decoration and small cubic windows. The effect is a mix of modernism with older styles in an overall modernistic design. Graves contrasted it with modernist architecture in the following way:

Figure 1. Peel chair (2002). Orange peels falling to the ground inspired this design

While any architectural language, to be built, will always exist within the technical realm, it is important to keep the technical expression parallel to an equal and complementary expression of ritual and symbol. It could be argued that the Modern Movement did this; it expressed the symbol of the machine, and therefore practiced cultural symbolism. But in this case, the machine is retroactive, for the machine itself is a utility. So this symbol is not an external allusion, but rather a second, internalized reading. A significant architecture must incorporate both internal and external expressions. The external language, which engages inventions of culture at large, is rooted in a figurative, associational and anthropomorphic attitude. (Wheeler, 1982, p. 11)

The Portland building makes a distinction between external (artistic, symbolic) and internal (technical) expression. The "external language" Graves refers to consists of reflections of elements in the local surroundings, which are literally embodied in the building's façade. It consists of symbols professionals can relate to (e.g., small cubic windows on a light-colored background make one think of the Bauhaus, whereas the blue ribbons have an artistic or non-functional association).

The combination of expressions from a non-technical (external) language with the concrete material of the building forms the hallmark of the postmodern approach to architectural design. The two kinds of languages (internal and external) have direct implications for user interface design. A user interface is defined by an internal language (programming) as well as an external language (interaction design), although the latter is often not thought of as such. However, from the point of view of theory-based design, one can think of this in terms of two domains of discourse – one associated with the technical system and the other with socio-cultural theories. It is the expression of the latter into the former that can be seen as equivalent to the externalized design of buildings.

A Translational Approach

In order to adopt externalized design for interactive systems, the following claim is made. In the same way as nature, local surroundings and symbolic association have inspired architects and materialized in the built environment, theories, concepts, and terms (in sum, *ideas*) from the applied social sciences ought to provide the same kind of inspiration for interaction designers in HCI and CSCL. This claim is based on the following differences between computational and physical artifacts:

Figure 2. Portland building (1982). Reflections of elements in the local surrounding are embodied in the façade

- **Level of abstraction:** Computational artifacts like software components are abstract compared to physical artifacts like chairs (Kramer, 2007). This is manifest when software components are defined in terms of program code in addition to being visible objects for human interaction.
- **Theoretical foundations of HCI:** Theoretical ideas and conceptual models have been important to the success of many innovative user interfaces (see the Introduction and Theory-based design).

A multistage process for theory appropriation is presented below. It adopts the "architectural model" presented above and was inspired by the retrospective analysis performed by Carroll and Kellogg (1989) to identify the "myriad of claims and their interrelations" embodied in the Training Wheels and HyperCard interfaces, to determine how the claims were given coherence by being codified in software. Carroll and Kellogg used the term "psychological claim," instead of theoretical idea. A socio-technical approach puts more emphasis on cultural tools (Wertsch, 1991) and conceptual artifacts (Bereiter, 2002) than on cognitive artifacts (Norman, 1988; Carroll & Kellogg, 1989). In spite of this, cognitive artifacts have been important in understanding the design of interactive systems, and re-conceptualizing them in terms of cultural artifacts will bring a social dimension to that line of work.

The following stages serve as gradual steps of translation and placeholders (intermediate abstraction) for talking about the early (creative) phases of interaction design:

1. **Selection:** Any source of inspiration one wishes to explore for the purpose of realization into physical (computational) form. A criterion for selection is to be able to communicate the idea to others (designers and users). However, there are no intrinsic reasons for prohibiting certain ideas. In the work presented here, selection is associated with theories, and chosen from a domain outside computation and cognition (sociocultural theory).
2. **Appropriation:** From a socio-cultural point of view, appropriation has been defined as "the process of taking something that belongs to others and making it one's own" (Wertsch, 1998, p. 53). According to Wertsch, the path to appropriation is not always straight and smooth, but sometimes involves tension between what we appropriate and the way we use it within a particular context. Appropriation is the act of breaking down an idea so that it will stand out in a contemporary design context, and restructuring the elements to make a concrete design possible without distorting conceptual integrity.
3. **Translation:** This is arguably the most critical step, as it is the most revealing. It involves turning appropriated material into concrete design. An example is the translation of a conceptual artifact (e.g., key words) into a physical or computational artifact (e.g., GUI objects). There are multiple ways of accomplishing this, some better than others. To avoid "Kitsch design" (poor translation, misunderstanding of the original idea), evaluation criteria for assessing the quality of a translated idea are necessary.

In the remainder of this chapter this three-staged process is used for analyzing a design environment and a collaboration system.

Retrospective Analysis

The two systems presented below (Janus and FLE-Assistant) have developed over a number of years and have been written about in the literature, but they have not been profiled in terms of theory-informed interaction design. The theoretical idea that inspired Janus was reflection-in-action (Schön, 1983) and for FLE-Assistant it was generalized-other (Mead, 1934).

Reflection-in-Action and Janus

The Janus system (Fischer, McCall & Mørch, 1989; McCall, Fischer & Mørch 1990; Fischer *et al.*, 1991) is a design environment for kitchen design. It was inspired by Donald Schön's concept of reflection-in-action (Schön, 1983). This understanding resulted in the integration of two sub-systems with a design critique system.

Selection: Reflection-in-action (Schön, 1983) can be described as "thinking on our feet." Schön has examined this largely unarticulated, improvisational process in a study of practitioners in a variety of professional domains to identify how they explore design spaces and "communicate" with the domain materials for inspiration. It involves looking to our experiences, connecting with our feelings, and attending to our working theories. It entails building new understandings based on these things to inform our actions in new situations. From this perspective, the knowledge inherent in practice is to be understood as artful doing. In Schön's own words:

In a good process of design, this conversation with the situation is reflective. In answer to the situation's back talk, the designer reflects-in-action on the construction of the problem, the strategies of action, or the model of the phenomena, which have been implicit in his moves. (1983, p. 79)

Appropriation: Schön was primarily interested in developing a descriptive account of design activities, illustrating and explaining what designers do, identifying the importance of human collaboration in this process, and arguing for educational changes on this basis. Therefore, his ideas do not lend themselves to operationalization in an interactive system design. His concepts must be further interpreted and broken down into manageable chunks before they can be experimented with in terms of computer support. We considered "action" and "reflection" as the basic activities of a reflective practitioner, which form the basic components of computer support for reflection-in-action. For reflection to be part of reflection-in-action, however, it needs to be brought to the designers' attention during the "action present," and to provide answers to the situation's "back talk." In this respect, Schön's notions of "action present" and "back talk," intimately connected to reflection-in-action, have been interpreted to mean automated feedback from the work area the designer is interacting with immediately after an operation on a design has occurred. This is analogous to how a human design critic stands behind the shoulder of a student in a design studio and gives feedback on work in progress.

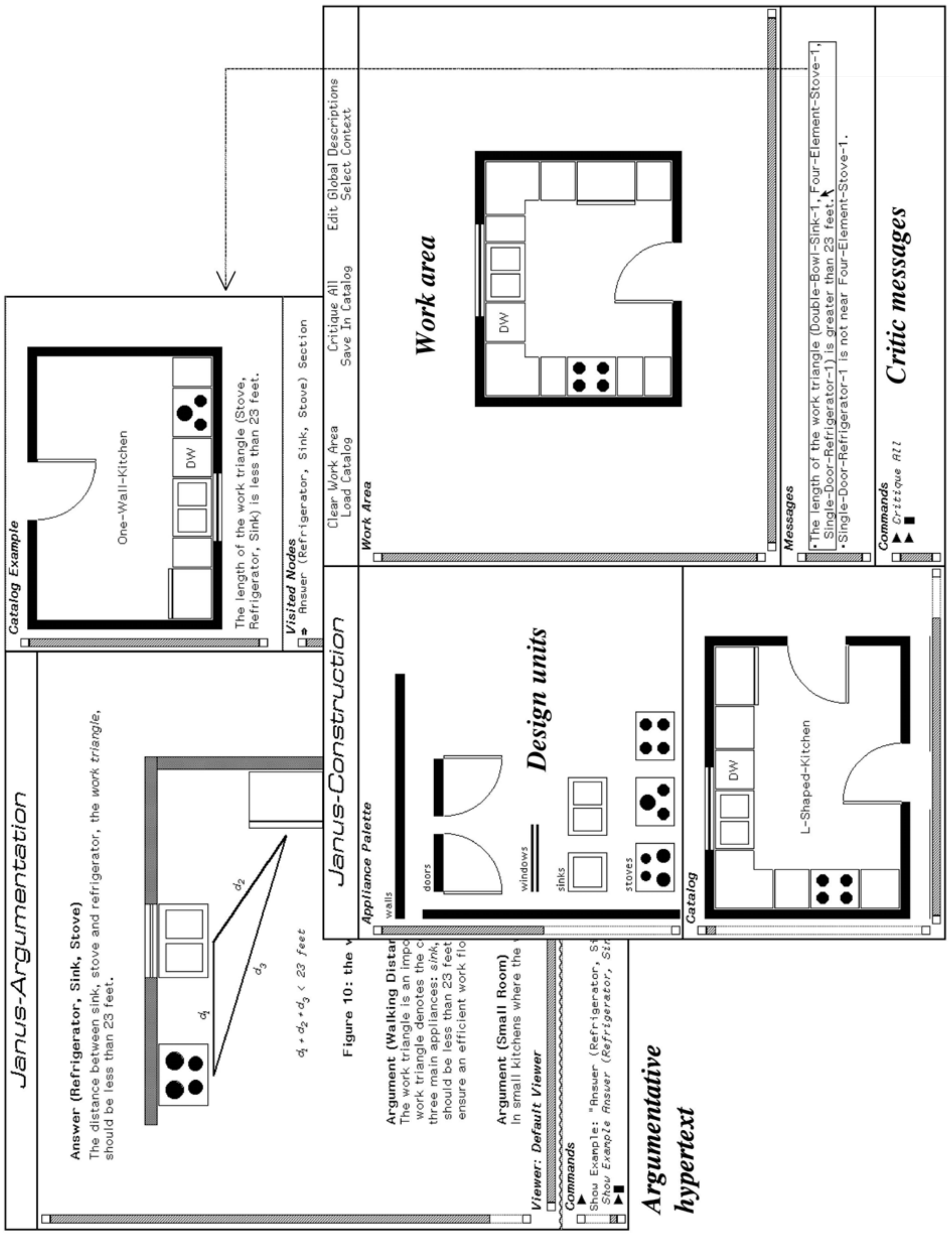
Translation: Janus consists of two separate interfaces, one supporting action (construction) and the other supporting reflection (argumentation), as seen in Figure 3. During construction, designers select "design units" from the palette and place them into the "work area." The critiquing component links construction and argumentation. Critics provide automated feedback, "critique messages," as shown in the lower right part of Figure 3 (Janus Construction), and they operationalize Schön's notion of "back talk." The "back talk" of the situation depicted in the screen image in Figure 3 tells the designer that the "work triangle" is greater than 23 feet. This may trigger reflection on how to incorporate a design recommendation into the design currently under development. The left screen image of the figure shows the argumentation interface. It is an early hypertext system based on the IBIS design methodology (McCall, 1991). It is hierarchically structured as issues, answers, and arguments, and represents the design rationale behind kitchen planning principles, and in this case shows a discussion of the various pros and cons of the work-triangle concept.

Generalized-Other and FLE-Assistant

FLE-Assistant (Dolonen, Chen & Mørch 2003; Mørch, Jondahl & Dolonen 2005) is a software agent that has been integrated with Future Learning Environment (FLE), a Web-based collaborative educational technology (Muukkonen, Hakkarainen & Lakkala 1999).

Selection: Conceptually, the FLE-Assistant interface was inspired by George Herbert Mead's

Figure 3. Janus provides computer support for action and re.ection with "back talk" triggered by critic messages



concept of the generalized-other (Mead, 1934). As one of the founders of American Pragmatism, Mead is known for using the metaphor of "playing a game" in order to understand aspects of human communication and learning while interacting with significant others. The generalized-other is a person's notion of the common expectations that others have about actions and thoughts in a particular community. Any time that a person situated in a community (known or foreign) tries to imagine what is expected of him in terms of what to do, he is taking on the perspective of the generalized-other. This perspective is more than the sum of individuals' actions in the community, or as Mead said it in the context of play:

In the game, the individual is required to internalize, not merely the character of a single and specific other, but the roles of all others who are involved with him in the game. He must, moreover, comprehend the rules of the game that condition the various roles. This configuration of roles-organized-according-to-rules brings the attitudes of all participants together to form a symbolized unity: this unity is the "generalized other." The generalized other is "an organized and generalized attitude" with reference to which the individual defines her own conduct. (1934, p. 151)

Mead proposed the "game" as a model for the social aspects of personal development. In playing and gaming, as in conversation and even collaboration, the key element to master is role-playing. Mead suggested that individual participants learn by internalizing both the "roles" of other players and the "rules" in order to combine them at a more abstract level into the "common attitude," or the expectations that others have about how one should act in the game. Role-playing in this context is more than mastering a specific role. It involves the ability to seeing things from another person's perspective, to act as though they were that person, using those perspectives for guidance. For example, a child may take the role of mother, doctor, nurse, etc. By doing this, the child may eventually be able to visualize the intentions and expectations of all others within a group and see itself not just from another's point of view but also from that of groups of others. The generalized other represents the "common attitude" of those groups.

Appropriation: Mead's notion of generalized-other is very useful when trying to understand motivation to act, resistance to act, and common point of reference in a group or community (f2f or online). To make use of this theoretical resource in the context of a virtual learning environment, the concept can be broken down into smaller units that can be interpreted in a contemporary context. It can mean engaging in a social learning situation by imitating and responding to unfamiliar gestures, gradually adopting the attitudes held by the senior participants (instructors and more capable peers) and their collaboration patterns, and eventually even surpassing them. This is one goal of the collaborative learning process. In our work, we have interpreted generalized-other to mean conceptual awareness (Mørch, Jondahl & Dolonen, 2005). This is related to but not the same as awareness of social interaction in collaborative environments (e.g. Bødker & Christiansen, 2006; Ogata, Matsuura & Yano, 2007). Conceptual awareness (Mørch, Jondahl & Dolonen, 2005) is social awareness presented at a level of abstraction as informed by the concept of the generalized-other.

Translation: A collaborative learning environment such as FLE has a set of rules governing interaction (suggested by the underlying pedagogical model). These rules are not straightforward for most participants and require practice (Ludvigsen & Mørch, 2005). There are also more specific roles that emerge in student inquiry processes, such as student, peer, assistant, coordinator, editor, web master, instructor, active/inactive/passive student, active/inactive/passive instructor, etc. When this set of roles-organized-according-to-rules or common attitudes is internalized and shared among other users it may improve individuals' participation and collaboration in the activity. This is an empirical claim we are testing by building and evaluating virtual learning environments. The interface of the combined system (FLE and FLE-Assistant) is shown in Figure 4.

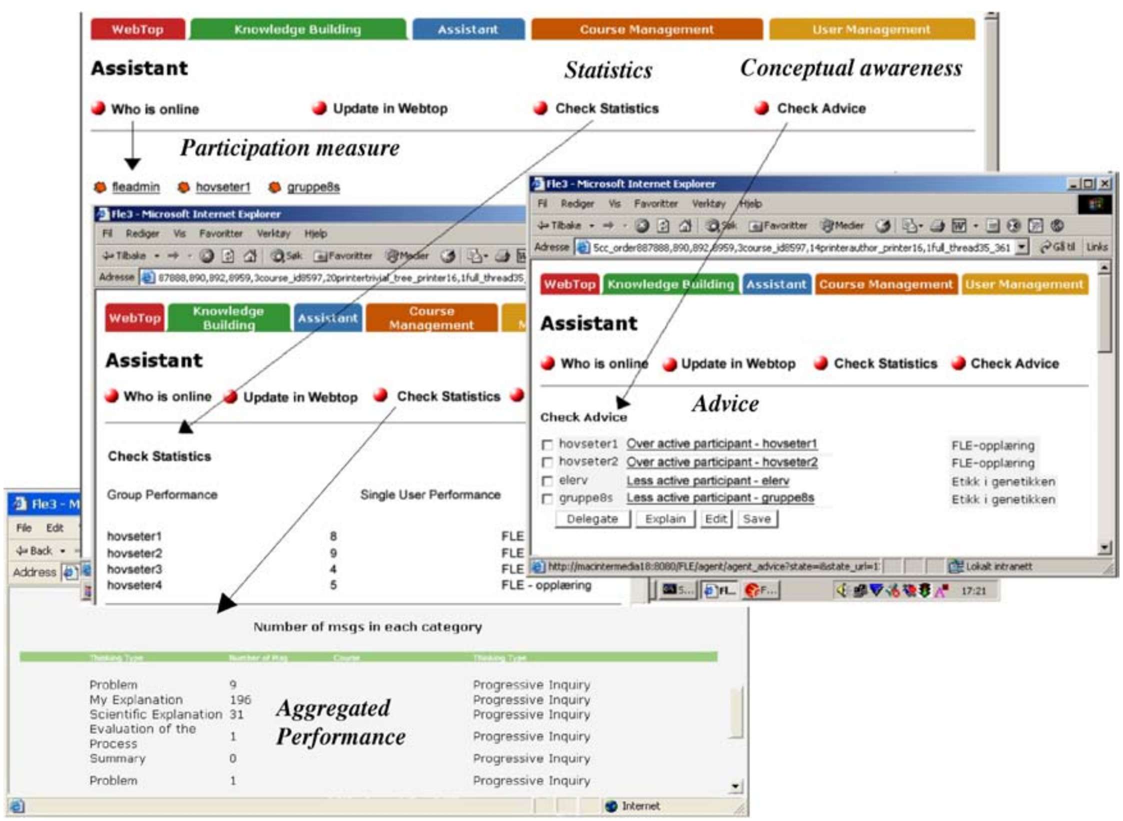
If software agents are allowed to reason with these representations, conceptual awareness can be implemented as a computational mechanism. This is shown in Figure 4. Here, pedagogical interface agents (software components of FLE-Assistant) monitor the shared state of the FLE system, which is captured from the students' online interactions and stored in a database. The FLE-Assistant can automatically generate higher level representations based on information about who is logged on, who participates with whom, who is less active, what messages are posted in each reply category, and how many messages each group has posted (Dolonen, Chen & Mørch, 2003). These findings can be organized in various meaningful formats depending on the target audience (students or instructors, in our case). FLE-Assistant has been useful in scaffolding critical aspects of the pedagogical model underlying FLE (progressive inquiry) (Muukkonen, Hakkarainen & Lakkala 1999), such as being reminded of what message category to choose for a new posting based on messages previously posted in the knowledge building forum (Mørch, Jondahl & Dolonen, 2005).

Table 2 summarizes our efforts to operationalize reflection-in-action in Janus and generalized-other in FLE-Assistant.

In sum, strengths and limitations of the translational approach to interaction design are as follows:

- **Strength:** This chapter proposes a translational approach to theory-informed design, which is characterized by "transforming" artifacts through a design space that starts with (theory) appropriation and ends with concrete

Figure 4. FLE-assistant provides conceptual awareness of individual and group activity by statistics and advice.



HCI artifacts. It identifies a new "first stage" in the lifecycle of an interactive system, before conventional design-time and use-time (Ye & Fischer, 2007). This is a stage where end-user developers (amateur computer scientists) can participate with professional developers. It requires multidisciplinary expertise, spanning two domains of discourse (theory domain and technical systems domain), and the ability to think out of the box when it comes to translation across domains.

- **Limitation:** Externalized design in architecture has been criticized for creating Kitsch design, incorporating expressions from the external environment that are not considered successful (e.g. poor translation, misunderstanding of original idea), which for theory-informed interaction design might mean unrecognizable ideas and theory having little impact on design. Successful results require subscribing to the multistage process suggested in this chapter and proficiency in two domains of discourse, which might be demanding and/or uninteresting.

General Discussion and Further Work

The research questions raised in the beginning of this chapter were:

- How can we trace the development of abstract objects (theoretical ideas) into concrete artifacts in terms of evolution and participation?
- What methodological support (guidance, model) is needed during the early (creative) stages of design before designers start to think in terms of technical (software) objects? What other fields of design can we learn from in this regard?

Related to the first question, I have explored the integration of two kinds of artifacts that belong in disparate worlds. In terms of the philosopher Karl Popper, they are World 3 (conceptual artifacts) and World 1 (physical and computational artifacts). I have shown how one can trace artifacts from World 3 to World 1, expressing generally accepted ideas of the former in the material of the latter. This should be thought of as acts of externalization (Kaptelinin & Nardi, 2005), and seen as an evolutionary process of forming artifacts. Another of our long-term goals is to understand the transition from World 1 (external expressions) to World 2 (mental representations, preconceptual structures), which can provide a model for internalization and learning. Whether or not there is a connection from the work presented here (W3 → W1) toward that end (W1 → W2) and (W2 → W3) is an open issue outside the scope of this work, but a grand challenge for further research.

Related to the second question is the open issue as to what extent there should be selection criteria for choosing a theory/idea to be appropriated in the first place. I have not advocated selection criteria in this chapter, only that we strive for the goal of being able to communicate the idea to others (designers and users). Another criterion is motivation: To select an idea that you believe is important to understand and put it into a concrete form (other than writing) for others to interact with, learn from, and criticize.

Table 2. Translation table for Janus and FLE-assistant

Stage	Janus	FLE-Assistant
Selection (theoretical idea)	Reflection-in-action (D.A. Schön)	Generalized-other (G.H. Mead)
Appropriation (design context)	Action, reflection, action-present, back-talk	Game, roles, rules, roles-organized-according-to-rules, common attitudes
Translation (GUI objects; configuration)	Work area, design units, critic messages, argumentative hypertext	Participation measure, statistics, aggregated performance, conceptual awareness, advice

Motivation and previous experience have been the selection criteria for choosing the examples used in this chapter. The externalized design examples motivated the author's writing effort, and the two software systems were chosen because of the author's previous involvement in their design processes. One may ask to what extent the examples are "paradigmatic," or good enough to convince the reader of the proposed approach to socio-technical interaction design (STID). I will only elaborate on the case of Janus, since it was developed some 15 years ago with a "proof of concept" that has matured over time, and arguably is equally relevant today as it was when it was first introduced. Even though the critiquing approach that characterizes Janus may not be widely known, its basic components and unique configuration are well established in HCI and CSCL. Computer-based critics are software agents that integrate a hypertext system with a computer-aided design environment, for the purpose of increasing productivity and educational value, by bringing generally useful information about a domain of interest to a designer/user's attention, upon demand, as automated feedback by the critic component. Its applicability to performance support systems exploded with the introduction of the World Wide Web, and can today be interpreted as a technique for putting semantic web technology into practical use (i.e. integrating domain semantics and design rules with performance support). For example the pedagogical agents in FLE-Assistant can be seen as an evolution of the critiquing approach to CSCL.

Open issues for further investigation based on the current work is as follows:

- The translational approach and the "design principles approach" have many similarities. For example, educational technology developers have made "scaffolding" into a design principle for instructional design. Does that mean that the translational approach should provide design principles as intermediate abstractions (normative adaptations of a concept) rather than working directly with the original ideas, as presented in this chapter?
- Complex ideas like reflection-in-action and generalized-other offer affordances and constraints for design (as well as motivation), and the analyses in this chapter show that the user interface of Janus and FLE-Assistant can be traced back to the ideas of reflection-in-action and generalized-other, respectively. Could similar or better results be obtained if other developers were asked to do the same exercise, i.e., starting with the same basic ideas and expressing them in different designs? My tentative answer is that these designs will be variations (better or worse) of a common theme already established with the first examples.
- There is a related area of research that addresses many of the same issues as presented in this chapter, not in terms of HCI and CSCL, but rather as methods, findings, and research associated with the creative arts, creative design, and media arts. For example, Laurel (2003) provides insight into the design process of professionals by collecting different designers' stories of how they perform their work and what methods and techniques they rely on when designing. Further work on STID ought to consult this body of work more carefully to extend the multistage design process, for comparison, and for cross-fertilization.
- Another area for further work is to extend the current (technological) approach to STID to also embrace the non-technical aspects of design, e.g. organization design and competency (HR) development. How sociological theory can influence the design of these components of a STS is outside the scope of this work, but it is an important area for further research. My tentative answer is to think of the connection between sociological theory and non-technical design in terms of *implications* rather than *applications*, in the same way one talks about the implications of G.H. Mead's theoretical ideas for education, for psychology, etc.

ACKNOWLEDGMENT

The author thanks Gerhard Fischer and Raymond McCall, who contributed to the design of Janus and suggested Donald Schön's concept of reflection-in-action as inspiration, and Weiqin Chen and Jan Dolonen who contributed to the development of FLE-Assistant. Colleagues and students at InterMedia, University of Oslo provided constructive feedback on previous versions of this article. The writing was supported financially by the Knowledge Practices Laboratory (KP-Lab) project of the European Information Society Technologies (IST) 6th framework program, under contract no. 27490.

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Chapter XXV
A Social Framework for Software Architectural Design

Manuel Kolp
Université Catholique de Louvain, Belgium

Yves Wautelet
Université Catholique de Louvain, Belgium

ABSTRACT

Information systems are deeply linked to human activities. Unfortunately, development methodologies have been traditionally inspired by programming concepts and not by organizational and enterprise ones. This leads to ontological and semantic gaps between the systems and their environments. The adoption of Multi-Agent Systems (MAS) helps to reduce these gaps by offering modeling tools based on organizational concepts (actors, agents, goals, objectives, responsibilities, social dependencies, etc.) as fundamentals to conceive systems through a development process. Socio-technical design is concerned with the direct involvement of users in software design. To this respect the DesCARTES framework presented in this paper offers three main contributions: 1) the use of agents modeled according to organizational concepts, 2) the use of social patterns in software design that better match with users' organization structures, and 3) the inclusion in an iterative development methodology that involves the user intensively in software development.

If you think good architecture is expensive, try bad architecture.

—Brian Foote and Joseph Yoder

1. INTRODUCTION

Information systems are deeply linked to human activities. Unfortunately, development methodologies have been traditionally inspired by programming concepts and not by organizational and enterprise ones. This leads to ontological and semantic gaps between the systems and their environments. The

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adoption of Multi-Agent Systems (MAS) helps to reduce these gaps by offering modeling tools based on organizational concepts (actors, agents, goals, objectives, responsibilities, social dependencies, etc.) as fundamentals to conceive systems through all development process. Moreover, software development is becoming increasingly complex. Stakeholder expectations are ever more demanding, while development times are supposed to be shorter. Project managers, analysts and software developers need adequate processes to model the organizational context, capture requirements and build efficient and flexible software systems. Those methodologies have to cover the whole life cycle (Kruchten, 2003) of the project while reducing risk as much as possible, offer tools to manage the complexity of human organizations and provide features to develop applications in a correct way.

At the architectural design level, an important technique that helps handle software construction and documentation complexity is the reuse of development experience and know-how. Styles and patterns have become an attractive approach to reusing architectural design knowledge. Architectural styles are intellectually manageable abstractions of system structure that describe how system components interact and work together (Shaw & Garlan, 1996). Design patterns describe a problem commonly found in software designs and prescribe a flexible solution for the problem, so as to ease the reuse of that solution. This solution is repeatedly applied from one design to the next, producing design structures that look quite similar across different applications (Gamma, Helm, Johnson, & Vlissides, 1995).

Taking real-world social structures as metaphors, the DesCARTES[1] (Faulkner, Kolp, Coyette & Do, 2004) framework proposes a set of generic architectural structures (Kolp, Giorgini & Mylopoulos, 2001). It, as well as i*, Tropos and SPEM, is supported by the DesCARTES tool (Kolp & Wautelet, 2007). The aim is to offer and validate a software architectural design process specifically for agent-based systems:

- At the architectural level, organizational styles inspired from organization theory and strategic alliances are used to design the overall MAS architecture. Styles from organization theory describe the internal structure and design of the MAS architecture, while styles from strategic alliances model the cooperation of independent architectural organizational entities that pursue shared goals.
- At the detailed design level, social design patterns drawn from research on cooperative and distributed architectures, offer a more microscopic view of the social MAS architecture description. They define the agents and the social dependencies that are necessary for the achievement of agent goals.

The paper uses a running example to illustrate our approach: E-Media is a typical business-to-consumer application supporting the following features:

- An on-line web interface allows customers to examine the items in the *E-Media* catalogue, and place orders;
- Customers can search the on-line store by either browsing the catalogue or querying the item database. An online search engine allows customers to search title, author/artist and description fields trough keywords or full-text search;
- Internet communications are supported;
- On-line financial transactions including credit card and anonymity are protected;
- All web information (e.g., product and customer turnover, sales average, …) of strategic importance is recorded for monthly or on-demand statistical analysis;
- Based on this statistical and strategic information, the system permanently manages and adapts the stock, pricing and promotions policy. For example, for each product, the system can decide to increase or decrease stocks or profit margins. It can also adapt the customer on-line interface with new product promotions.

The chapter is organized as follows. Section 2 describes the main contributions of the framework to socio-technical design. The objectives of each discipline as well as the workflow and artifacts used as input or output are described. Section 3 overviews architectural organizational styles, details one of them, the structure-in-5, and applies it to design the architecture of the e-business application. Section 4 presents the social design patterns, details one of them, the broker, and applies them to design in details part of the e-business application. Section 5 overviews the agent oriented e-business system implementation. Section 6 overviews related work. Finally, Section 7 concludes the paper.

2. Towards a Socio-Technical Design Oriented Development Framework

Socio-technical design is an under development discipline in which contributions are coming from different aspects of literature. We claim that the development framework proposed in this chapter contributes to the development of socio-technical design on different levels.

Indeed, following (Scacchi, 2004), *socio-technical design is concerned with advocacy of the direct participation of end-users in the information system design process*, furthermore the paper highlights the system environment as being a part of it. The software process described in this chapter contributes to the development of socio-technical approaches in three distinct ways.

First of all, the use of the agent oriented paradigm allows modeling concepts and techniques in accordance to the reality of human organizations. Indeed, when developing multi-agent systems (MAS) the system being modeled can be represented by using organizational concepts (actors, agents, goals, objectives, responsibilities, social dependencies, etc.) as fundamentals to conceive systems through all development process. Moreover, the i* approach (Yu, 1995) included in our framework proposal allows one to model the actors inside and outside the system as well as their collaborations in terms of goals, tasks, resources or softgoals.

Secondly, by the use of social patterns into software design, some human organizational structures are directly used/mapped into software design which emphasizes even more the benefits from using MAS conceptualization into a socio-technical approach.

Finally, the process presented into this paper is part of a broader (iterative) development methodology called I-Tropos (Wautelet, 2008). Figure 1 offers a two dimensional view of the I-Tropos process: it shows the disciplines and the four different phases to which they belong. This methodology is by essence iterative so that users are intensively involved into the system development; their participation, feedbacks as well as environmental evolutions/changes are directly incorporated into the development process. Such a process leads to a better user involvement and the development of software product with a higher perceived quality. Software users, enterprise workers, other project stakeholders and their environment are thus centric in our approach; this is perfectly in accordance with the principles of socio-technical design. This makes our approach different of a traditional software engineering one based on the activities performed by professionals designed to build a set of solution-driven development artifacts. Due to a lack of space we cannot document the complete I-Tropos software process in this chapter, the interested reader can refer to (Wautelet, Kolp & Achbany, 2006; Wautelet, 2008) for such a documentation using the Software Process Engineering Metamodel (Object Management Group, 2007) concepts.

The case study developed in this chapter, e-media, is interesting from the socio-technical design point of view since it has involved intensively into the development a large number of users having various profiles (the social system) and other physical devices (the technical system). A broader illustration of the framework also pointing the advantages of iterative development on a coking plant production management system development is available in (Wautelet, 2008). The latest case study is also very illustrative of socio-technical design especially onto the technical system in which various machines behaving as agents are involved.

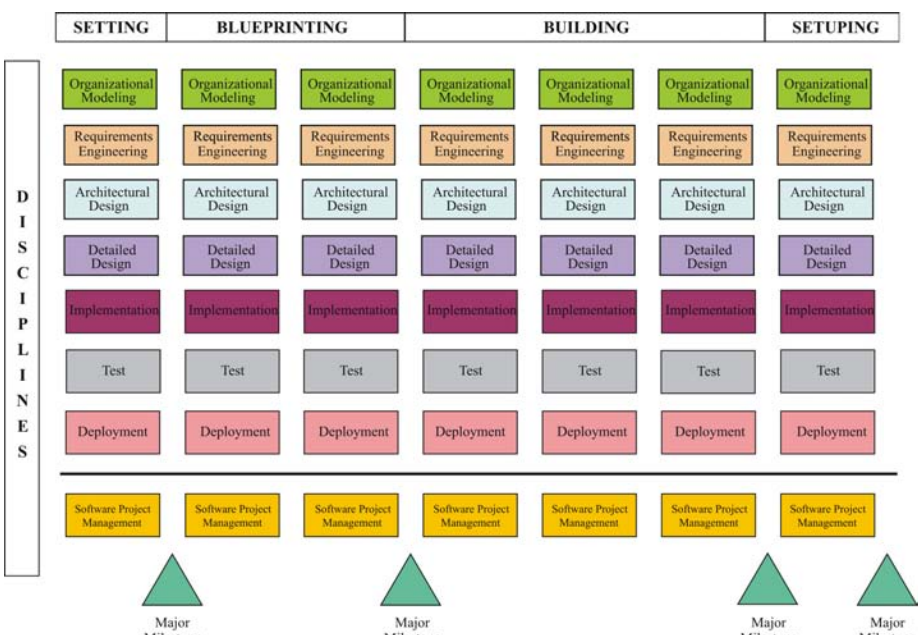
3. Architectural Design with Organizational Styles

System architectural design has been the focus of considerable research during the last fifteen years that has produced well-established architectural styles and frameworks for evaluating their effectiveness with respect to particular software qualities (Bass, Clements, & Kazman, R., 1998). Examples of styles are pipes-and-filters, event-based, layered, control loops and the like (Shaw & Garlan, 1996). Examples of software qualities include maintainability, modifiability, portability etc (Kruchten, 2003). We are interested in developing a suitable set of architectural styles for multi-agent software systems. Since the fundamental concepts of a Multi-Agent System (MAS) are intentional and social, rather than implementation-oriented, we turn to theories which study social structures for motivation and insights. But, what kind of social theory should we turn to? There are theories that study group psychology, communities (virtual or otherwise) and social networks. Such theories study social structure as an emergent property of a social context. Instead, we are interested in social structures that result from a design process. For this, we turn for guidance, in DesCARTES, to organizational theories, namely ***Organization Theory*** and *Strategic Alliances*. Organizational Theory (e.g., Mintzberg, 1992; Scott, 1998; Yoshino & Srinivasa Rangan, 1995) describe the internal structure and design of an organization, while Strategic Alliances (e.g., Dussauge & Garrette, 1999; Morabito, Sack & Bhate, 1999; Segil, 1996) model the strategic cooperation of independent organizational stakeholders who pursue a set of shared goals.

3.1 Organizational Theory

"*An organization is a consciously coordinated social entity, with a relatively identifiable boundary, that functions on a relatively continuous basis to achieve a common goal or a set of goals*" (Morabito, Sack & Bhate, 1999). Organization theory is the discipline that studies both structure and design in such social entities. Structure deals with the descriptive aspects

Figure 1. The I-Tropos process: Iterative perspective



while design refers to the prescriptive aspects of a social entity. Organization theory describes how practical organizations are actually structured, offers suggestions on how new ones can be constructed, and how old ones can change to improve effectiveness. To this end, schools of organization theory have proposed models patterns to try to find and formalize recurring organizational structures and behaviors.

In the following, we briefly present organizational styles identified in Organization Theory. The structure-in-5 will be studied in detail in Section 3.3.

The Structure-in-5 style. An organization can be considered an aggregate of five sub-structures, as proposed in (Mintzberg, 1992). At the base level sits the *Operational Core* which carries out the basic tasks and procedures directly linked to the production of products and services (acquisition of inputs, transformation of inputs into outputs, distribution of outputs). At the top lies the *Strategic Apex* which makes executive decisions ensuring that the organization fulfils its mission in an effective way and defines the overall strategy of the organization in its environment. The *Middle Line* establishes a hierarchy of authority between the Strategic Apex and the Operational Core. It consists of managers responsible for supervising and coordinating the activities of the Operational Core. The *Technostructure* and the *Support* are separated from the main line of authority and influence the operating core only indirectly. The Technostructure serves the organization by making the work of others more effective, typically by standardizing work processes, outputs, and skills. It is also in charge of applying analytical procedures to adapt the organization to its operational environment. The Support provides specialized services, at various levels of the hierarchy, outside the basic operating workflow (e.g., legal counsel, R&D, payroll, cafeteria).

The pyramid style is the well-know hierarchical authority structure. Actors at lower levels depend on those at higher levels. The crucial mechanism is the direct supervision from the Apex. Managers and supervisors at intermediate levels only route strategic decisions and authority from the Apex to the operating (low) level. They can coordinate behaviors or take decisions by their own, but only at a local level.

The chain of values merges, backward or forward, several actors engaged in achieving or realizing related goals or tasks at different stages of a supply or production process. Participants, who act as intermediaries, add value at each step of the chain. For instance, for the domain of goods distribution, providers are expected to supply quality products, wholesalers are responsible for ensuring their massive exposure, while retailers take care of the direct delivery to the consumers.

The matrix style proposes a multiple command structure: vertical and horizontal channels of information and authority operate simultaneously. The principle of unity of command is set aside, and competing bases of authority are allowed to jointly govern the workflow. The vertical lines are typically those of functional departments that operate as "home bases" for all participants, the horizontal lines represents project groups or geographical areas where managers combine and coordinate the services of the functional specialists around particular projects or areas.

The auction style involves competitively mechanisms, and actors behave as if they were taking part in an auction. An auctioneer actor runs the show, advertises the auction issued by the auction issuer, receives bids from bidder actors and ensures communication and feedback with the auction issuer who is responsible for issuing the bidding.

3.2. Strategic Alliances

A strategic alliance links specific facets of two or more organizations. At its core, this structure is a trading partnership that enhances the effectiveness of the competitive strategies of the participant organizations by providing for the mutually beneficial trade of technologies, skills, or products based upon them. An alliance can take a variety of forms, ranging from arm's-length contracts to joint ventures, from multinational corporations to university spin-offs, from franchises to equity arrangements. Varied interpretations of the term exist, but a strategic alliance can be defined as possessing simultaneously the following three necessary and sufficient characteristics:

- The two or more organizations that unite to pursue a set of agreed upon goals remain independent subsequent to the formation of the alliance;
- The partner organizations share the benefits of the alliances and control over the performance of assigned tasks;
- The partner organizations contribute on a continuing basis in one or more key strategic areas, e.g., technology, products, and so forth.

In the following, we briefly present organizational styles identified in Strategic Alliances.

The joint venture style involves agreement between two or more intra-industry partners to obtain the benefits of larger scale, partial investment and lower maintenance costs. A specific joint management actor coordinates tasks and manages the sharing of resources between partner actors. Each partner can manage and control itself on a local dimension and interact directly with other partners to exchange resources, such as data and knowledge. However, the strategic operation and coordination of such an organization, and its actors on a global dimension, are only ensured by the joint management actor in which the original actors possess equity participations.

The arm's-length style implies agreements between independent and competitive, but partner actors. Partners keep their autonomy and independence but act and put their resources and knowledge together to accomplish precise common goals. No authority is lost, or delegated from one collaborator to another.

The hierarchical contracting style identifies coordinating mechanisms that combine arm's-length agreement features with aspects of pyramidal authority. Coordination mechanisms developed for arm's-length (independent) characteristics involve a variety of negotiators, mediators and observers at different levels handling conditional clauses to monitor and manage possible contingencies, negotiate and resolve conflicts and finally deliberate and take decisions. Hierarchical relationships, from the executive apex to the arm's-length contractors restrict autonomy and underlie a cooperative venture between the parties.

The co-optation style involves the incorporation of representatives of external systems into the decision-making or advisory structure and behavior of an initiating organization. By co-opting representatives of external systems, organizations are, in effect, trading confidentiality and authority for resource, knowledge assets and support. The initiating system has to come to terms with the contractors for what is being done on its behalf; and each co-optated actor has to reconcile and adjust its own views with the policy of the system it has to communicate.

3.3. An Organizational Style in Detail

Figure 2 details the structure-in-5 style using the *i** framework. As said, i* diagrams in this chapter are drawn with DesCARTES.

The Technostructure, Middle Agency and Support actors depend on the Apex for strategic management. Since the goal Strategic Management does not have a precise description, it is represented as a softgoal (cloudy shape). The Middle Agency depends on the Technostructure and Support respectively through goal dependencies Control and Logistics represented as oval-shaped icons. The Operational Core is related to the Technostructure and Support actors through the Standardize task dependency and the Non-operational Service resource dependency, respectively.

A number of constraints can also be applied to supplement the basic style:

- The dependencies between the Strategic Apex as depender and the Technostructure, Middle Line and Support as dependees must be of type goal;
- A softgoal dependency models the strategic dependence of the Technostructure, Middle

Line and Support on the Strategic Apex;
- The relationships between the Middle Line and Technostructure and Support must be of goal dependencies;
- The Operational Core relies on the Technostructure and Support through task and resource dependencies;
- Only task dependencies are allowed between the Middle Line (as depender or dependee) and the Operational Core (as dependee or depender).

3.4. Applying Organizational Styles

Figure 3 models the agent-oriented architecture for E-Media following the structure-in-5 style.

The Store Front plays the role of the structure-in-5's Operational Core. It interacts with customers and provides them with a usable front-end web application for consulting, searching and shopping media items.

The Back Store constitutes the structure- in-5's Support component. It manages the product database and communicates to the Store Front relevant product information. It stores and backs up all web information about customers, products and sales to be able to produce statistical information (e.g., analyses, average charts and turnover reports). Such kind of information is computed either for a predefined product (when the Coordinator asks it) or on a monthly basis for every product. Based on this monthly statistical information, it provides also the Decision Maker with strategic information (e.g., sales increase or decrease, performance charts, best sales, sales prevision, …).

The Billing Processor plays the role of the structure-in-5's Technostructure in handling customer orders and bills. To this end, it provides the customer with on-line shopping cart capabilities. It also ensures the secure management of financial transactions for the Decision Maker. Finally, it handles, under the responsibility of the Coordinator component, stock orders to avoid shortages or congestions.

As the structure-in-5's Middle Agency, the Coordinator assumes the central position of the architecture. It is responsible to implements strategic decisions for the Decision Maker (Strategic Apex). It supervises and coordinates the activities of the Billing Processor (initiating the stock and pricing policy), the Front Store (adapting the front end interface with new promotions and recommendations) and the Back Store.

3.5. Selecting an Architecture

Software quality attributes (i.e., non-functional requirements describing how well the system accomplishes its functions) relevant for multi-agent systems have been studied in (Kolp, Giorgini, & Mylopoulos, 2001). These are, for instance: predictability, security, adaptability, coordinability, cooperativity, competitivity, availability fallibility-tolerance, modularity, aggregability.

Three of them (adaptability, security, availability) have been identified as particularly strategic for e-business systems (Do, Faulkner, & Kolp, 2003). Due to the lack of space, we will only focus on these three qualities for the structure-in-5 style and refer the author to the bibliography for the other attributes and other styles.

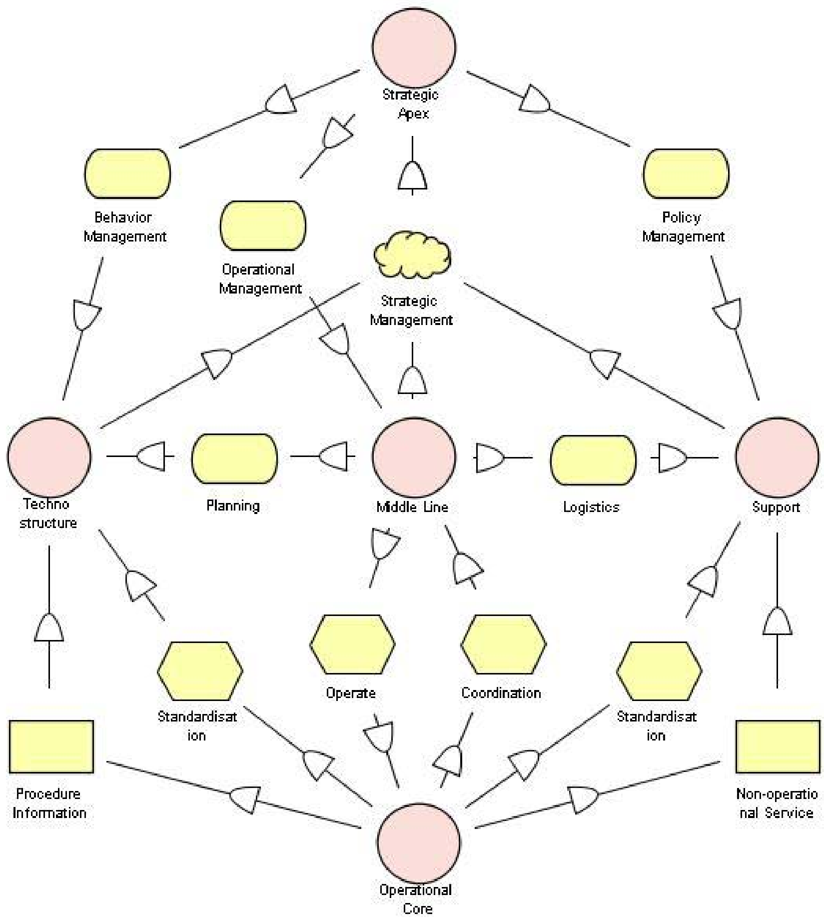
Adaptability deals with the way the system can be designed using generic mechanisms to allow web pages to be dynamically changed. It also concerns the catalogue update for inventory consistency.

The structure-in-5 separates independently each typical component of the E-Media architecture isolating them from each other and allowing dynamic manipulation.

Security. Clients, exposed to the internet are, like servers, at risk when using Web applications. It is possible for web browsers and application servers to download or upload content and programs that could open up the client system to crackers and automated agents. JavaScript, Java applets, ActiveX controls, and plug-ins represent a certain risk to the system and the information it manages. Equally important are the procedures checking the consistency of data transactions.

In the structure-in-5, checks and control mechanisms can be integrated at different levels assuming

Figure 2. The Structure-in-5 style



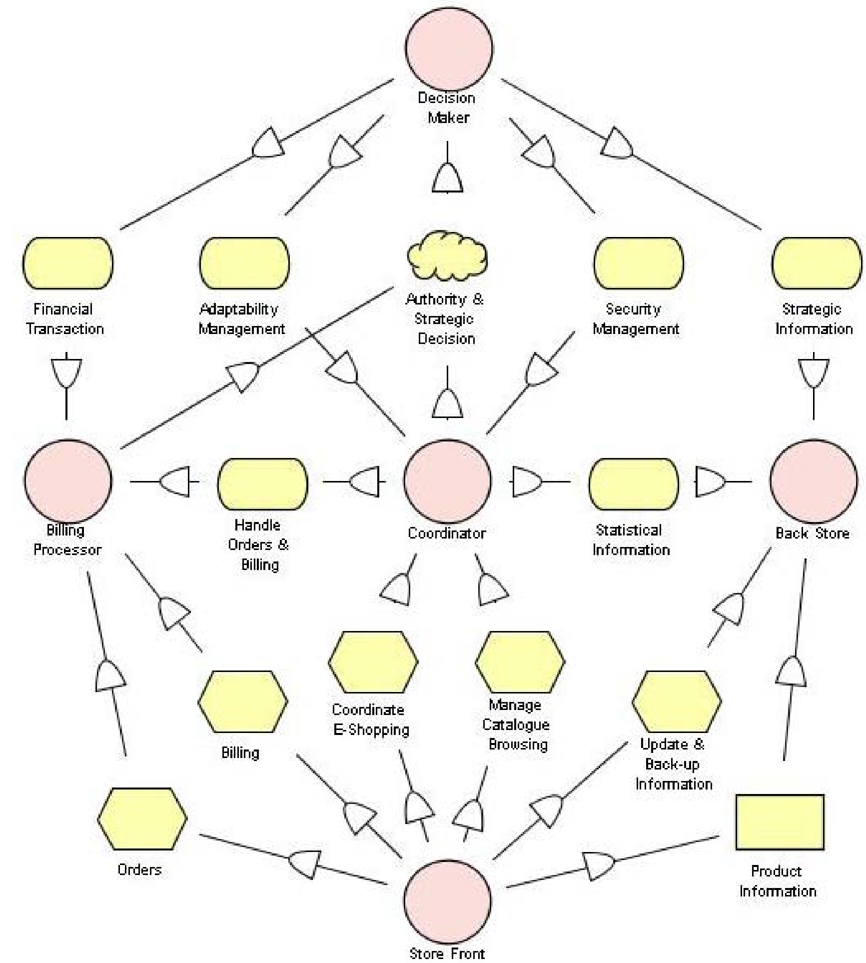
redundancy from different perspectives. Contrary to the classical layered architecture (Shaw & Garlan, 1996), checks and controls are not restricted to adjacent levels. Besides, since the structure-in-5 permits the designer to separate process (Store Front, Billing Processor and Back Store) from control (Decision Maker and Monitor), security and consistency of these two hierarchies can also be verified independently.

Availability. Network communication may not be very reliable, causing sporadic loss of the server. There are data integrity concerns with the capability of the e-business system to do what needs to be done, as quickly and efficiently as possible in particular with the ability of the system to respond in time to client requests for its services.

The structure-in-5 architecture make agents more tolerant to network availability problems by differentiating process from control. Besides, higher levels are more abstract than lower levels: lower levels only involve resources and task dependencies while higher ones propose intentional (goals and softgoals) relationships.

To cope with software quality attributes and select the architecture of the system, we go through a means-ends analysis using the non-functional requirements (NFRs) framework (Chung, Nixon, Yu & Mylopoulos, 2000). In the NFR framework, software quality attributes are called non-functional requirements represented as softgoals (cloudy shapes). The analysis involves refining these softgoals to sub-goals that are more specific and more precise

Figure 3. The E-Media architecture following the structure-in-5 style

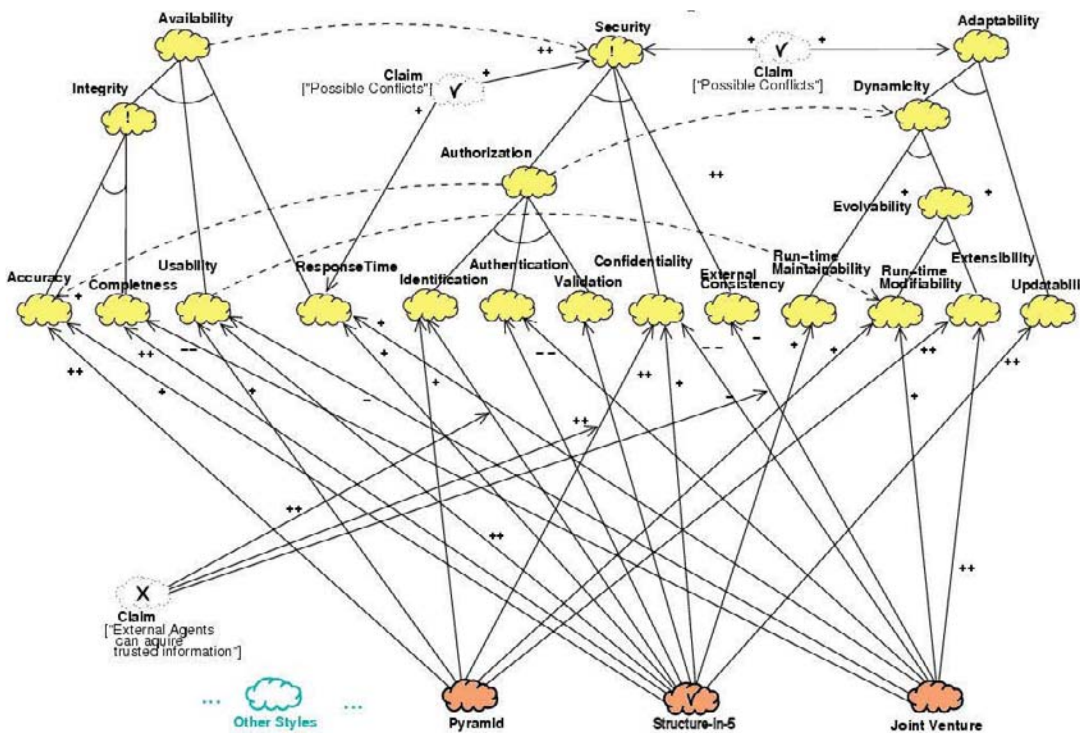


and then evaluating alternative architectural styles against them, as shown in Figure 4. The styles are represented as operationalized softgoals (saying, roughly, "make the architecture of the new system pyramid-/joint venture-/co-optation-based,…"). Design rationale is represented by claim softgoals drawn as dashed clouds. These can represent contextual information (such as priorities) to be considered and properly rejected into the decision making process. Exclamation marks (! and !!) are used to mark priority softgoals. A check-mark "✓" indicates a fulfilled softgoal, while a cross "×" labels an unfulfillable one.

In Figure 4, Adaptability is AND-decomposed into Dynamicity and Updatability. For our e-commerce example, dynamicity should deal with the way the system can be designed using generic mechanisms to allow web pages and user interfaces to be dynamically and easily changed. Indeed, information content and layout need to be frequently refreshed to give correct information to customers or simply be fashionable for marketing reasons. Frameworks like Active Server Pages (ASP), Server Side Includes (SSI) to create dynamic pages make this attribute easier to achieve. Updatability should be strategically important for the viability of the application, the stock management and the business itself since *E-Media* administrators have to very regularly update the catalogue for inventory consistency.

Availability is decomposed into Usability, Integrity and Response Time. Network communication may not be very reliable causing sporadic loss of

Figure 4. Selecting an architecture



the server. There should be data integrity concerns with the capability of the e-business system to do what needs to be done, as quickly and efficiently as possible: in particular with the ability of the system to respond in time to client requests for its services. It is also important to provide the customer with a usable application, i.e., comprehensible at first glimpse, intuitive and ergonomic. Equally strategic to usability concerns is the portability of the application across browser implementations and the quality of the interface.

Security has been decomposed into Authorization*,* Confidentiality *and* External Consistency.

Eventually, the analysis shown in Figure 4 allows us to choose the structure-in-5 architectural style for our e-commerce example (the operationalized attribute is marked with a "✓"). More details about the selection and non-functional requirements decomposition process as well as evaluation and comparison of the styles with respect to architectural criteria can be found in (Castro, Kolp, & Mylopoulos, 2002; Kolp, Giorgini & Mylopoulos, 2001).

4. Detailed Design with Social Patterns

The organizational abstraction sketched during the architectural design discipline gives information about the system architecture to be: every time an organizational style is applied, it allows to easily pointing up, to the designer, the required organizational agents.

Next step in MAS architectural design requires detailing and relating identified (organizational) agents to more specific ones in order to proceed with the agent behavior characterization. Namely, each agent in Figure 3 is much closer to the real world system actor behavior than software agent behavior that we consequently aim to achieve. Consequently, once the organizational architectural reflection has figured out the MAS global structure in terms of actors and their intentional relationships, a deepener analysis is required to detail the agent behaviors and their interdependencies necessary to accomplish their roles in the software organization.

To effectively deal with this objective, design patterns are used to describe a problem commonly found in software designs and prescribe a flexible solution for the problem, so as to ease the reuse of that solution. In DesCARTES, we adopt social patterns (Do, 2005) that are design patterns focusing on social and intentional aspects that are recurrent in multi-agent or cooperative systems. Similarly to organizational styles, social patterns are generic structures that define how (a small number of) agents are interacting together in order to fulfill their obligations.

DesCARTES classifies social patterns in two categories. The Pair patterns describe direct interactions between negotiating agents. The Mediation patterns feature intermediate agents that help other agents reach agreement about an exchange of services. These patterns are then applied to design in detail the E-Media application.

4.1. Pair Patterns

The **Booking** pattern involves a client and a number of service providers. The client issues a request to book some resource from a service provider. The provider can accept the request, deny it, or propose to place the client on a waiting list, until the requested resource becomes available when some other client cancels a reservation.

The **Subscription** pattern involves a yellow-page agent and a number of service providers. The providers advertise their services by subscribing to the yellow pages. A provider that no longer wishes to be advertised can request to be unsubscribed.

The **Call-For-Proposals** pattern involves a client and a number of service providers. The client issues a call for proposals for a service to all service providers and then accepts proposals that offer the service for a specified cost. The client selects one service provider to supply the service.

The **Bidding** pattern involves a client and a number of service providers. The client organizes and leads the bidding process, and receives proposals. At each iteration, the client publishes the current bid; it can accept an offer, raise the bid, or cancel the process.

4.2 Mediation Patterns

In the **Monitor** pattern, subscribers register for receiving, from a monitor agent, notifications of changes of state in some subjects of their interest. The monitor accepts subscriptions, requests information from the subjects of interest, and alerts subscribers accordingly.

In the **Broker** pattern, the broker agent is an arbiter and intermediary that requests services from providers to satisfy the request of clients.

In the **Matchmaker** pattern, a matchmaker agent locates a provider for a given service requested by a client, and then lets the client interact directly with the provider, unlike brokers, who handle all interactions between clients and providers.

In the **Mediator** pattern, a mediator agent coordinates the cooperation of performer agents to satisfy the request of a client agent. While a matchmaker simply matches providers with clients, a mediator encapsulates interactions and maintains models of the capabilities of initiators and performers over time.

The **Wrapper** pattern incorporates a legacy system into a multi-agent system. A wrapper agent interfaces system agents with the legacy system (source) by acting as a translator. This ensures that communication protocols are respected and the legacy system remains decoupled from the rest of the agent system.

More details about the evaluation and comparison of the styles with respect to architectural criteria can be found in (Do, 2005).

4.3 A Social Pattern in Detail

Figure 5 details the Broker social pattern in *i**.

It is considered as a combination of (1) a Subscription pattern (shown enclosed within dashed boundary (a)), that allows service providers to subscribe their services to the Broker agent and where the Broker agent plays the role of yellow-page agent, (2) one of the other pair patterns—Booking, Call-for-Proposals, or Bidding—whereby the Broker agent requests and receives services from service providers (in Figure 5, it is a Call-for-Proposals pat-

*Figure 5. The broker pattern in i**

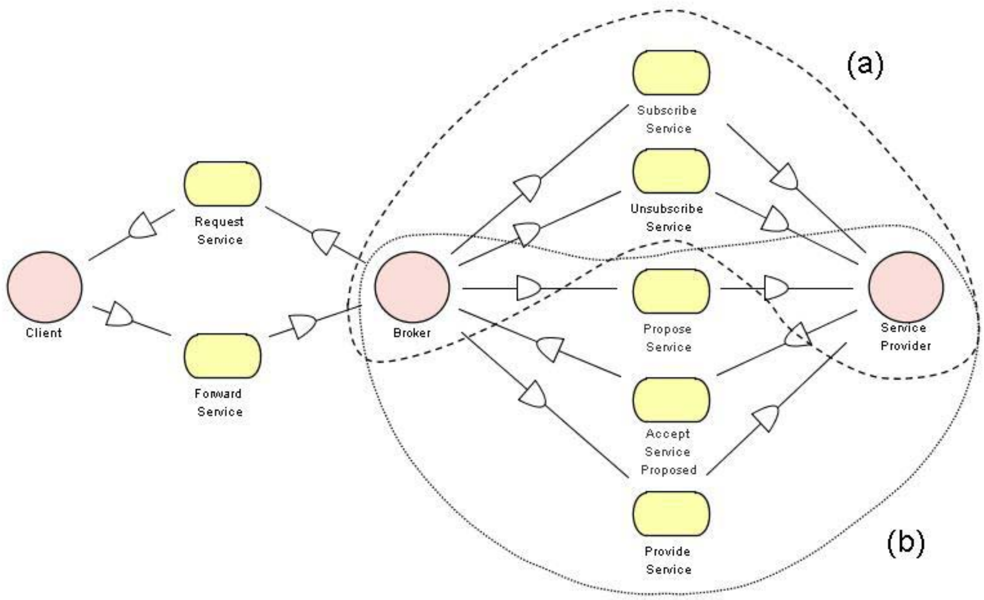
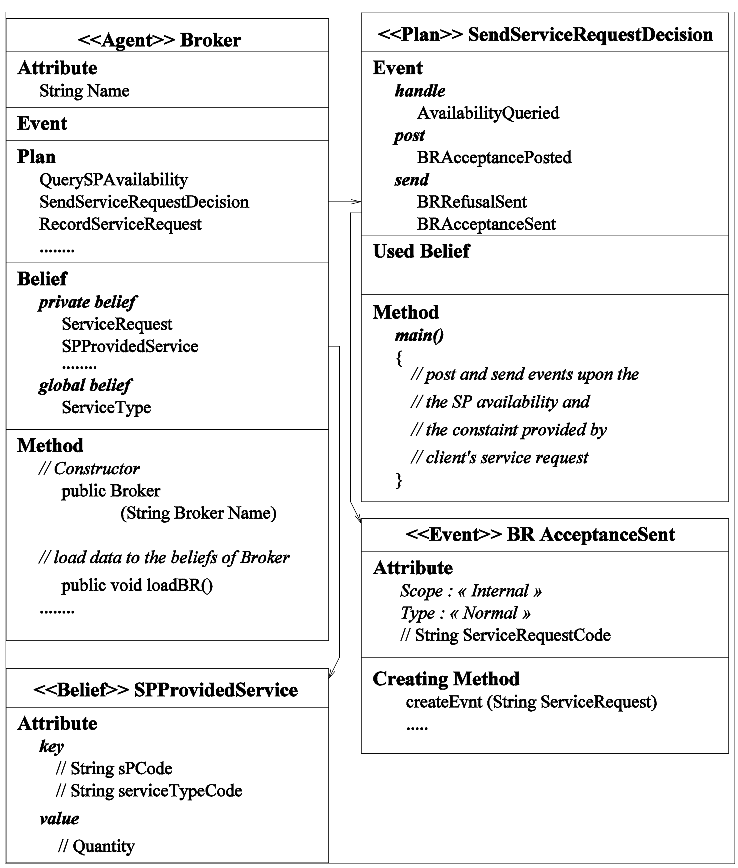


Figure 6. Structural diagram: Some components of the broker pattern



tern, shown enclosed within dotted boundary (b)), and (3) interaction between broker and the client: the Broker agent depends on the client for sending a service request and the client depends on the Broker agent to forward the service.

Figure 6 depicts the Broker pattern components. For brevity, each construct described earlier is illustrated only through one component.

Broker is one of the three agents composing the Broker pattern. It has plans such as QuerySPAvailability, SendServiceRequestDecision, etc. When there is no ambiguity, by convention, the plan name is the same as the name of the service that it operationalizes. The private belief SPProvidedService is used to store the service type that each service provider can provide. This belief is declared as private since the broker is the only agent that can manipulate it. The ServiceType belief stores the information about types of services provided by service providers and is declared as global since its must be known both by the service provider and the broker agent.

The constructor method allows the programmer to give a name to a broker agent when created. This method may call other methods, for example loadBR(), to initialize agent beliefs.

SendServiceRequestDecision is one of the Broker pattern plans the broker uses to answer the client: the BRRefusalSent event is sent when the answer is negative, BRAcceptanceSent when the broker has found some service provider(s) that may provide the service requested by the client. In the latter case, the plan also posts the BRAcceptancePosted event to invoke the process of recording the client's service request and the process of 'call for proposals' between the broker and the services providers. The SendServiceRequestDecision plan is executed when the AvailabilityQueried event (containing the information about the availability of the service provider to realize the client's request) occurs.

SPProvidedService is one of the broker's beliefs used to store the services provided by the service providers. The service provider code sPCode and

Figure 7. Interaction diagram for the broker pattern

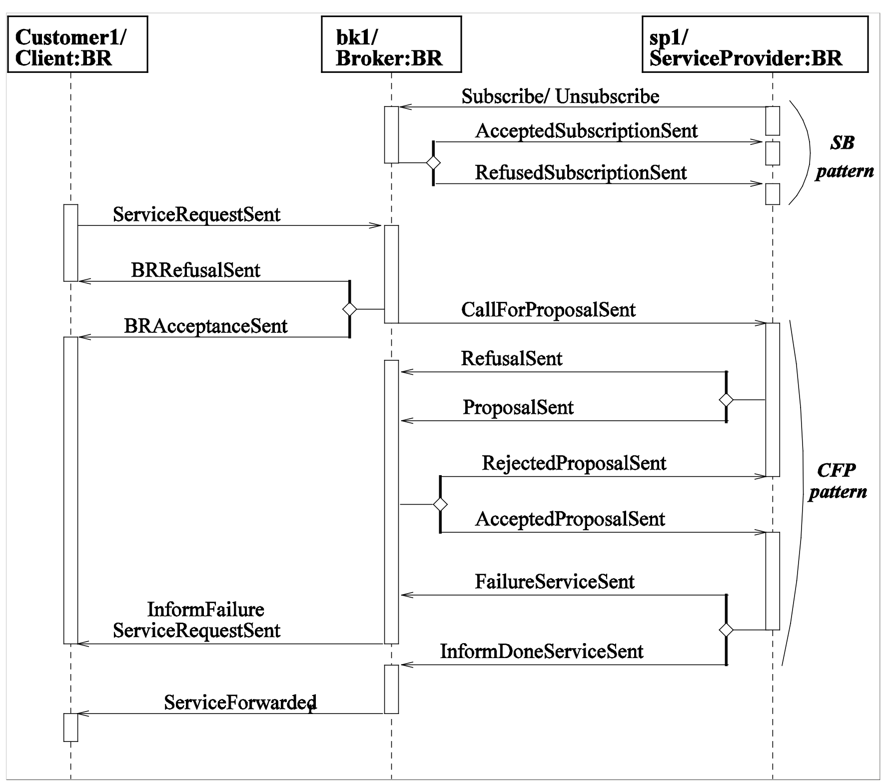


Figure 8. Dynamic diagram: Broker

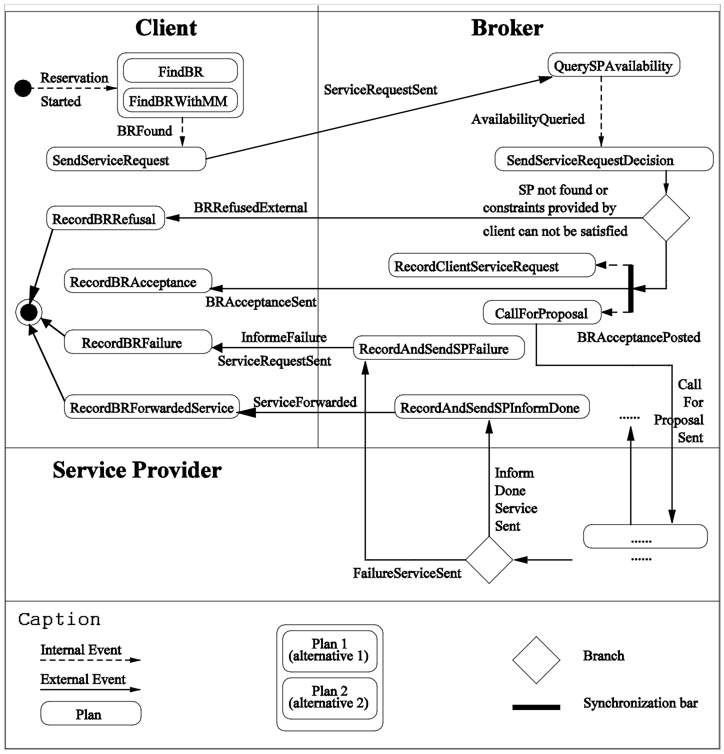
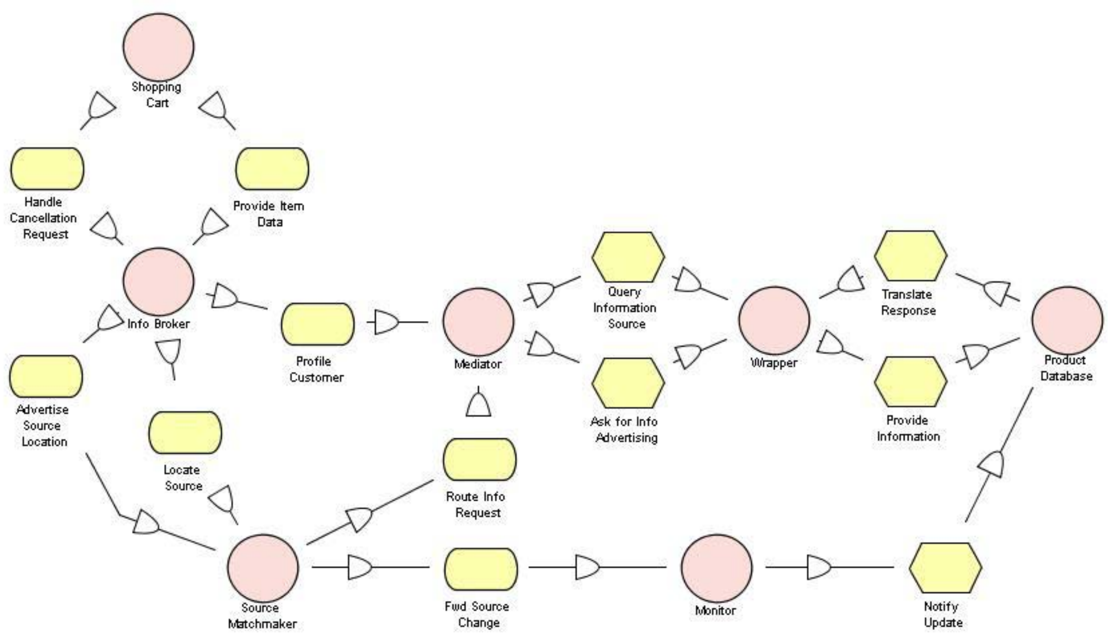


Figure 9. Decomposing the Store Front with Social Patterns



the service type code serviceTypeCode form the belief key. The corresponding quantity attribute is declared as a value field.

Figure 7 shows a sequence diagram for the Broker pattern. The client (customer1) sends a service request (ServiceRequestSent) containing the characteristics of the service it wishes to obtain from the broker. The broker may alternatively answer with a denial (BRRefusalSent) or a acceptance (BRAcceptanceSent).

BRAcceptanceSent is an event that is sent to inform the client that its request is accepted.

In the case of an acceptance, the broker sends a call for proposal to the registered service providers (CallForProposalSent). The call for proposal (CFP) pattern is then applied to model the interaction between the broker and the service providers. The service provider either fails or achieves the requested service. The broker then informs the client about this result by sending a InformFailureServiceRequestSent or a ServiceForwarded, respectively.

The communication dimension of the subscription pattern (SB) is given at the top-right and the communication dimension of the call-for- proposals pattern (CFP) is given at the bottom-right part of Figure 7. The communication specific for the broker pattern is given in the left part of the figure.

We omit the dynamic dimension of the Subscription and the CFP patterns, and only present in Figure 8 the activity diagram specific to the Broker pattern. It models the flow of control from the emission of a service request sent by the client to the reception by the same client of the realized service result sent by the broker. Three swimlanes, one for each agent of the Broker pattern, compose the diagram. In this pattern, the FindBroker service is either operationalized by the FindBR or the FindBRWithMM plans (the client finds a broker based on its own knowledge or via a matchmaker).

4.4. Applying Social Patterns

Figure 9 shows a possible use of the patterns for the Store Front component of the e-business system of Figure 3. In particular, it shows how to realize the dependencies Manage catalogue browsing, Update Information and Product Information from the point of view of the Store Front. The Store Front and the dependencies are decomposed into a combination of social patterns (Kolp, Giorgini & Mylopoulos, 2002) involving agents, pattern agents, subgoals and subtasks.

The booking pattern is applied between the Shopping Cart and the Information Broker to reserve available items. The broker pattern is applied to the Information Broker, which satisfies the Shopping Cart's requests of information by accessing the Product Database. The Source Matchmaker applies the matchmaker pattern to locate the appropriate source for the Information Broker, and the monitor pattern is used to check any possible change in the Product Database. Finally, the mediator pattern is applied to dispatch the interactions between the Information Broker, the Source Matchmaker, and the Wrapper, while the wrapper pattern makes the interaction between the Information Broker and the Product Database.

5. Implementation

We briefly describe in this section the E-Media system itself by focusing on the role of the *agents* and how they interact. The implementation has been derived from the architectural design explained previously. It has been realized on the JACK agent-oriented development environment (Agent Software, 2007).

When a user gets connected to E-Media, the Front-Store is instantiated and displays the interface depicted on Figure 10. It allows the new coming user to register on the web-site (1). The information provided by the users is handled by the Back-Store which checks the validity (2). Once this has been done, the users can perform purchases on E-Media by adding product to the shopping cart (4). The shopping cart is managed by the Billing-Processor. At any moment during the session the user can use the navigation-bar (3) to switch from one to another section. Promotions (5) and the top 5 best sales (6)

Figure 10. E-Media main interface

Figure 11. E-Media main interface, DVD section

are part of the strategic behaviour. The promotion policies are initiated by the Decision-Maker from the strategic information provided by the BackStore. The Coordinator chooses the best promotions and adapts the promotion interface. The coordinator acts in the same way with the best sales, the Back-Store computes the five best sellers and the coordinator is in charge of updating the Front-Store interface.

Figure 11 describes the Store-Front interface when the "DVD" button of the navigation-bar is activated. To start a search the users must fill one or several fields from the search engine (1). The Front-Store sends the query parameters to the Back Store which provides the results to the Front-Store (2). At any moment during the session, if the user clicks on a product (best seller, query result, shopping cart…) a request is sent to Back-Store to provide more information on this product (3).

The E-Media administrator has also the possibility of consulting information computed by the various agents. For instance Figure 12 gives indications on the Billing-Processor. The administrator can either displays the current stock for each product or the orders that have been sent for a certain period.

Particularly for the broker pattern implementation, Figure 13 shows the remote administration tool for the information broker described in Figure 2. The customer sends a service request to the broker asking for buying or selling DVDs. He chooses which DVDs to sell or buy, selects the corresponding DVD titles, the quantity and the deadline (the time-out before which the broker has to realize the requested service). When receiving the customer's request, the broker interacts with the media shops. The interactions between the broker and the media shops are shown in the bottom-right corner of the figure.

6 Related Work

Literature on MAS offers many contributions on using social concepts to design MAS. Fox (1981) has introduced the idea that using such metaphors can be useful to *describe* the organization of distributed systems. Our motivation is different: we focus on how to use organizational and social concepts to effectively *design* multi-agent architecture and how to apply them in a software engineering perspective while Fox studies organizations as an emergence of social behavior.

Figure 12. Statistics on stock and sent-orders

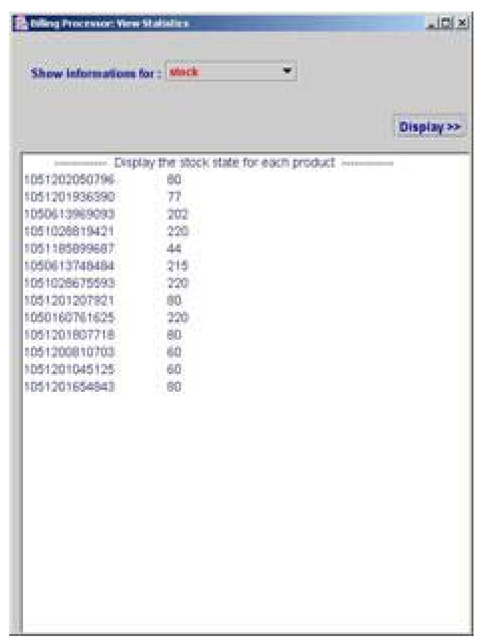
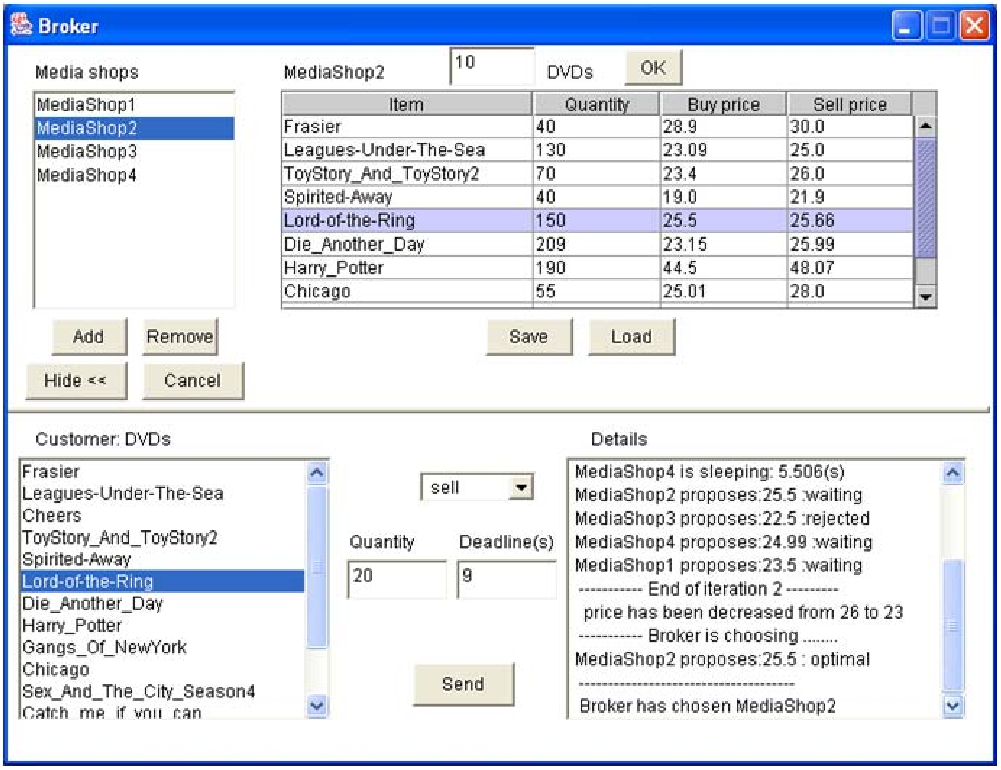


Figure 13. The Information Broker of E-Media



Computational methods have been used to better understand the fundamental principles of structuring MAS (Lesser, 1999) based on an organizational perspective. Although they can be extremely useful for detailed design (modeling sophisticated capabilities, alternative methods, activity-related effects, and complex interactions), they are not suitable for architectural design, where more abstract concepts, such as actor, goal and strategic dependencies are needed.

Other research work on multi-agent systems offers contributions on using social concepts such as agent (or agency), group, role, goals, tasks, relationships (or dependencies) to model and design system architectures. Aalaadin (Ferber & Gutknecht, 1998) uses such concepts to model the organizational structure of multi-agent systems. Different types of organizational behavioral requirement patterns have been defined and formalized. Similarly, in the Gaia methodology (Wooldridge, Jennings & Kinny, 2000), role and interaction models are used for analyzing the understanding of the system and its structure. The main difference with our approach is that in both Gaia and Aalaadin, the organization description does not include the goals associated to the agents.

On a design patterns perspective, the proposals of agent patterns (see e.g., Do, Kolp & Faulkner, 2005) are not intended to be used at a design level, but during implementation when low-level issues like agent communication or information gathering are addressed.

7 CONCLUSION

Agent-Oriented modeling and design is an engineering discipline still under development. But the interest of this recent software paradigm comes from that it can better meet the increasing complexity and flexibility required to develop software built in open and distributed environments while deeply embedded in social and human activities. Nevertheless, the emergence of a new approach requires time to be absorbed by the software community and market. Indeed, it needs standardization, productivity gains, proven efficiency on huge and complex user-interactive software development projects, well-designed development frameworks, etc. to review its standards.

Architectural design for MAS has not yet received the attention object-oriented architectures have had during the past decade. Collection of well-understood architectural styles and patterns exist but for object-oriented rather than agent-oriented systems.

Considering the social intrinsic nature of MAS, this chapter has proposed a social-driven framework to design architectures for such systems. The framework considers MAS architectures at two social levels: Organizational architectural styles constitute a macro level; at a micro level it focuses on the notion of social design patterns.

In particular we have detailed and adapted the structure-in-5, a well-understood organizational style used by organization theorists and the Broker social design pattern viewed as a combination of several other social patterns.

The chapter has proposed a validation of the framework: it has been applied to develop E-Media, an e-business platform implemented on the JACK agent development environment.

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KEY TERMS

DesCARTES: Design CASE Tool for Agent-Oriented Repositories, Techniques, Environments and Systems (DesCARTES) is a framework proposes a set of generic architectural structures. It is also constituted of the DesCARTES Architect, a CASE Tool for the edition of i* and other Tropos diagrams.

Tropos: Tropos is a novel methodology for building agent-oriented software systems. Tropos is based on two key ideas. First, the notion of agent and all related mentalistic notions (for instance goals and plans) are used in all phases of software development, from early analysis down to the actual implementation. Second, Tropos covers also the very early phases of requirements analysis, thus allowing for a deeper understanding of the environment where the software must operate, and of the kind of interactions that should occur between software and human agents.

Architectural Design: The objective of Architectural Design is to organize the dependencies between the various sub-actors identified in the previous phases in order to meet functional and non-functional requirements of the system.

Detailed Design: in Detailed Design the behavior of each architectural component is defined in further detail. This discipline is concerned with the specification of the agent micro level taking into account the implementation platforms. The objective is to perform a design that will map directly to the code.

ENDNOTE

1 Design CASE Tool for Agent-Oriented Repositories, Techniques, Environments and Systems (http://www.isys.ucl.ac.be/descartes)

Chapter XXVI
Designing for Trust

Piotr Cofta
British Telecom, UK

a bstract

Designing for trust is a methodology that attempts to design our perception of trust in information systems, in the long-term expectation that such systems will foster justified trust among people. The methodology contains several tools, but this chapter concentrates on a specific analytical tool that can be used to assess the compatibility between existing and required relationships of trust, in the context of information flow. While still under development, this methodology brings interesting results, identifying and addressing the strengths and weaknesses of incoming technical systems before they are actually deployed. This chapter discusses basic principles of designing for trust, presents the architectures of trust compatibility assessment tool and shows its applicability to citizen identity systems, using the proposed United Kingdom scheme as an example.

We become what we behold. We shape our tools and then our tools shape us.

—Marshall McLuhan

Introduct Ion

Trust is one of the most pervasive yet least understood phenomena. While it has 17 different meanings and encompasses more than 30 constructs (McKnight & Chervany, 1996), the average person can intuitively and immediately determine the extent of trust in another person—as long as he can interact with such a person, preferably face to face. Unfortunately, digital systems negatively impact our ability to assess trust, thus reducing the benefits of modern information systems. Furthermore, they often become sources of distrust and distress, dis-connecting rather then connecting, as they allow criminals to alter the flow of information and deceive other participants.

All these negative consequences of a lack of trust in the operation and through the operation of digital systems leads to insufficient adoption of information systems, contributing to a surpris-

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ingly high failure rate of such systems (Clegg at al., 1997). The number of digital systems that have been deployed, only to be eventually scrapped as unaccepted (yet expensive) is quite large, and every system of this kind has contributed to a decline in the social trust of technology as such (Lacohee, Crane, & Phippen, 2006).

This undesirable situation has been noticed and several initiatives have been undertaken, such as Microsoft's Trustworthy Computing strategy (Charney, 2008). Designing for trust subscribes to the same stream, even though it addresses the problem of trust at earlier stages of the system lifetime, during the design phase of the information system. The methodology provides methods and tools that allow for the design of systems that reflect the extent of justified trust that one party has towards the other. As such, this methodology is less concerned with the trustworthiness of particular communicating agents or communication channels, as it concentrates on the ability to detect trusted and untrusted agents at the design stage, mostly to encourage further adoption of the system.

From the perspective of social trust and social acceptance, one of the most challenging projects of its kind is the deployment of citizen identity systems (known as identity card schemes) that are currently being pursued in several countries. While such schemes may be considered totalitarian by some, they can be of great benefit by improving and securing digital interaction, allowing for recognition of social norms and thus instilling trust. The prerequisite for them is social acceptance of such schemes (Cofta, 2004). However, current propositions are driven by technology efficiency (yet not always cost efficiency) and generally disregard the adoption factor and their impact on social trust.

It can be expected that by altering certain technical or operational aspects of such schemes, it is possible not only to build trust in systems and gain their social acceptance, but actually to turn the challenge into an opportunity by developing a platform where social trust can flourish, supported (rather then destroyed) by the technology.

This chapter starts from a general discussion of trust, then it drafts basic principles of 'Designing for Trust', to concentrate on a specific analytical tool and method, 'Architectures of Trust'), Finally, it shows the applicability of such a tool to the case of citizen identity systems, using an example of the proposed UK scheme.

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Trust is one of the most pervasive yet least understood phenomena. While it has 17 different meanings and encompasses 30 constructs (McKnight & Chervany, 1996), the average person can intuitively and immediately determine the extent of trust in another person—as long as he can interact with such a person, preferably face to face. The operational definition of trust that is used throughout the paper is derived from several typical constructs found in the literature (Mayer, Davis, & Schoorman, 1995).

The willingness of a party to be vulnerable to the actions of another party based on the expectation that the other party will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party

It is generally accepted that trust can be expressed towards human intentional agents, but it can also be expressed towards technical or social agents that evoke an intentional stance (Dennett, 1989). Furthermore, trust can be expressed not only by humans, but also by technical agents, usually under direct or indirect instruction from humans. Within the methodology presented here, human (including social) and technical agents will receive similar treatment, even though their sources of trust (hence methods to determine it) may differ. While both humans and devices are nodes in the global communication networks, we attribute consciousness and cognition only to humans (Hodgson & Cofta, 2008). Trust between technical agents (such as computers) is therefore a reflection and representation of trust between human agents, not an emergent property of the technical system.

From the perspective of information exchange, the notion of vulnerability can be interpreted depending on the position of the agent. The receiving agent becomes vulnerable if it accepts (and possibly acts upon information received from other agent, even though it cannot verify such information while accepting that such information may place the receiving agent at a disadvantage. For the sending agent, the vulnerability is associated with a loss of control over information, so that such information can be abused by the receiving agent, e.g. by altering it, distributing to other agents, withholding it etc.

Distrust, also used by the 'Designing for Trust' methodology is understood here as a construct different from trust, its functional equivalent (Luhmann, 1979), not as a simple lack of trust. Distrust is associated with belief that the other proactively tries to harm the agent (Cofta, 2007a). Finally, one agent may hold no beliefs regarding the other agent, in which case neither trust nor distrust is present. Such a situation will be described as uncertain.

DESIGNING FOR TRUST

When designing for trust is considered, such a proposition may be considered to be an elusive one as several alternative answers can be provided. First, a face-lifting exercise can be proposed where an otherwise untrustworthy system receives a new lick of paint to elicit the user's trust. While this is a popular approach and one can find it in several guidebooks (Egger, 2000), this is not what this methodology is after, as such design eventually breaks, leading to even greater disappointment, not only for the individual service, but for the technology in general. What is needed is a justified trust.

There is also another goal, a far-reaching one. While justified trust is a solution for now, it may also let trust and trustworthiness grow, as in the end trust is a socially less expensive option, an option that greases wheels of social interaction and sustains society through deep crises (Fukuyama, 1996). So, Designing for Trust may eventually drive people towards being more trustworthy, either by (optimistically) allowing them to reveal the better side of their nature or (pessimistically) by imposing social rules that will drive them towards trustworthy behaviour.

Designing for Trust is a methodology that attempts to improve our ability to design our perception of trust in information systems at early stages of system lifetime. Of several challenges that it brings, the methodology addresses the following three:

1. How to design a technical system that allows participants to express and develop justified trust among themselves?
2. How to drive the social adoption of information systems by making them compatible with the existing structure of justified trust?
3. How to develop socio-technical solutions that facilitate the creation of long-term justified trust in technical systems?

In response to the first challenge, an environment can be designed that accentuates and consolidates evidence of trust (and equally evidence of distrust) so that such evidence is not overlooked, but is passed to the decision-maker. Such systems have been classified as Trust Enhancing Technologies (TET) (Cofta, 2007a), and some elements are actually already available. This chapter does not discuss TET.

The second challenge, that is discussed here as Architectures of Trust is addressed by tools that allow for the verification of the compatibility of trust and information flow to provide for the early detection of possible incompatibilities. The remaining part of this chapter provides a detailed description of the method used by such a tool.

The final challenge is addressed by a set of recommendations and associated verification tools that together form a proposition for a complete, sociotechnical approach to system design and operation. This part of Designing for Trust is not discussed here and is currently under development.

Justified Trust

Within a relationship, certainty about the future can be handled by a mixture of trust and control (Cofta, 2007a). Trust is generally seen as beneficial and superior to control, as it decreases the cost and increases the flexibility of a relationship. Sources (Fukuyama, 1996) suggest that if only everybody were able to reach the stage where trust is the prevalent attitude, this would greatly benefit the economy, nations and individuals.

Designing for Trust takes a different stance, as it aims at systems where justified trust flourishes, i.e. where trust is met by trustworthiness, as greater trust does not always lead to the greater good (Figure 1.). While too little trust leads to the under-utilisation of opportunities, too much trust makes individuals too vulnerable to possible mischief by the other party. It has been demonstrated that it is justified trust that drives the optimum market equilibrium (Braynov & Sandholm, 2002).

Therefore the task discussed here is not how to make people trust more but how to make them trust just enough—not too little and not too much. Interestingly, such an approach may eventually lead to an overall increase in the amount of trustworthiness—leading to an increase of trust. This is because both individuals and institutions will eventually learn that they are trusted only to the extent of their trustworthiness, so that the only way to benefit from being trusted is to work on improving such trustworthiness—assuming that there is a perceived value in being trusted.

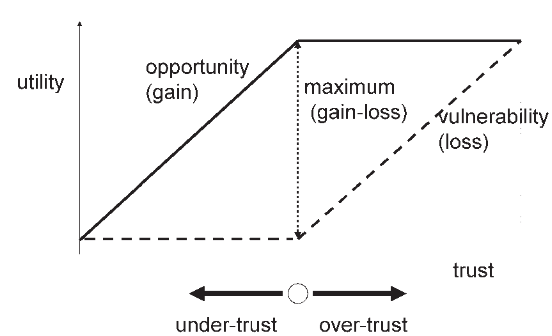
t echnology a doption

Studies in technology adoption (acceptance) demonstrate two distinctive streams. The first one analyses the process of personal adoption, seeking clarification regarding decisions made by individuals, on assumptions that individuals are relatively free and well informed to accept or reject the given technology. The Technology Acceptance Model (TAM) (Davis, 1989) is a well know example of the conceptualisation of this process, where ease of use is seen as a driver to usefulness, both influencing intentions to interact and finally the use of the technology. The richer UTAUT model (Venkatesh, Morris, Davis, & Davis, 2003) addresses components that relate to social influence, but neither model directly mentions trust. It is only in later studies, related e.g. to the adoption of mobile technology (Kaasinen, 2005) where trust influences adoption. Even there, such trust is primarily related to reliability of technology (Clarke, Hardstone, Rouncefield, & Sommerville, 2006) and of the operator of such technology, only marginally addressing the need for control and privacy.

Another stream addresses the social adoption of technology, where an individual decision to adopt is embedded into the structure of social relationships. Some research addresses technology adoption and diffusion (Isham, 2000) to investigate how individual decisions are affected by the socially-embedded dissemination of knowledge and practice. It is commonly observed that both diffusion and adoption follow the social relationship of trust, i.e. if individuals and groups that are trusted adopt the given technology, they are followed by those who trust in their choice.

A compatible, yet alternative angle is provided by an analysis of the relationship between society and technology (rather than individual decisions), to analyse the compatibility value between technology and the society. It has been demonstrated that such compatibility with regards to value and structure greatly improves technology adoption.

Figure 1. Justified level of trust



For example, a multi-dimensional analysis of the value compatibility of the information system within the corporate environment (Bunker, Kautz, & Nguyen, 2006) shows that even if structural and practical dimensions of compatibility can be satisfied, adoption can be hampered by perceived cultural incompatibility. This demonstrates the difference between a formal recognition of trusted relationship (as embedded in organisational structures and practices) and informal ones (mostly reflected in the corporate culture). This case study also shows how employees respond to the perceived incompatibility by innovating practices around such incompatible technology, often contravening the original intent of the deployment.

Not considering regulated societies of corporations but self-regulated nations, Bohmann (1989) addresses the concept of social compatibility of technology, defining a desired set of values that should be embedded in the technology, in the form of a postulate proposition that should benefit the society.

Architectures of Trust

'Architectures of Trust' subscribes to the latter stream, i.e. it explores the socio-technical compatibility, between social and technical structures, in the expectation that such compatibility will improve adoption. However, this method does not explore value compatibility, but the compatibility between information flow and relationships of trust, in the expectation that relationships of actual trust relate to the set of values the society adheres to.

In the adoption of information systems one of the main concerns is that information flow will be disturbed by its incompatibility with social practices. This methodology captures such practices in the form of relationships of trust, to compare with such a flow, in the expectation that trust both enables and facilitates information flow. If there is a visible incompatibility, such an information system is unlikely to be adopted and recommendations can be drawn on how to improve its architecture.

While this tool is still under development and some early thoughts have been presented e.g. in (Yan & Cofta, 2003), it has already been successfully used to identify deficiencies and suggest improvements to some technical systems.

Note that the tool concentrates on a specific aspect of information systems, allowing for a deep analysis, formalisation, instrumentation and automation of such analysis. Furthermore, the tool operates on a relatively high level of abstraction, thus allowing for an analysis of large information systems. This can be seen as beneficial compared to existing methods that are often fragmented and subjective.

However, the tool may also be seen as constraining as it focuses only on the specific aspect of compatibility, leaving aside such important constructs as ease of use, expected increase in performance etc. It is expected that the tool will do better in determining non-conformity (thus predicting the failure of adoption) than the actual extent of the adoption. However, considering that the majority of information systems are not adopted as designed, a tool that allows for the early detection of potential problems is of significant value.

Concepts

Basic concepts of 'Architectures of Trust' can be derived from an observation that information (whether in digital systems or otherwise) flows along lines of social trust. Therefore, if social relationships of trust can be captured (e.g. on a diagram) and information flow can be superimposed on it, the compatibility between information flow and trust relationships can be discovered.

Assuming that the relationship of trust is directional (i.e. a trustor trusts the trustee, but not necessary vice versa), we can see that there are two constraints to such information flow, compatible with vulnerabilities of information sender and recipient.

1. If information is of value to the sender who would like to constrain its distribution, then

it should flow towards the trustee (i.e. along the direction of the relationship), in expectation that the trustee will take due care of such information. This expectation is particularly important for personally identifiable information, is closely related to the need for privacy and can be encapsulated into a perception of obligations (Mbanaso, Cooper, Chadwick, & Anderson, 2007). A corporate environment with strict document classification and restricted access rights provides an illustration of an environment where such a principle is embodied in technical systems, even though frequently in a highly imperfect way. Furthermore, the challenge (and recent market failure) of Digital Rights Management demonstrates that if there is insufficient trust between the sender and recipient, then even a sophisticated technology may not be sufficient to protect the unconstrained distribution of information.

2. If information is of value to the recipient who would like to act upon such information, it should flow from the trustee (i.e. against the direction of the relationship), in the expectation that the quality of such information, its fitness for purpose etc. is high. This expectation is particularly important if the recipient is to base their action on such information, and can be expressed as a qualified reliance on information (Gerck, 2002). When applied to business activities, where decisions quite often have a measurable financial outcome, a whole industry of analysts attempt to satisfy the need for valuable information. Among the general public, the need for trusted information became specifically acute with the emergence of user-generated content which is quite often of unknown origin.

By analysing the existing information flow, the relative value of information and existing relationships of trust it is possible to infer whether both constraints are satisfied, i.e. whether the existing information system is operational. Considering the deployment of a new technology, there may be a need for modifications to existing information flow. By analysing the postulated flow it is possible to see whether it satisfies both constraints once technology is introduced. In both cases it is necessary to analyse jointly human and technical agents, if they form a part of the system that is being analysed.

There is a difference between detecting a need for trust and building trust. While the former is within limits of the tool, the latter is not. For example, one of the recurring questions with regard to modern information technology is the creation and the role of the so-called trusted third party. Such a party usually forms a central hub to facilitate the flow of information, flow of credentials that are used to express trust, management of the system etc. While trust in such a party is necessary for the system to operate (and this will be detected by the analysis), Architectures of Trust cannot tell how to develop trust in such a party. Such considerations form another part of the overall framework of Designing for Trust.

Note also that the compatibility of social and technical architectures of trust is not the only method to assure technology adoption. Disruptive introduction of technology can be used to undermine existing relationships in the expectation that new relationships will form out of temporary chaos to alter social structures, mostly by re-defining the notion of groups, relationships and hierarchy (and power). Those two types of adoption are not mutually exclusive, as e.g. the history of the Internet is teaching us. Originally designed to protect the military ability to 'command and control', the Internet has been re-discovered by rebels and become adopted as the mainstream medium for commerce, only to become a disruptive platform to create social trust through cooperation.

method

The method and notation proposed by 'Architectures of Trust' can be explained below on the basis of a simple example of the e-mail delivery system (Figure 2). This diagram provides a graphical representation of relationships that exist between different agents. It maps jointly both social and technology agents, in the context determined by the technology of e-mail. Relationships of trust between them are expressed as a directed graph, with solid lines labelled with their types (explained later). Required information flow is superimposed on the diagram in a form of dotted lines linking small circles next to respective nodes.

In the example, we have three human agents: A (sender), B (recipient) and X (operator of the common mail gateway). A operates her computer, a; B uses her computer b and X operates the gateway c. Information flows from A through her computer, gateway and another computer to B.

The purpose of the analysis is to verify whether there is a socio-technical compatibility between the social architecture of trust and architecture required by the information flow. This particular analysis concentrates on the information flow from A to B, but the same tool can be applied to analyse other flows.

Once agents are identified, it is necessary to determine relationships of trust between them. Note that as trust is a relatively complex concept, the analysis should be very specific and concentrate on trust that is relevant to the given information flow, not on trust in general. We assume that if one agent trusts another for the purpose of information flow, this means that the trustor believes that the trustee-sender delivers information in the best interest of the trustor (i.e. relevant, timely, unaltered etc.) and that the trustee-recipient will take proper care of information that has been sent to it (i.e. not disclose to third parties, forward to the destination etc.).

In the case of human agents, such information can be gathered though appropriate methods such as interviews, observations etc. In the case of technical agents, information about trusted relationships can be quite often readily derived from the actual settings of such devices, e.g. from the list of 'trusted sites' or approved certificates, or from the access level allowed by a particular password. It may be argued that such indicators do not signal trust between devices, but rather between operators of such devices, but for the purpose of the analysis presented here such differentiation is not essential.

Some relationships may not have any trust value assigned to them, possibly because they are not directly available for inspection. For some relationships the analysis may lead to conflicting results, e.g. trust and distrust will be reported at the same time. Reasoning rules presented later allow for the removal of conflicts as well as for the assignment of trust values to inaccessible relationships.

For the purpose of this example, we assume here that information is both important for A and for B, even though possibly for different reasons, e.g. the e-mail may contain confidential information that will help B make a proper decision. Note that it is not always the case, e.g. marketing information can be of higher value to the recipient (who is to make a purchase decision) while personal information may be of higher value to the sender (who may fear such information being abused). In such cases the relationship of trust does not have to be symmetric.

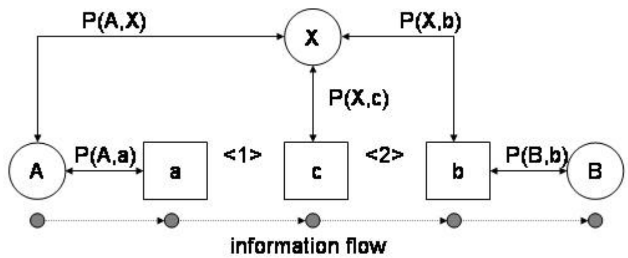
Notation

The following notation is used. Note that this notation intentionally simplifies possible types of relationships, as qualitative compatibility and direct link to observable properties of agents are more important than quantitative exactness. Consequently, the relationship of trust here, if known, can take only two values: trust or distrust. However, the notation can be enhanced to capture more specific contexts, several levels of trust, uncertainty etc. For a more sophisticated set of tools please refer to (Josang, Marsh, & Pope, 2006) or (Gutscher, 2007).

T(x, y)	x trusts y (in a given context, for the purpose of information flow)
D(x, y)	x distrusts y (in the same context)
P(x, y)	there is a mutual trust between x and y, i.e. T(x, y) and T(y, x)

Further, it is possible to reason about relationships

Figure 2. Example: architecture of trust



of which information is not available (e.g. in the example relationships between a and c or c and b). In this case the following set of rules are applicable.

(1) $T(x, y), T(y, z) \rightarrow T(x, z)$ (transitivity)

(2) $T(x, a), T(x, b) \rightarrow P(a, b)$ (delegation)

(3) $T(x, y), T(y, x) \rightarrow P(x, y)$ (consolidation)

(4) $T(x, y), D(y, z) \rightarrow D(x, z)$ (pruning)

(5) $T(x, a), D(x, b) \rightarrow D(a, b)$ (conflict)

(6) $T(x, y), D(x, y) \rightarrow D(x, y)$ (distrust)

Returning to the example, in order for the system to be deemed compatible, there should be a path from A to B that consists only of P-type edges, i.e. information should be trusted both by every sending and receiving party. It can be seen from the diagram that there are two edges <1> and <2> that have no relationship associated with them. However, it can be reasoned that:

<1>: $P(A, a), P(A, X) \rightarrow P(a, X)$
$P(a, X), P(X, c) \rightarrow P(a, c)$

<2>: $P(X, b), P(X, c) \rightarrow P(b, c)$

This allows the claim that there is a complete chain of relationships of mutual trust between A and B along the path of information, thus information flow is compatible with the underlying relationship of trust.

Note however, that if the relationship P(X, c) is removed, it is no longer possible to reason about relationships between a, c, and b. In such case the analysis shows an incompatibility, as information is supposed to travel along relationships where trust may not exist. If the relationship of P(X, c) is replaced with D(X, c) (e.g. the operator has found a fault in the gateway) then such distrust propagates to relationships between a, c, and b, making the flow entirely incompatible.

cItIzen IdentIty schemes

Several governments have embarked on various projects to become identity providers for their citizens. While such projects may vary in scale, maturity and cost, their most striking feature is that they vary significantly in their social adoption. There are nations that happily embraced such systems and there are those that struggle with it, seeing such systems as overly invasive and encroaching on their civil liberties (London School of Economics, 2005).

While such a difference can be easily dismissed as a 'cultural' issue, it also provides an excellent opportunuity to study their relationship of trust; to see whether they are 'designed for trust', i.e. whether the way they are designed to follow social relationships of trust.

From a purely technical perspective, citizen identity systems follow the concept of 'trust management' (Blaze, Ioannidis, & Keromytis, 2003) whereas an issuer verifies an identity and then issues a credential that can be authenticated against information held by such an issuer. Several modern implementations of identity management schemes (Birch, 2007) follow the same concept, with more flexible protocols or more comprehensive policies. The most notable feature of modern citizen identity systems is the use of cards and the existence of a large, centralised database.

The question that is usually asked when it comes to citizen identity systems is the one of privacy, as collecting so much personal information in an easily accessible form in one place (i.e. in the centralised database) creates incentives to explore it for criminal, commercial and political benefits. While certain privacy enhancing technologies can be deployed to prevent or minimise such risk, they are unlikely to fully alleviate it due to their impact on performance, resources and cost as well as on needs of law enforcement.

The question of privacy can be effectively expressed in terms of trust in an entity that controls such a database (which is usually the government) (Cofta, 2007b). Should one trust the government, one has no problem disclosing personal information. If there is no trust, then citizens will embark on different ways of protecting their valuable personal information (that they believe rightfully belongs to them, not to the government (Lacohee & Phippen, 2007). This may take on the form of psychological withdrawal, civil disobedience, usage of informal relationships, development of black market etc., depending on the severity of the problem and tools that are at the disposal of the society.

As this chapter is interested in designing for trust, and more specifically in Architectures of Trust, the main question discussed here is whether the information flow of personal data follows relationships of trust, from the perspective of a citizen.

For that purpose the analysis presented below will explore national citizen identity systems, specifically the proposed system of the UK identity card (House of Commons, 2006). While findings may apply equally well to other national ID systems, this will allow us to draw on existing research and build upon a practical example. For reference, the UK scheme assumes the issuance of smart cards to citizens where such cards can be verified against data (including biometrics) stored in a set of inter-connected central databases. The main users are various government agencies (including law enforcement), but commercial organisations and foreign governments may gain access to the database as well.

It is worth bearing in mind that the question of citizen identity goes beyond national boundaries. While current and proposed schemes are national (or regional at best), everyday experience is increasingly global. GSM, the Internet, international commerce as well as cheap flights have created an expectation that any identity scheme should work globally and that roaming is possible and desired. This brings into the discussion another layer of complexity: globally recognised identity together with its related complex management issues.

In the case of citizen identity schemes the main interest is in an orderly adoption, where such adoption depends mainly on the adherence of such systems to the existing social architecture of trust. It is expected that neither governments nor citizens are interested in the disruptive adoption (or rejection) of such systems.

Perceived a rchitecture of t rust

People tend to see themselves as being at the centre of an identity bubble, with their self-identities (Giddens, 1991) being protected against disclosure through a series of presentations that they tend to construct. Such presentations are functionally specialised (and probably slightly improved) subsets of our self-identity and are often the last and most effective ways of protecting one's privacy (Nissenbaum, 2004).

While identifying entities that interact with an individual, two observations are important. First, while individual presentations can be constructed to interact with separate entities, people are aware that such entities collectively belong to the wider world and that they can exchange information between them regardless of whether an individual allows for it or not. In the case of citizen identities, such a 'world' consists of cooperating governments, each government exercising control over citizen identity within the country.

Furthermore, (at least in the UK) people see the government not as a single monolithic organisation, but a collection of (again) functionally specialised ones: car registration, tax collection, health care etc.

Those observations, together with specific research in the individual perception of identity systems (Lacohee & Phippen, 2007) allows for synthesis (as an example) of the following picture of the perceived architecture of trust (Figure 3.), that reflects the citizens' understanding of entities and relationships between them.

Three governmental services X, Y and Z are accessed by A. Two of these services are within the control of a first government unit P, the last one—by a different one Q. On the basis of research it can be determined that there are relationships of trust between an individual and specific service providers and between such service providers and their respective central governments. There are also two relationships of distrust, between A and central governments P and Q (i.e. A does not trust either of the governments). Furthermore, it is optimistically assumed (for the purpose of this example) that there is mutual trust between governments.

As an acceptance of any citizen identity system is mostly a question of privacy and trust, it is assumed that personal data is more valuable to A then to any other agent. Therefore there is a need at least for trust between A and X, Y and Z, as they are involved in collecting and processing personal data. Furthermore, the relationship of trust between service providers and governments may be useful e.g. for data generalisation (e.g. for national statistics) while trust between governments is needed for international acceptance of identities. All those requirements are satisfied and the current system can be deemed to be stable.

Should a person require a particular service, she can use an appropriate identity to access a trusted service. As the communication happens along relationships of trust, A has no problem with disclosing personal information to services and with services keeping such information. Furthermore, if such a person requires communication with any government, she can use one of the services to do it, assuming that such communication will be maintained again along trusted relationships.

Implied a rchitecture of t rust

The centralised citizen identity system proposed in the UK removes the direct relationship between service providers and citizens and replaces it with a relationship that passes through central government. It is central government that collects personal data, verifies the identity, issues the card and runs centralised databases.

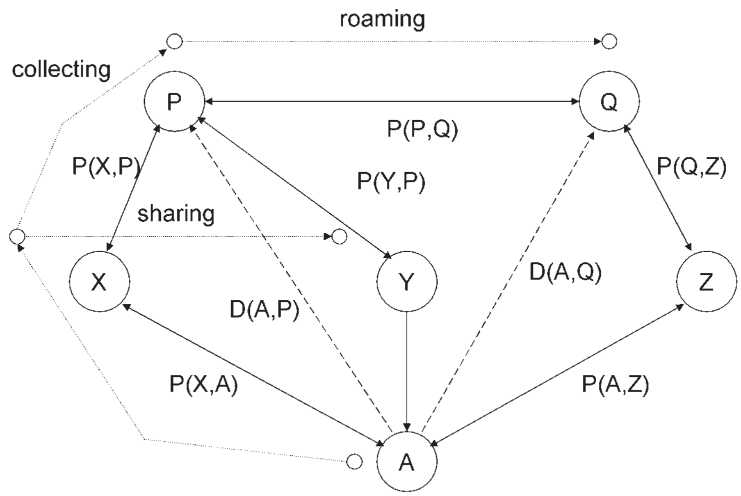
The implied architecture of trust (implied by such a centralised system) is significantly different (Figure 4). While there is still a separation between governments, all identities under one government consolidate so that the citizen deals directly with one government contact point every time she uses any of its services. Effectively, the government becomes a third party intermediating all the relationships with services.

This implies that the citizen is supposed to directly trust the government, i.e. that there should be at least T(A, P) and T(A, Q), as for the remaining edges there are already documented relationships of trust. However, there is already a relationship of distrust between A and P and A and Q, effectively preventing trust.

Even worse, the government dis-intermediates an existing trusted relationship with services and enforces a relationship that is distrusted. As the only way to access trusted services is through a distrusted government, such services become unaccessible and may even eventually become distrusted as well. So, it is not only a question of a lack of trust in government, it is also a question of damaging trust in individual services.

The analysis has demonstrated that the proposed citizen identity system implies information flow that conflicts with existing relationships of trust.

Figure 3. Perceived architecture of trust



It can be therefore expected that, even if deployed, the system will be met by a certain resistance from citizens, potentially derailing its adoption.

c onclus Ion

The methodology of 'Designing for Trust' attempts to embed principles of justified trust into the design of a technical system by the combination of socio-technical requirements and an analysis of a compatibility between architectures of trust and information flow. Currently, the methodology offers three tools to address three different questions: how to design a technical system that allows participants to express and develop justified trust among themselves; how to drive the social adoption of information systems by making them compatible with the existing structure of justified trust; and how to develop socio-technical solutions that facilitate the creation of long-term justified trust in technical systems. Architectures of Trust address the middle question of compatibility between trust and information flow.

There is a growing dissatisfaction with governments' ability to effectively and efficiently run large ICT projects, and the citizen ID system is one of those. While this does not imply lack of trust in government's intentions or goodwill (that is beyond the scope of this analysis), it certainly does in its competence to design, implement and run such systems. Still, this means that there is no trust when it comes to managing citizen identities, so citizens take responsibility into their own hands, working with or around existing solutions. However, it does not imply that large government identity systems are always doomed to fail. The following is a brief discussion of some solutions.

The first solution is the most straightforward one, even though it is not the easiest one: the government should earn the trust of its citizens, potentially by deploying technology that will allow it to demonstrate its trustworthiness, in the expectation that citizens will notice and will grant justified trust. Such technology should facilitate not a simple dissemination of information but it should amplify evidence that is relevant to developing trust (and distrust). While details of such technology should probably be left for a separate discussion, support for democratic trusted intermediaries and social groups may provide some solutions.

Alternatively central government may use principles of Trust Enhancing Technologies (see (Cofta, 2007a) for details). Here, it can offer its citizens something that only the government can reliably provide: a complete assurance and restitution when the technology delivers a negative outcome, to stimulate curiosity and experimentation. Such assurance (written into the law and supported by visible practices) may (but only may) offset a lack of trust and facilitate the adoption of a centralised system.

Another solution hangs on the trust that citizens have in functionally specialised outposts of the central government. By accepting the existing social architecture of trust, an ID system can be built where the citizen may and will have several identities to deal with her functionally specialised needs. However, the central government may develop a unifying technology and an interconnectivity platform, similar to the one that exists in the financial world to allow for the global acceptance of credit cards, regardless of the issuer. It will be up to the citizen whether she will be willing to cross-share her identities (i.e. form a federation of such identities) or to designate one identity as a leading one (in the form of an affinity) or finally whether she wants to keep them separate.

Finally, the government may appoint independent operators for the ID system, those that are already trusted, reserving for itself a regulatory role, treating the ID area similarly to public utilities. Such an operator will directly work with governmental outposts (analogies from the financial world can be found again), so that trust in the government will become irrelevant. Banks or mobile operators may be willing to assume such responsibility, effectively becoming identity providers. The socially relevant identity of a citizen can be then constructed (either by the citizen or for her) using one or several of existing, publicly available ID schemes.

It is important to remember that the social acceptance of a technology is always a work in progress, as society in a characteristically openly creative way will always use technology to construct its own meanings and satisfy its goals, rather than those that were envisaged by the original designers. Therefore a continuous dialogue and social monitoring should always be an integral part of any solution.

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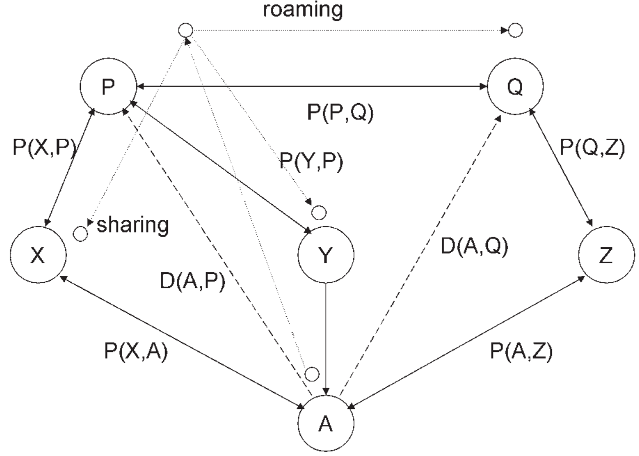
Figure 4. Implied architecture of trust



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key terms

Agent: Collective name of a human or technical entity that takes active part in the information flow and in relationships of trust.

Distrust: The functional complement of trust, where the perception of a hostility of an agent leads to the desire to avoid any reliance on such agent.

Identity system: The socio-technical system that is used to assert identities of human agents with an aid of certain technical means, according to formal policies and social practices

Justified trust: The extent of a trust that the trustor has towards the trustee that is matching trustworthiness of such trustee.

Socio-technical compatibility: Compatibility between social relationships assumed by the technology and actual relationships present at the time of technology adoption

Technology adoption: The extent by which a given technology becomes accepted and incorporated into approved social practices.

Trust: The willingness of a party to be vulnerable to the actions of another party based on the expectation that the other party will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party

Chapter XXVII
Pattern languages for CMC Design

Dan Dixon
University of the West of England, UK

abstract

Three decades ago the concept of pattern languages were introduced in the field of architecture and they have since become widely used in object-oriented programming and HCI. However their use in computing is divergent from Alexander's original goals on two main points. Firstly, they were largely intended to describe the spaces formed by or for human activities and events. Secondly, they were intended as a way for professionals and lay people to communicate whilst designing buildings. This chapter suggests that the socio-technical design of social software should rediscover both these principles, firstly in a fuller appreciation of the wider human angle, and secondly in the participative design approach. Indeed, a pattern language approach within a socio-technical framework seems the ideal way to design the next generation of computer-mediated communication applications, as it will do so in a social context and in partnership with end users.

The power to make buildings beautiful lies in each of us already.

—Christopher Alexander

Introduct Ion

Over the last decade many new forms of computer-mediated communication (CMC) have appeared. These have progressed well beyond the original forms of, largely interpersonal, communication that appeared with the early internet; email, usenet and internet relay chat (IRC). Large scale social networks, social bookmarking, wikis, media sharing, instant messaging and now mobile applications are all reshaping our understanding of CMC. Many of these new applications involve large-scale, net-

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worked interactions and the people who use them are now very different from the academics and engineers who originally built them.

In software design there is a process gap between understanding the overall objectives and having a well specified system that can be handed programmers to build. In software product management terms, this often gets called the 'fuzzy front end' of a project. At the beginning of any product development, the team involved, will often a lack an understanding of what the software product needs to be and lack a clear process on how to move from what are usually business or organisational level goals to the level of detail needed so that developers can create the correct software (Khan, 2004). Different projects and organisations tackle this in different ways. Often they will tend to rely on experts who have deep tacit knowledge in specific application areas and experience of working on many projects. This approach locks knowledge into these individuals, makes them critical to the process and isn't necessarily conducive to a participative approach.

In most cases this gap is currently filled by techniques like requirements gathering, functional specification, use cases or user stories. These techniques are very useful if the end product is well understood but they are better used as part of the specification phase of a project. In systems focused on single user applications or in well understood domains they may be sufficient to bridge the gap between the 'fuzzy front end' and software design, but aren't sufficient to plug the gap when we are building systems for computer-mediated communication. These single-user focused approaches to specification try to understand interaction as atomic tasks, and focus only on interactions between the user and the system. The sociotechnical systems we are looking at are inherently complex systems and because they are complex, they also need to be understood on a macroscopic scale through their emergent properties. Reductionist approaches, like the ones described above, will not work and so a technique that looks to emergence is required.

The architect Christopher Alexander was tackling similar problems and introduced the idea of patterns and pattern languages as a way of creating a participative design process. Patterns are a way of recognising and describing approaches and structures that are encountered repeatedly in a discipline. He described patterns through a three part rule; a relationship between contexts, problems and solutions (1979). These ideas although not being used commonly in architecture have been adopted widely in computing. In architecture these patterns are common parts of buildings or the ways that urban areas are laid out, in software development they are common ways that objects interact, and in HCI they are common site architectures or interface components.

Architecture has a lot in common with software design. Across both disciplines the designers are trying to create artefacts that fit into and enhance people's daily lives. Sociotechnical systems theory is, a now very established, approach to understanding how people and organisations relate to technology. The idea is that there are inter-linked human and technological systems involved in the use of any technology. Sociotechnical design was an approach that used these ideas as a basis for systems development. These ideas that started with investigations into how people use very physical machinery now make even more sense in an age of online social networks (Pasmore, Francis, Haldeman & Shani, 1982).

Pattern languages using a sociotechnical background are a possible way of bridging the divide between high level objectives and the lower level specification of any CMC system. Pattern languages can be used as a shared communication and collaboration tool between the technical professional and the lay person and they can be used to create an intermediary design artefact—an application pattern language for a product or system. This is exactly the way that Alexander intended pattern languages to be used in architecture, a very high level way of describing a building before drawing up any detailed blueprints. Additionally, this suits modelling the complex systems of computer-mediated communication as it is concerned with documenting and understanding the emergent properties at different scales, not delving into details.

the soc Iotechn Ical back Ground

The sociotechnical perspective essentially says that whenever we create any form of software, there are two interrelated and inseparable systems at work, both the technical system that has been built and the human system of the people who use it. The technical system is made up of the computing hardware and software and the social system is made up of the psychological and sociological activity that occurs on and around the technical systems (Whitworth, 2006). There is a chicken and egg debate that often occurs as to the relationship between each system but when there are changes to one of either the social or technical system then there will necessarily be some form of change in the other system in reaction to it.

The origins of sociotechnical systems theory can be traced back to 1951, well before even ARPANET was in place (Pasmore, Francis, Haldeman & Shani, 1982). Although in its early days the technology it was concerned with was broader, during the 1970s it had become focused on computer systems in organisations. Sociotechnical design was founded in the 1970s, well before CMC was common, and well before the current social software revolution. At this time the researchers were interested in gaining a wider understanding of why and how certain technologies were and weren't adopted, and how the hardware and software design process could support this adoption and ongoing use. Most of these systems weren't necessarily intended as communication tools but the researchers and practitioners of the time saw the human dimension, the communication that happened around their computer systems, was as important as the technical build.

Based on sociotechnical systems theory, Albert Cherns outlined principles for sociotechnical design that are currently very relevant (1976, 1987).

- The design processes must match up with what is being designed. One process does not fit all projects or systems.
- The design should not be so detailed that it does not allow adaptation and evolution.
- Scope and boundaries are difficult to control. Often, what is included or excluded from a project or product is difficult to discern.
- Information and resources need to be made available and accessible.
- Those who are creating and using the system should be in control of what is being built, not managers and consultants.
- The social, political and technical influences are inherently complex and difficult to understand. This understanding emerges through the project
- There are mechanical and deterministic processes at work as well as organic and unpredictable processes.
- A clear, shared understanding is crucial for success.
- Systems evolve over time, even from the time of conceptual design to implementation.

These principles outline how these systems are complex and fluid, and require collaborative design, using approaches that are understandable and useful to both software development professionals and end users alike.

In this time of online social networks, social software and computer-mediated communication the inter-linked nature of the software and the human systems becomes even more evident. This long tradition of sociotechnical systems research becomes even more relevant when software is being specifically designed for forms of communication, rather than computer systems where communication occurred, often in spite of the the design.

Any process or technique for the creation of social software, social media or computer-mediated communication must take into account both the technical and the social systems being created. A process that unifies these two systems, and doesn't differentiate between the two domains is required to help us design these systems in the future. Pattern languages, of a kind described by Alexander, are a useful tool to navigate through the fuzzy front end of projects.

The Core of Alexander's Pattern Language

Alexander's original pattern language is a way of describing what a building will be like before an actual plan is drawn up. It would describe which way a building should face, what the shape of walls might be like and what the construction techniques might be. However the pattern language for a project wouldn't actually be a blueprint or a floor plan of the building. Although architects might intuitively understand Alexander's principles and be applying them, they would usually do these activities subconsciously and invisibly to their clients. Alexander's pattern language was a way to create, at the very least, a useful domain language and shared design tool, so that this step in a process could be shared with clients.

According to Alexander, this meant that buildings and urban planning were more widely accepted by the people who lived or worked in them (1979). These issues of acceptance and use are instantly recognisable to any developers of software, let alone creators of social software.

There are five important points from Alexander's original works that are worth highlighting:

- The importance of 'the quality without a name'.
- Space shapes human interaction.
- Patterns describe an evolutionary balance of forces, not a design.
- Pattern languages are a project communication tool and unique to a project.
- A pattern language is a generative system.

His first, and most important, concept is 'the quality without a name', usually shortened to simply 'the quality'. This 'quality' is whether a construction, generally a building, part of one or even a city, is 'good', that it 'works'. This is an intangible property, but, to paraphrase his words, it is a property that is easy to understand and can be collectively agreed on. The words he uses to describe 'the quality' are: aliveness, whole, comfortable, free, exact, egoless and eternal, but he does reiterate that it can't be exactly described (Alexander, 1979, Ch 2, 3).

In programming this 'quality' could best be described in terms like elegance, readability or reusability, in user interface terms it could be described by words such as intuitive, learnable or usable (Borchers, 2000b).

Alexander starts with the idea that our lives shape our buildings and vice versa, our architecture is informed by us as individuals and our socialisation. Where the architecture is good, that it possesses the 'quality', the building itself, pieces of it, or larger structures are copied, so the good characteristics of our buildings are repeated. Where these repeating structures occur, there has probably been some optimal solution formed that supports human activity in that place. This forms the basis for his patterns. (Alexander, 1979, Ch 4, 5)

Indeed, a culture always defines its pattern of events by referring to the names of the physical elements of space which are 'standard' in that culture. And the mere list of elements which are typical in a given town tells us the way of life of the people there. (Alexander, 1979)

Although he appears concerned with identifying and cataloguing the morphology of architecture and urban planning, he is using it as a route, or as he says a gateway, into understanding the patterns of human activity that take place in the spaces formed by these constructions. The physical patterns that are documented are really two steps removed from what he is really interested in, which is 'the quality' in everyday human events. The human side of 'the quality' he talks about is reflected in 'the quality' of the building, which is evidenced by repetition of physical patterns in physical structures. His theory is therefore very grounded in the social side of life.

Patterns tend to be pigeonholed as a tool for solving problems, and this simplification appears to be an understanding based on the way he structured his patterns—context, system of forces, configuration. Although solving design problems is the eventual outcome, the patterns appear because there is a common balancing of forces in the system being examined, not just finding a solution to a single problem. In many cases the problems may not even be easily identifiable. Alexander describes his patterns as being alive (Alexander, 1979, Ch 6). A different approach to this would be to describe the forces he is talking about as being parts of a complex, dynamic systems.

This balance of forces is maybe most evident in his larger scale patterns for regions and towns, for example in CITY COUNTRY FINGERS the forces being balanced are urbanisation, the need to be near work and infrastructure, whilst wanting to be close to nature, as well as very current issues like lowering food miles (Alexander et al, 1978, p21). In the SCATTERED WORK pattern, the forces at work are issues such as work-life balance, education, transport, noise and pollution (Alexander et al., 1978, p21). These are also apparent on a more microscopic scale when he talks about the physical forces involved in COLUMN CONNECTIONS (Alexander et al., 1978, p1068) or the infrastructure demands in DUCT SPACE (Alexander et al., 1978, p1076). Generally though, the forces are more human, like needs for sleep, work or food.

At the heart of a building or any piece of urban planning are a number of these patterns that can describe what the physical structure will be like, without being prescriptive about the detail. Creating a pattern language is a process of balancing all the forces in the project at hand. In most cases these forces cannot be resolved through the use of a single pattern, so more of them are added and the introduction of these might bring other forces into play. Thus using patterns to design with is a process of the piecemeal addition and modification until all the forces are apparently in balance. Together the patterns form a network, and this aggregation creates an associative network of concepts and hierarchical relationships. This is then the specific pattern language for the project. (Alexander 1979). Again, we see a strong flavour of systems thinking at work here.

It seems that more attention gets paid to Alexander's collection of patterns than to the process of using them. The creation of a pattern language for a project is more important than the cataloguing of patterns. The patterns are a route to the pattern language. Although Alexander collected many hundreds of patterns (Alexander, 1977) these were obviously not all the patterns he had used. In *The Timeless Way of Building* (1979) he describes patterns of barn building as well as providing a case study for the creation of a mental health hospital. Specialist buildings, different cultures and locations have different patterns, and identifying these as part of the process is more important than referring back to a catalogue of generic patterns. An important aspect of this is that patterns need to be understandable by everyone, simple enough for anyone in the project to grasp, not just the architects.

Lastly, a pattern language is intended to be the specification for a project. From this a detailed plan could be created. This is what Alexander refers to as the generative nature of pattern languages. In architectural terms a blueprint could be drawn up from the pattern language, in software terms, more detailed design could occur. The focus of using patterns and pattern languages is this generative activity, the creation of more detailed designs. The activity of identifying and documenting patterns themselves are only a route through to creating designs.

With well documented patterns and a language created collaboratively with inhabitants, architects can create buildings that have in essence been designed by the people who will use them.

Christopher Alexander set out his concept of pattern languages in 1979 but his ideas never gained much traction in architecture. They become more popular with non-professionals who were interested in designing their own buildings (Erickson, 2000). However, starting with the field of object-oriented programming, then human-computer interaction (HCI), computing has picked up patterns and pattern languages, and used them more widely than their original field.

Pattern lan Gua Ges and so Ftw are

In 1995 the so called ‘Gang of Four’ popularised Alexander’s work in the field of computing (Gama, Helm, Johnson & Vlissides, 1995). They brought the idea of pattern languages over from architecture and used it as a way to document and reuse cross-language solutions to common problems in software engineering, specifically object-oriented programming.

Although successful and very useful for programmers, the Gang of Four to a certain extent got it wrong. Both members of the computing field (Gabriel, 1998; Tidwell, 1999; Borchers, 2000b) and Alexander himself (1996) say that their implementation of patterns were not what was originally intended. All the critics point out that the Gang of Four didn’t implement Alexander’s pattern languages on two critical points. Firstly that they weren’t being used as a method of interaction between programmers and end users, secondly they were heavily focused on documenting programming morphology. As Alexander points out below it had become very focused on the patterns themselves as elements and not on the contextually informed design approach that he had intended.

When I look at the object-oriented work on patterns that I’ve seen, I see the format of a pattern (context, problem, solution, and so forth). It is a nice and useful format. It allows you to write down good ideas about software design in a way that can be discussed, shared, modified, and so forth. So, it is a really useful vehicle of communication. And, I think that insofar as patterns have become useful tools in the design of software, it helps the task of programming in that way. It is a nice, neat format and that is fine.

However, that is not all that pattern languages are supposed to do. (Alexander, 1996)

It is interesting to note that in programming this area tends to get referred to as *object-oriented design patterns* and that the idea of them as a language has drifted well into the background (Borchers, 2000a). The use of them as a collaborative design tool, and as a way to describe a situation linguistically has also disappeared. Additionally they can’t be used as a generative system; by themselves they can’t describe how a piece of software will function.

This is not to say that what the Gang of Four have achieved is to be underrated or dismissed. Their contribution to programming and computer science in general has proved to be very useful. Although at the surface their patterns and Alexanders pattern language appear identical, there are a few key differences in their goals, and as such they end up being different in practice. In defence of programming patterns, it should be said that those involved in this endeavour are very concerned with the act of writing code, and the code itself is not for end users; the users or inhabitants of code are other programmers.

The HCI community were some of the key critics of programming pattern languages, but saw in the original principles a useful technique for carrying out interaction and interface design (Borchers, 2000a, b). In contrast to the Gang of Four’s intentions, HCI specifically deals with end users of systems and within the design part of the discipline is, nearly universally, tries to get end user involvement in the the design process. To do this they need simple language and simple collaborative design tools. So they have managed to integrate the earlier criticism that was directed at the object-oriented design patterns movement and taken on the concepts themselves.

In this incarnation the concept of patterns have become very popular, with numerous papers published, books written, as well as many online collections of user interface patterns. Good examples of these web based collections are the Yahoo pattern library (Malone, Leacock & Wheeler 2005) and Martijn van Welie’s personal site (van Welie, 2007).

HCI implementations of pattern languages still, as Borchers very consciously points out, misses the human-to-human interaction that is inherent in physical architecture (2000b, p3).

However, issues such as social interaction should be treated with caution: while it is very important that these aspects are dealt with when designing a user interface, patterns about them would not address the human-computer dialogue directly. The pattern format is without doubt extremely suitable to model aspects of human-human interaction as well as human-computer interaction. However, to keep the notion of HCI patterns focused, it may be necessary to deal with those "HHI patterns" under a separate name. (Otherwise, why call our patterns HCI patterns?)

Borchers addresses this by suggesting that there should be an application domain pattern language (Borchers, 2000b, p5).

As well as that, most of these so called pattern languages are merely collections of common interface morphology rather than being used as languages. They are quite often lists of good practice in interface design. So rather than being a design language for interaction with end users they become ways to promote interface paradigms, consistency and standards. Take for example the following comments "When a community agrees upon a collection of patterns, it is possible to speak of a pattern language." (van Welie, van der Veer, Eliëns, 2000, p321) or "This site contains a lot of best practices in Interaction Design." (van Welie, 2007, homepage). The first conflates a collection of patterns with the idea of a pattern language and both illustrate the tendency to end up with collections of best practice rather than an evolving design tool.

It appears easy to overshadow the process of using a pattern language with the documentation and collection of those patterns. In all the examples cited above the patterns themselves are presented first and foremost, published in books or documented on web-sites. The process of using them are hidden or non-existent. It is then easy for readers to be distracted by the patterns and not to fully realise how they were intended to be used. There is a tendency for them to end up as templates to copy rather than patterns to generate project specific languages.

Following on from their adoption in object-oriented programming in the nineties and the growth of patterns use in interaction design since 2000, patterns have found their way into a variety of computing related fields:

- A study of pedagogical patterns emerging from teaching computer science ("Pedagogical Patterns", n.d.)
- Patterns to help in the design of ubiquitous computing (Chung et al, 2004)
- Mobile social software (Bleecker, 2006)
- As moderation strategies patterns (Shirky, 2007)
- Wiki creation and adoption patterns ("Wikipatterns", 2008)
- Patterns to help design Computer Supported Co-operative Work (CSCW)
- systems (Schummer & Lukosch, 2007)
- Game design patterns (Bjork & Holopainen, 2004)

Although the concept of patterns has gained much momentum in computing, the deeper human nature of 'the quality' has been changed and lost its social element. The conceptual design level has not used patterns to describe the human-to-human interactions and the online social spaces required for computer-mediated communication. To do this they need to be understood in a sociotechnical frame.

Pattern lanGuaGes In a socIotechnIcal Frame

It is interesting to see that sociotechnical systems theory and design overlaps very heavily with Alexander's thinking.

Firstly and most importantly they both start with the idea of two systems being at work. Alexander has his interrelated patterns of events and patterns of space. Sociotechnical systems theory has its social systems and technical systems. This does not mean that space creates events, or that it causes them. It simply means that a pattern of events cannot be separated from the space where it occurs.

But there is a fundamental inner connection between each pattern of events, and the pattern of space in which it happens. (Alexander, 1979)

One of the most important points recognised about sociotechnical systems is that they are inherently complex systems. They are not linear, mechanical or predictable, where they succeed they do so by adapting to, not being designed for, their environment. Their atomic parts are less important than the emergent properties of the system as a whole. As such they are difficult to analyse in a reductionist sense and to design in an atomic fashion. These emergent properties in architecture are what Alexander recognised and described as patterns, the same language is used by academics to describe the emergent properties and structures observed in chaotic and complex systems. Patterns at their heart are about recognising and reproducing the emergent properties, the common structures, whilst trying to understand the forces behind these properties. There is no linear determinism operating in these, it is as Alexander describes it, a balancing of forces.

The second point is that they are both also strong on user involvement. The designers of the artefacts are facilitators of a design process, not arbiters of the final product. Interestingly, Alexander says that people already know how to build buildings. He points out that buildings are all around us and that we are continuously exposed to architecture; we have a subconscious understanding of it. He goes on to say that in most parts of the world people don't use architects, they build buildings or do urban planning without resorting to a planning professional (Alexander, 1979, Ch 10). For him, the pattern language is a way of surfacing this shared understanding; it is a participative design process. As he says "The power to make buildings beautiful lies in each of us already" (Alexander, 1979, p14).

The same can't always be said to be true when building computer systems. To date, the creation of new computer systems for whatever purpose has been one of exploring requirements and and applying new technologies. In the easiest of cases this is about automating existing tasks, which in itself is never as easy as it appears. However many times the application of computing technology is involves a complete transformation of old processes and practices, the new sociotechnical system has little in common with the old.

Through the 20th century software and computers were a new phenomena in organisations, and for most of the 70s, 80s and 90s an experience confined to the workplace. In the last decade however, computers and the internet have become a ubiquitous experience. They are not isolated in the workplace, and they are not simply for work related activity. We are now entering a time when sociotechnical systems are all around us and in our everyday life. There are two important consequences of this, and these help us to use sociotechnical patterns as a design tool. First, that non-professionals have more interaction with, and therefore basic understanding of, the patterns in these systems. Secondly, that there are more of these applications in use, more of them being created, explored and experimented with. This creates a rich evolutionary base from which new patterns can emerge. Alexander, the Gang of Four and HCI researchers didn't create their patterns, they recognised them. There needs to be a large enough population of experimentation within a field and a rapid enough turnover of these experiments for patterns to emerge and be recognised.

It should be said that neither theory outline an entire design process. Sociotechnical design pointed out that the design process needs to fit the project, it only outlines a number of principles for what the process should be like. Pattern languages themselves are but a single tool to be used in the design process, albeit one that heavily shapes and determines what the process will be like.

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There are two approaches here with similar motivations and similar goals. It seems natural that they can be combined. A redefinition of patterns using a sociotechnical framework gives us a new way to look at a stage in systems design that has to this time been a bit sketchy.

Using sociotechnical systems theory to frame the patterns, we see that they are ones made up of a mix of social, psychological and technological forces and always a mixture of these forces. The patterns which emerge from these combinations of forces are different to any patterns inherent in any of these systems by themselves. The interaction and the balancing between the social and the technical forces creates new systems that quite often bear little relationship to the separate systems.

Although this approach could be used more generally for software design, the complexity involved in designing CMC systems points towards the usefulness of pattern languages as a tool for aiding understanding in the development process.

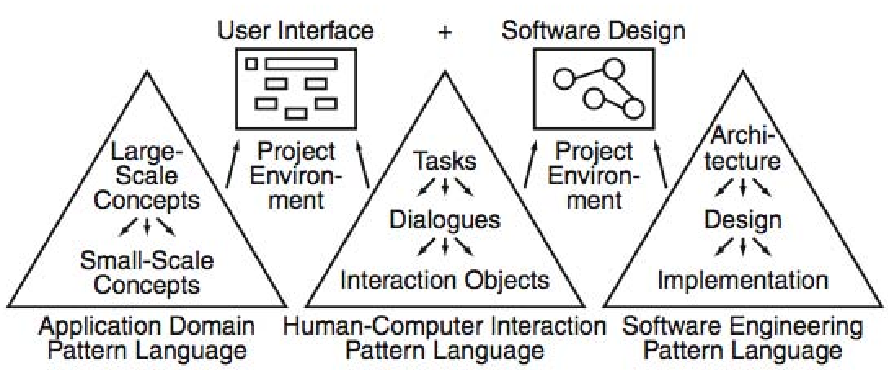
The introduction of technology to social systems, especially now when they are mediating the social interactions, has a transformative effect on them. Most of the recognisable sociotechnical patterns are phenomena that did not occur in any form prior to the introduction of technology. For example the patterns of MODERATION did not make any sense prior to the many-to-many communication of usenet. The word itself existed before hand, but the sense of it applied to any form on online community is different to its meaning beforehand. The idea of a THREADED CONVERSATION might be conceivable but without ASYNCHRONOUS COMMUNICATION would be difficult to maintain.

The sociotechnical pattern languages used to describe contemporary CMC applications work at a different level of detail to the ones that are used to describe the interface and interaction, and they are also applied in a much less specific way than are software engineering patterns. As I've mentioned earlier, they can operate effectively at the beginning of social software projects as a way to describe what needs to be built with a broad understanding of the complex nature of the interactions between the social systems and the technology.

The space for this has already been recognised. Towards the end of his *Twelve Thesis* paper Borchers (2000b, p5) points out that pattern languages can work in a number of different domains; they can be used in those domains simultaneously during a single project. HCI patterns can work with software patterns in the same project, they can be used as communications tools in different conceptual domains and at different stages in a project. Not only does he recognise the relationship between HCI and software patterns, but also shows that there is a place for patterns to be used at the conceptual planning stage, what he calls the *application domain*.

This application domain is the work that happens at the beginning of projects, 'the fuzzy front end' where the concepts get determined. At the application domain level, that is the level of using a sociotechnical pattern language, we are to a certain extent interested in describing the user interface, but only in such a way as it relates to both the larger

Figure 1. Relationship between pattern languages in a project. (Borchers, 2000b, p5)



human and technical systems involved, and we are certainly not interested in describing the software engineering level.

In effect Alexander used his patterns at the application domain level; this is the level that a sociotechnical based patterns approach can be used. These are the style of pattern we need to use to help us understand and build new forms of computer-mediated communication.

These patterns are not concerned with interfaces or implementations, as there may well be many ways to implement them. The particular environments, users and technologies will influence how this happens. In these situations HCI patterns or software patterns may be used, however there is no reason that they will form similar languages, even if there are similar patterns at the sociotechnical level.

Because of its close relationship to sociotechnical theory, Computer Supported Co-operative Work is already adopting this approach to the use of design patterns (Guy, 2004, 2005; Schummer & Lukosch 2007). However these areas of research have a focus on systems used in organisations and although they may be adopting patterns that might have appeared first on the web, such as SOCIAL BOOKMARKING, they have not to date recognised the macroscopic patterns that allow these applications to function in the way they do in organisations or the patterns that are required on the public web.

case study : beanba G and JIVa technolo Gy

Beanbag (Beanbag, 2008) is a social media service run in Bristol by Jiva Technology (Jiva, 2008). It is primarily a web-site to match secondary school students to potential tutors, however Jiva intend to eventually offer a broader service that will include matching students with any other form of educational material or resource.

In Feburary 2008, two workshops were run that used the concept of pattern languages to map out the CMC system that forms Beanbag. The workshops comprised of stake-holder and actor mapping as well as the creation of a pattern language for the product. These were joined together to form a product roadmap that used the patterns as a way to explain the vision for each major software release.

Jiva had already started building an application using agile project management processes but had reached a point where they were not sure how the service would work as a whole. At this stage they had been using a simple framework of groups, sharing, presence, conversation, relationship, reputation and identity (Smith, 2007). They were developing functionality but not sure how to fit all their aspirations together. The goals of the workshop were to work out how a business driven "community" delivered value to their service, or in their words, "where all the social stuff fits in".

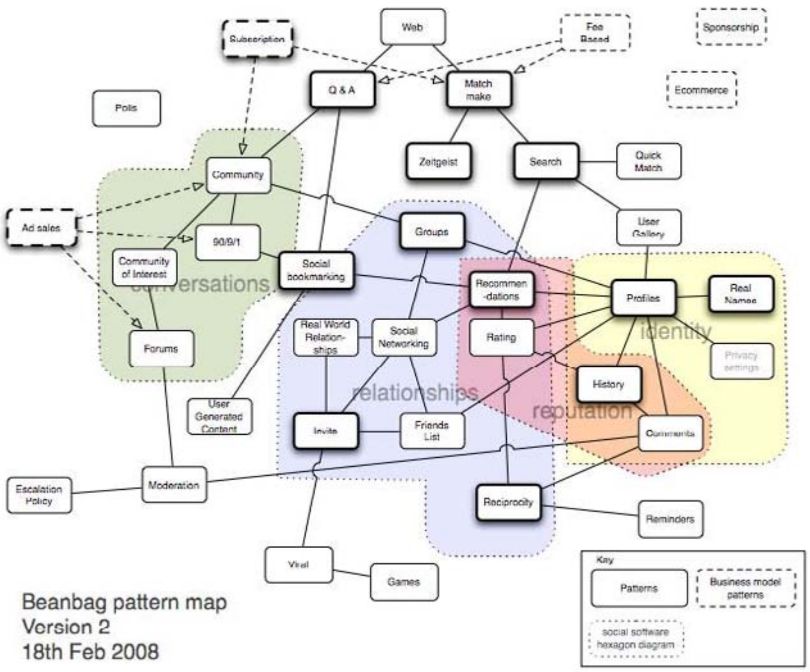
Over the two sessions a pattern network map was generated in the same manner as Alexander's original method. The first session was primarily about identifying the right patterns. A map was generated mostly through using patterns that have already been identified (Dixon, 2008) and partly through specialist patterns identified during the workshops. In the week long break between the sessions examples of these patterns were circulated and validated among the participants. The second session became one of understanding the relationships between the patterns and the discussion became one of understanding how they might reinforce one another.

The workshops gave the Jiva team a way of thinking about their site overall, not thinking about pages on the web. This has helped them to move from their high level objectives through to individual features and page design. As Peter Ferne, the CTO of Jiva technology, said,

"The patterns workshop gave us a way of thinking about what we wanted to build that neatly bridged the gap between vague hand waving about 'community' and getting sucked down into the nitty gritty of interface design."

As in Alexander's original method, this has become a shared, generative language that is specific to

Figure 2. Pattern language for Beanbag project.



this service. The pattern language gives Jiva a way to discuss and understand their service beyond just the technology and the user interface. This meant that the team could discuss how the site would function using easy to refer to working examples from other sites and a way to start the process of understanding how these work together. Using sociotechnical patterns allowed the project to get to a significantly deeper level of understanding than the broad areas that were present before the workshop. For example, to achieve a form of personal reputation on the site they had use RATINGS for users to express opinions of real world interactions. It was felt that RECIPROCITY in relationships was key to valuable data, and for this to work effectively they needed to use REMINDERS to get members back to carry out rating.

conclus Ion

Patterns have a long and rich tradition, three decades of use in architecture, albeit marginal, and over ten years of popularity within computing fields. Whilst all of these implementations of the concept might differ, its popularity points toward it being a useful tool. However, whilst humans have been creating buildings for many millennia we have only been programming computer systems and developing computer-mediated communication applications for a much briefer period. Whereas architecture has had many thousands of years to evolve these patterns of human habitation involving the entire human race, computing has had only a few decades with a much smaller subset of participants.

The goals in computing have shifted from a method to bring architecture to the people, but with a sociotechnical reworking these ideas can become a way of understanding the new social architectures that networks and computers bring.

Although software engineering design patterns and interface patterns have a valid and relevant place in designing any form of social software they don't have a wide enough perspective or an application specific focus. A high level design of this type of software requires a domain specific tool and domain specific languages. To create new forms and improve on existing social software we need the understanding that a pattern language can expose.

The pattern language required is one that is described above, a method of recognising, understanding and recording the emergent patterns that occur in the meeting between the technical and social spheres.

Finally, this is a rich area that is already bearing results and one that requires further hands on investigation. This approach is a practical approach, not a an abstract method for analysing this area. Without some form of construction in mind the exercise of recognising, collecting and reusing them is pointless. These patterns must themselves have Alexander's 'quality', they must be dynamic, alive, whole, comfortable, egoless and free.

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key terms

Computer-Mediated Communication (CMC): CMC is communication that occurs between two or more people in the medium of networked computers. This could be person to person, i.e. email, SMS, or many-to-many, i.e. social networks, wikis. Also known as Social Software or Social Media, especially when discussing the many-to-many aspects.

Fuzzy Front End: Often, when a project is started the exact outcomes and process are unknown and need to be defined as the first activity. The front end of the project is ill defined, hazy or fuzzy.

Pattern: A repeatedly observed structure that has evolved to solve problems in context. This structure is usually a complex balancing of forces, not a single solution to a single problem. These patterns are a template for re-use.

Pattern Language: A set of patterns built up to describe a project. These form a common language of assosiated concepts.

Sociotechnical Systems Theory: An approach to understanding the relationship between technology, individuals, organisations and society in work place design. This systems based approach includes (but is not limited to) the hardware, software, social, psychological, political, policy and legal systems that comprise the overall organisational system.

Sociotechnical Design: A set of principles put forward by in the 1970's, intended to help with organisational change projects involving computers in the workplace. It was a reflection of practitoners experience in the light of the original Sociotechnical Systems Theory.

Chapter XXVIII
Creating Social Technologies to Assist and Understand Social Interactions

Anton Nijholt
University of Twente, The Netherlands

Dirk Heylen
University of Twente, The Netherlands

Rutger Rienks
University of Twente, The Netherlands

abstract

In this chapter the authors discuss a particular approach to the creation of socio-technical systems for the meeting domain. Besides presenting a methodology this chapter will present applications that have been constructed on the basis of the method and applications that can be envisioned. Throughout the chapter, illustrations are drawn from research on the development of meeting support tools. The chapter concludes with a section on implications and considerations for the on-going development of social technical systems in general and for the meeting domain in particular.

Assimilation into the Borg Collective might be inevitable, but we can still make it a more human place to live.

—Pentland, 2005

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Introduct Ion

Socio-technical computing inherits the complexity related to software engineering and system integration whilst embedding the human in the loop. It also inherits the difficulties of understanding and modeling human-human and human-computer interaction in the context of a changing environment (see Clancey, 1997). In this chapter we will outline an approach to the development of Social Technical Systems, with the focus on meeting support. This approach can be characterized as theory-informed data-driven. In essence the method consists of the following four steps.

Step 1: Collection of a multimodal corpus of social activity signals
Step 2: Description of a myriad of aspects of system relevant activities (annotation) in the collected material
Step 3: Discovery of interdependencies between recorded signals and annotations, annotations and annotations, and signals and signals (e.g. by means of machine learning.)
Step 4: System creation based on knowledge obtained from the previous steps

In the collection and annotation steps, the process relies heavily on the insights provided by the social sciences; in particular sociology, social psychology and linguistics. In return, the annotated collection and the machine learning effort may provide important insights for social theorizing as the annotated corpus provides the researcher with statistics about the occurrence and distribution of certain phenomena and interesting correlations. Increased insight into how people behave can point out problems they encounter in their activities that may be relieved by technologies that are based on this understanding of their activities as derived through Steps 1 to 3. This means that these steps can be viewed both as a way into requirements engineering and as providing the basic data and algorithms to build the tools that can solve some of these problems.

Technology that inherits these possibilities can be said to be social for three reasons. The first is in the way in which the system supports social activities. The second relates to the way the technology can provide insight into social processes which occurs when correlations between phenomena are found. The third reason in which the qualifier *social* relates to the term *technical system* is in how social theories are at the basis of the construction of the technical applications. Given theories on how humans 'operate', technology is equipped with the manual in order to understand and support their operating.

As example case for this chapter our focus is on small business meetings. Currently several projects worldwide are investigating the way technology can support the needs of people in meetings and how it can relieve them of some of the frustrations that meetings seem to impose upon them. Examples in this chapter will be drawn mainly from studies in a series of European projects on meeting analysis and meeting support: M4, AMI, and AMIDA. These projects investigated how human-centred computing techniques can detect and interpret activities of participants in smart meeting rooms and how these techniques can be used to design tools that support meeting participants in their encounters and activities.

This chapter discusses a variety of methodological issues and charts several results showing the rationale behind the scientific drive to develop technological support for social gatherings and events. The chapter also contains a short discussion on ethical issues and potential pitfalls on the road ahead.

mach Ine Inter Pret at Ion o F human encounters

When humans interact, they use their natural skills to sense and interpret signals in the environment in such a way that specific behavioural responses result. In any social encounter, including meetings, every person displays both consciously and unconsciously a pattern of verbal and nonverbal behaviour, which when recognized, reveals his view of the situation and shows information about his internal assessment of the other participants (Goffman, 1955). Recognition and retention of behavioural regularities and patterns identifies opportunities, and can be turned into new insights, a competitive advantage, and a profitable business. The emergence of social patterns forms the basis for automatic detection, analysis and for the retrieval of its components. The main challenge here, of course, is to know how to let machines distinguish patterns of interest, and to let machines make sound and reasonable inferences and decisions, not forgetting the technological opportunities for exploitation.

Although the *automatic* observation and interpretation of human interactions (e.g. on large multimodal corpora) has only recently become an established domain for human computing research, the study of human interactions both computationally (in the field of natural language understanding, for instance) and within the humanities is well established. Social psychologists, for example, have been actively engaged in the development of explanatory (Smith, 1942) and descriptive (Bales, 1950) models of behavioural patterns for over 60 years. All the theories of group behaviour and interaction research can, when operationalized, potentially be used as input for social technical systems in the way we will describe in the next sections. They provide valuable insights that can be exploited for the creation of the quantitative and mathematical models suited for machine perception.

The (business) meeting domain is a relevant and practical domain for the analysis and support of humans and their activities. We cannot think of a world without meetings, and although sometimes we wish we could, they play an important part in our daily lives. Meetings are hard to avoid and everywhere. The domain embodies the comprehension of a subset of people's everyday activities, working and living, that moves beyond the individual. In multi-party interaction, messages are exchanged between individuals in various flavours and melodies, thereby exposing the full gamut of human communication abilities.

The way people meet and interact with each other has altered significantly in the last decade through new telecommunication technologies. Everyday conversations have, by means of technology, more and more been replaced by e-mail, conference calls, and shared data access. A high speed Internet connection, a webcam, a microphone and a few speakers nowadays offer employees access to almost all the resources they need. Technology has altered the notion of a meeting in a way that, instead of physically sharing the same environment, the opportunity to mentally share the same environment has become a more frequent condition for people to interact.

In 1987, Richman predicted that software systems could one day change the way groups of people work together by means of *comprehending* the ongoing group process (Richman, 1987). Although the state of the technology was far from actual recognition, the field of socio-technical computing and interaction augmentation by means of technology started to gain increasing momentum (for a summary, see Rienks, 2007). In the 1990's the idea of autonomous software agents was introduced aiming to assist humans in their everyday task. The agents were assumed to be able to adapt their actions to the environment depending on their understanding of the environment. It is this sort of system -*that can adapt its actions to the interpretation of the sensed environmental information*- and that is central in the remainder of this chapter.

This type of socio-technical system can be decomposed into three parts, the sensing ability, the reasoning ability and the acting ability. These three are depicted in Figure 1.

Sensor information is gathered and depending on the system's abilities, to a certain extent, analyzed and interpreted. Given the systems' interpretations models of the environment are fed with, and possibly adapted by, this information. If a model decides to plan an action based on the input, the acting ability of the system is subsequently triggered to execute the plan that maximizes the system's performance, possibly by using both its physical and its environmental conditions. Knowledge of the environment into which the system is to be applied can be an essential point.

For the meeting case socio-technical systems are likely to understand at least parts of the human-human communication process, before it can begin to provide adaptive and active support. But how do humans communicate (what is there to be sensed) and what are the technical abilities to interpret, reason and act (how can we act)? This makes a fundamental case to successful development.

The obvious initial question that one is to ask on the way towards the creation of a social technical system is about the goal of the system. What should the system do and where is its added value is expected? What do end users really want from it systems, and in our social event case: How can social events be improved by technological means? What is to be understood from the environment (a gathering of people) to make the system successful? What is in scope and what is out of scope? Does the system consider a single conversational partner or the group as a whole? Does it confine itself to just the conversation? Which input modalities are to be sensed: verbal and nonverbal, both, or none?

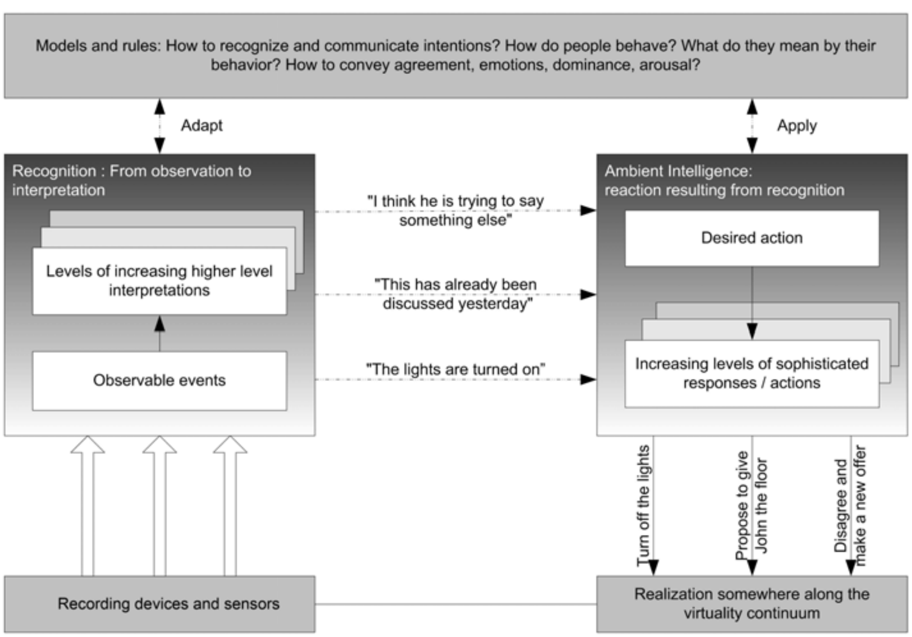
methodolo Gy

The previous figure showed the idea behind the social technological systems that process audio and video data, interpret what is happening and then react in various ways. The process of developing such systems generally starts by collecting a large number (a corpus) of recordings resembling the phenomena or the situations of interest (to the system). Starting from this collection of signals, manual or preferably *automatic,* recognition processes are then to apply predefined models or coding schemes. The resulting observations that systematically describe the data (annotations) are then to be used as input for further recognition, reasoning and acting, be it for either on-line and/or off-line (hindsight) support.

The construction of models that allow for the interpretation, annotation and derivation of human behaviour are central. For this construction an iterative loop of four steps is generally used.

- A representative corpus should be collected from which the behaviour (consisting of objects and events) that is to be modelled or detected emerges.

Figure 1. Three steps to action generation



- Initial coding schemes need to be devised to facilitate (statistical) inferences and correlations inspired by events or objects that are contained within the data.
- The coding scheme should be mapped correctly onto this data before inferences can be made.
- Machine learning algorithms are to be trained on the extended corpus for successful automatic replication of the coding scheme applied. Examination of the classification results then provides information on how to alter the coding schema in a subsequent iteration

The choice of models stems from research objective or foreseen applications and/or can be derived from corpus investigations (e.g. clustering techniques).

Collecting a Corpus

To learn things, one has to gain insight into what is going on and in the case of machine learning to obtain this insight one needs a lot of examples. Progress in data driven approaches to human computing research therefore requires a large data set that allows for empirical observations of the phenomena of interest. A large dataset that comprises a collection of recorded signals that represent a preferably representative sample of a particular phenomenon is also known as a *corpus*. A corpus enables the validation of domain related rules and hypotheses on empirical grounds. It also provides the opportunity for scientific explorations and hypothesis testing. As a corpus typically contains labels, tags, or annotations that signify occurrences of particular phenomena, it can in this way be used to check for the coexistence of certain phenomena within particular contexts and for the correlation of particular signals and events in a (semi-)automatic manner.

In a corpus that contains just data such as text, one could for example extract word combinations either to create a model that predicts the next word for any word from the text, or to validate such a model in terms of correct predictions. However, if this same corpus also contains a Part-of-Speech tag (such as `Noun' or `Verb') for each word, models can be built that predict the Part-of-Speech tag given a word (see e.g. Brants, Skut, & Uszkoreit, 2003). These models that explicate patterns in the data, and that transform data into information, can in turn also be validated either on other corpora, on parts of the corpus that were not used for training the model, or on new samples.

Machine learning techniques use statistic inferencing to deduce more complex observations from aggregations of features describing the signals. Focusing on multiple signals helps to disambiguate observations and therefore (theoretically) also allows for better recognition. Multi-modal signal collections or multimodal corpora are therefore usually collected to study social phenomena in which one wants to study higher level phenomena such as for the meeting case: agreement, rapport, dissonance, and group performance, that are not directly manifest through one unique behaviour but may show through a combination of features of various kinds of behaviour.

For the research that was conducted within the AMI project over one hundred hours of meetings that followed a similar scenario were recorded. The corpus comprised 120 different meetings in total. The signals that were recorded of these meetings were captured in meeting rooms equipped with many sensors. Typical sensors used for capturing the data were cameras (recording global and close-up views), lapel microphones, microphone arrays, a whiteboard and smart pens. But also meta-information such as the seating arrangement and the (PowerPoint) presentations that were used were collected. In the end the recorded data also included manually created transcripts, dialogue acts and summaries[1].

This corpus was analyzed by means of tools to discover regularities in annotated human behaviour and to construct consecutive models and hypotheses. These models in turn were evaluated, for example, by using the corpus itself, but also by means of simulations and user studies (See section on tools).

Annotation Schema Creation

Annotations are used to codify judgments of observers in relation to an annotation model or schema. They are the tangible result that captures, organizes, and conveys observed information in a structured manner.

Annotation schemas are created to fulfil a certain need; be it either answers to the question of the researcher or, as in case of a system, to fulfil part of its goals. Any resulting model, to put it more generally, should obtain sensible and interpretable distinctions from the data. For human computing applications, the annotation schemas are often inspired by social psychological hypotheses that try to describe human-human interaction. The models from Bales for example distinguish task-based and process-based participants whilst given a set of features that were to be recognized by the observers. He showed with his model that face-to-face interactions contain formal similarities that occur irrespective of the individual participants and their locations. In the AMI schema for dialogue acts, some of the typical categories used by Bales in his Interaction Process Analysis scheme were incorporated.

The annotation schemes in AMI stretch from the description of more easily observable features such as speech, gestures, and focus of attention to more semantic information: dialogue acts, topics discussed and perceived level of dominance.

As mentioned before, these annotations can be used for a number of tasks. They can be used to evaluate hypotheses in the area of social psychology, as examples for machine learning algorithms that strive for automatic model application on unseen data, and for the validation and re-design of the annotation schemas themselves.

The Annotation Process

To be able to apply an annotation scheme accurately, observers should make judgments about what they observe. This is not always a trivial task. Making adequate judgments requires observers to understand the `culture' of the observed interaction and to possess a certain (social) 'sensitivity' that includes the ability to empathize with the observed interactions. To quote Bales: 'We consider ourselves fortunate when we have roughly comparable rates of incidence of a series of phenomena. When these rates are based on data gathered in a comparable way and data conform standard definitions, we are able to make more definite comparisons' (Bales, Strodbeck, Mills, & Roseborough, 1951).

Thus a high agreement between observers means that observers highly agree on the chosen categories from the annotation schema for particular sections of the observations. A high agreement is beneficial as the observations now generalize across observers and become more easily reproducible (Cohen, 1960). However, there is a trade-off here between the amount of training that is required for the observers and the desired level of agreement. The more training needed for the observers, the harder it will be for others to apply the same set of categories with any assurance of obtaining similar results (see Bales et al., 1951).

Many projects face the challenge of manually annotating a large amount of data for various signals and modalities. The process of creating the annotations by itself is, even without focusing on the training of the observers and reliability of the resulting annotations, a tedious and expensive task. If annotations have to be performed manually, one can develop tools that allow for the efficient creation of annotations. Currently there are several tools available for free that all offer a similar functionality and interface; examples are Anvil,[2] or Elan.[3] The Nite-NXT toolkit[4] has the advantage that the interface can be easily adapted with a minimum of programming allowing the creation of an annotator-friendly interface depending on the kind of annotation.

So the way the annotations are created, the way the annotation schema is devised and the way the data is gathered are all relevant aspects to consider when one wants to create algorithms that are to replicate the human annotations on unseen data. For more elaborate information about annotations and issues related to their obtainment see (Reidsma, to appear).

schema Validation

Annotation schemas can be evaluated in order for them to be improved. These improvements can sometimes be necessary to realize an easier schema application for the observers, or a better fit with the data. This can happen in the case where particular categories that could describe the observations are missing, or if some are indistinguishable because there is too much overlap. Confusion matrices generated from annotations by various observers and/or algorithms can provide valuable insights in this respect. On the other hand, the applied annotations can be used in simulation environments to see how well they fulfil the goals of the designers. One way to do this is to re-create the events in a virtual environment using the annotations as a script to run a scene. One can then visually compare the video as it was originally recorded in parallel with the virtual scene and look for discrepancies. For our studies on the AMI corpus we built a replica of the meeting rooms for this kind and other kinds of studies (see picture further below).

machine learning

Automatic recognition of human behaviour and events, in the data-driven approach boils down to automating annotation of higher level phenomena using aggregates of lower level (more straightforward observable) features, where the automatic procedure is derived from examples created by hand. If we want to investigate how this can be achieved, we enter the world of machine learning. The field of machine learning is concerned with the question of how to construct computer programs that can learn from examples and that can adapt to their environment. Machine learning provides the technical basis of data mining, that is, it enables the extraction of implicit previously unknown and potentially useful information from the data. To be more precise, we want the machine learning algorithms to learn to reproduce the annotations that have been created on top of recorded 'sensor' data. If the corpus has been carefully selected and annotated, the resulting algorithms should be able to produce good results on new data as well, as long as this is sufficiently comparable to the data the algorithms were trained on.

To deduce the higher level phenomena we need classifiers that learn from the annotated data how to combine those features that are able to describe the categories defined by the annotation schemas with the highest accuracy. One needs to select the labels that one wants to enter in the algorithm: which combination of values for a series of phenomena can predict the outcome of the value of some other phenomenon. Machine Learning Toolkits allow one to investigate this and similar questions. Features are aspects that describe phenomena and a certain combination of features can be used to differentiate between phenomena. They check a single property of the classification instances, that is, the phenomena that are to be distinguished. For every phenomenon that is to be distinguished from any other phenomenon by a classifier, the same set of features needs to be available.

To know the appropriate set of features that is able to make the distinction amongst the phenomena that one is after is always a big challenge that is to be resolved. From all the features and their values that are available in the corpus machine learning algorithms are able to distil models by means of for instance rule miners that are able to predict a class label given a set of feature values. An example of such a resulting model is shown in the figure below.

For each of the meetings in the AMI corpus, we had several annotators decide who they found to be the most influential or dominant participant. We found that the agreement on this issue was quite high. We selected several features that can be fairly easily obtained by studying the speech transcripts and used several techniques to find out whether we could predict the same scores for dominance/influence based on these features. If one divides the participants and feature values in high(3), normal(2) and low(1) influential and uses the features "how many times did a participant take the turn", "how many interruptions by the speaker were successful", and "how often did the participant attempt to grab the floor", one can build an algorithm that judges correctly that a participant is in the same dominance/influence category that the human judges did 85% of the time.

The model depicted is able to give an influence label to instances of the feature set{Turns, Successful Interruptions, Floor grabs}. The feature values in this case are integers collected from the behaviour of one person in range from 1 (low) to 3 (high). From the model one could, for instance, distill that the observation {2,2,2} would obtain the class label 'Normal Influential'.

With the use of classification algorithms like this, one can start to craft off-line and on-line applications.

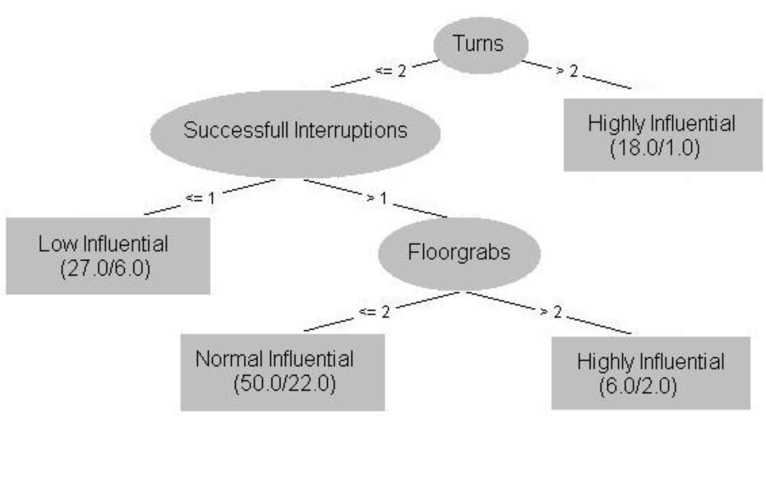
Tools and Applications

One application that was developed based on the influence detection showed the influence levels of participants over the course of a meeting. If this information were available in real time, a chairman could alter his style of leadership in order to increase the meeting's productivity (DiMicco, 2004). Combined with other information, systems could be created that directly suggest how to change the leadership style. One could even imagine a virtual chairman who is able to lead a meeting all by himself, maintain a good balance, give turns and keep track of a time-line.

Another implementation has been realized in a Virtual Meeting Room (VMR), (Nijholt, Rienks, Reidsma, & Zwiers, 2006). This VMR was particularly developed for schema validation, signal replay, as a remote conferencing application, and to serve as a test environment for software agents. This virtual meeting room can be augmented with the relative influence levels, as in this case depicted in Figure 4 by the size of the black balls shown in front of the participants. The domes surrounding the participants' heads provide information about their gaze behaviour.

One of the other results of our work that has been executed on the corpus is that a tentative profile has been constructed of how influential participants, as experienced by actual meeting participants, distinguish themselves by means of verbal behaviour from less influential participants. Our results here show that if a participant raises issues, elicits solutions, evaluates these solutions and then steers towards a choice amongst the possible solutions, this is indicative for a person who is highly influential, and who controls the course of a discussion (which intuitively also seems correct). On the other hand, it appeared that if someone provides options, back-channels a lot to others and resorts to shorter contributions in the decision phase of a discussion an (understandable) profile of a less influential participant appears.

Figure 2. A resulting decision tree to determine if a participant is of a particular influence category



Implications and Considerations

Ongoing developments in the area of progressing meeting technology and socio-technical computing could result in far reaching ramifications for human life and human well-being. The advent of the networked society has permitted people to interact with each other remotely in a fashion unprecedented in history. This, on the one hand, has brought about enormous benefits and convenience, whilst on the other hand, it has extended a dark side where a new technology is abused or disrupts human relations (Nishida, 2007).

It is however not unlikely that the introduction of new technologies in the meeting domain will, for example, pose difficult challenges for participants and their supervisors. Although a participant's access to remote participants all over the globe, for instance, may theoretically increase his or her productivity, ubiquitous connections to others comes along with temptations for distraction and the wasting of time. Not to mention the temptation that will emerge for supervisors to implement automated supervision techniques. How useful would it be for an employer to gain automatic insights into the performance of his or her participants over the previous meetings? And what would the participants think of this? It

Figure 3. An example of a meeting browser

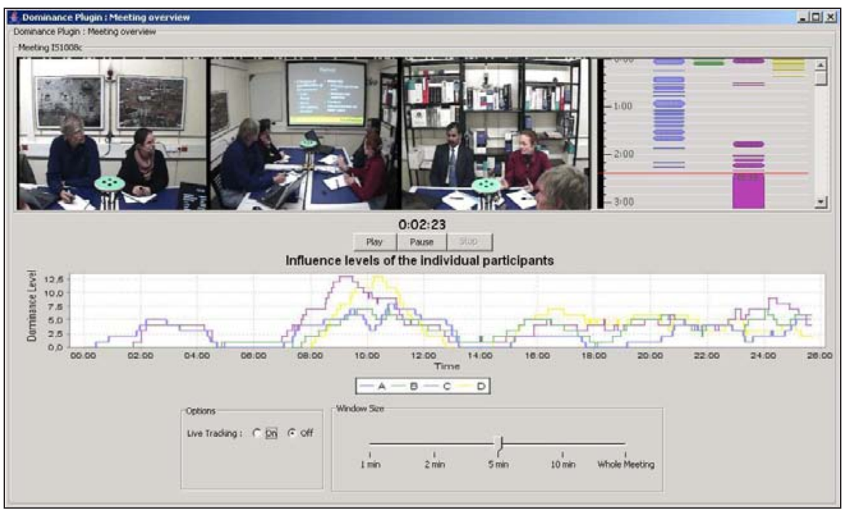


Figure 4. Visualizing gaze and dominance information in a virtual representation

seems not unimaginable that these `monitoring' techniques could lead to tension, distrust, and resentment. So what could seem beneficial and an advantage at first sight, might turn out to be a disadvantage in the end.

Another potential danger that lies enclosed in emergent technologies is over reliance on systems that are not flawless and that are trained on a specific domain. Over reliance on automatic systems, especially without knowledge of the rationale behind the systems could lead to annoying situations in which high expectations can turn out to become nasty dampers. The impact of faulty meeting technology will perhaps not be as large as that of an earthquake warning system that makes a mistake, but for a business meeting where high interests are at stake the risks can be serious. We assume it would be better to at least think twice and to always refrain from blindly following a system's proposals, and rather consider its advice as suggestions that could be taken into account. Of course the level of authority and autonomy that is given to the system plays a part in this. Also, as the technologies have been trained for a specific domain, the risk exists that they are put into practice in different domains.

c hallenges

The characteristics of emerging socio-technical systems imply new approaches to usability engineering as well as associated evaluation and testing techniques. Emerging systems that are devised to support, and to a certain degree also understand, social events as they naturally occur require the ability to comprehend messages emitted through various social signals, including voice, gestures, gaze and facial expressions. When allowing humans to communicate naturally with the input devices, these systems should be able to distil, within this gamut of signals, all the items that are of interest to the system.

Despite considerable research efforts in the field of multi-modal fusion (see e.g. Oviatt, 2003), knowledge about how humans combine different channels is still limited. Not to mention the recognition of the behaviour of the group as a whole. Furthermore, the system should also be sufficiently prominent, because a lack of a prominence might result in users who are unaware of the system's existence (Nijholt, Rist, & Tuijnenbreijer, 2004).

Data that is automatically sensed from sensors, such as microphones and cameras, needs to be sensed by sufficiently accurate sensors. The subsequent recognition module that transforms the perceived data into information should, in turn, also be sufficiently reliable for its task.

It is often mentioned that social behaviour is to be interpreted in a given context. For example, a smile in an everyday conversation can be a sign of appreciation, whereas, during negotiation, it can be a sign of disagreement. So, for the reliable interpretation of human behaviour, it is important for human sensing systems to be aware of the context of the situation. To date, there is no consensus on what context precisely is, or on how we should specify this. Without a good representation for context, developers are left to develop *ad hoc* systems for storing and manipulating this key information (see e.g. Abowd & Mynatt, 2000). Sometimes the major components of context are referred to as the 5 W's: who, what, where, when, why (Pantic, Pentland, Nijholt, & Huang, 2007). It is difficult to automatically assess the values for most, if not all, of these properties. As a consequence it is therefore recommendable that these socio-technical supportive systems are to be used as suggestive, rather than pro-active.

conclus lons

Social behaviour is an extremely complex phenomenon where many aspects of everyday life play a part and come together. Systems that are able to perceive and understand what is going on in any social setting pertain to the emergent human computing paradigm in which adaptive systems respond in accordance to their perceived (human) environment.

The methodology of corpus based research investigates the possibilities for this technological trend to sense higher level concepts after a clever combination of more direct observations. This methodology requires a model that describes the phenomena that should be recognized as well as a carefully chosen example domain on which this model should be manually applied. After manual application machine learning algorithms can be trained in order to replicate the human observations from a set of features that are both easily observable and expected to relate to the phenomena under consideration.

Blind reliance on current state of the art technological performance might lead to erroneous decision making and entails the temptation of abuse, which in turn can lead to nasty privacy and responsibility issues. In our opinion, at this moment in time, socio-technological systems can, hinging on their performance, in the best case be used as suggestive or informative guides. This is by itself not a bad achievement, especially when we realize that decisions concerning higher level human-human communication phenomena, such as those that occur in social encounters, are of a highly subjective nature on which humans themselves often disagree.

a cknowled Gment

We would like to thank the anonymous reviewers of an earlier version of this paper for their suggestions and discussions. This work is supported by the European IST Programme Project FP6-033812 (Augmented Multi-party Interaction, publication AMIDA-137). This paper only reflects the authors' views and funding agencies are not liable for any use that may be made of the information contained herein.

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key terms

Machine Learning: Machine Learning: This subfield of artificial intelligence is concerned with the design, analysis, implementation and applications of programs that learn from experience. The discovery of general rules from large data sets using computational and statistical methods is an important application area. Such large data sets can, for example, be corpora that contain audio and video recorded human-human or human-computer nteraction.

Corpus-based Research: Traditionally a corpus is a collection of language examples: written or spoken examples of words, sentences, phrases or texts. Nowadays a corpus can be any collection of examples, for example, human-human interactions, protoin interaction, video fragments, maintenance information, etc. A corpus is collected in order to learn from it, that is, to extract domain-specific information. Examples can be analysed and rules and models underlying the examples can be discovered. Machine learning algorithms are used to extract relationships between examples. Manual structuring of such data (annotation) allows the integration of human preferences and knowledge in machine learning algorithms.

Annotation Process: A corpus of examples, whether these are language or interaction examples (distinguishing between different kinds of interaction) can be annotated with human knowledge that makes it possible to distinguish characteristics of these examples. Machine learning algorithms can be guided and supported by such annotations and machine learning results provide feedback about our intuition and heuristics concerning which features of the examples help to distinguish them into classes. To support human annotators, tools are developed that visualize and otherwise emphasize characteristics of the examples in the corpus.

Multimodal Interface: Interface to a computer system (from a mobile device to a smart environment) that allows multiple modes of interaction. Among the modalities can be speech, touch, gaze, or gestures. Modalities can supplement one another, but also complement one another.Combining different input modalities is called fusion. It allows a system to disambiguate user input in order to get a more complete understanding of a user's commands or behavior.

Smart Meeting Room: A smart meeting room uses multi-modal sensors to detect and capture the verbal and nonverbal behavior of meeting participants. This is done in order to provide real-time support to these participants and to record meeting activity for off-line intelligent browsing and retrieval of meeting activities. Modeling multi-party human-to-human interaction, e.g. by using machine learning approaches, helps to recognize important activities and events during a meeting.

Nonverbal Behaviour: Nonverbal behaviour not only supports verbal communication. By observing nonverbal behavior, the observer, whether it is a computer system or a human observer, can learn about the intentions, the attitudes and the feelings of its human partner. Nonverbal behavior includes gaze behavior, facial expressions, body posture, gestures, and prosodic information, but it can also include physiological information. Hence, supporting verbal communication, issuing nonverbal commands, and allowing our human or computer partners to learn about our feelings, intentions, and preferences are the main reasons for needing to detect and interprete nonverbal behavior.

Sensor Information: Sensors in smart environments provide us with information about its inhabitants, their activities, and their interactions. Cameras and microphones allow audio-visual processing of perceived activity. Proximity and pressure sensors tell us about the location of inhabitants. Such sensors allow us to track the inhabitants and their activities in the environment. Devices that measure physiological information, including brain activity, can provide detailed information about the affective state of a user.

e ndnotes

1 See http://corpus.amiproject.org

2 http://www.anvil-software.de/

3 http://www.lat-mpi.eu/tools/elan/

4 http://www.ltg.ed.ac.uk/NITE/

Chapter XXIX
A Modern Socio-Technical View on ERP-Systems

Jos Benders
Tilburg University, The Netherlands, & Radboud University Nijmegen, The Netherlands

Ronald Batenburg
Utrecht University, The Netherlands

Paul Hoeken
Radboud University Nijmegen, The Netherlands

Roel Schouteten
Radboud University Nijmegen, The Netherlands

abstract

This chapter sketches an Organization Design perspective called "Modern Socio-technical Design", and subsequently discusses the implementation of Enterprise Resource Planning Systems from this perspective. The authors argue that the praxis of ERP-system implementation is often at odds with socio-technical insights, leading to various problems that ERP-end users are confronted with. These tensions may not be inevitable, but simply result from taken-for-granted organization assumptions underlying ERP-implementation praxis. The socio-technical insights are intended to help practitioners reflect on ERP-implementation praxis, and discuss to what extent an ERP-system is appropriate and if so, where socio-technically inspired choices may be made within configuration processes.

If you automate a mess, all you get is an automated mess

—Anonymous Saying

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Introduct Ion

Do ERP and teamwork coincide? Koch and Buhl (2001) studied 24 cases where teamworking and ERP-systems were introduced simultaneously. Their answer to the question is negative, as they argue:

> [s]*ince the concepts of teamwork and ERP-systems appear widely diffused, one might expect that both are closely aligned when they are implemented* [...] *As we demonstrate, however, this is not the case* [...] *Although ERP is possible to configure in such a way that autonomous teamwork on the shop floor is supported, we found that ERP and teamwork rarely interact directly. When they do, they are potentially competing change programs, and indirect competition predominates.* (Koch & Buhl, 2001, p. 165)

They argued that the problem was not the configuration of ERP-systems for autonomous teamwork, but that there were (1) no modules available for this configuration process and (2) no consultants with the necessary knowledge. To illustrate this, they discuss the case of a machine building company where an attempt was made to align ERP-systems and teamwork. The attempt was unsuccessful however, as it started from different premises: the consultants implementing the ERP-system focused on enhancing production planning and control from a central perspective and "did not push for supporting teamwork" (2001, p. 173). Furthermore, "in-built features" of the ERP-package used "were realized in a way that led to a strengthening of other parts of the planning than the teams" (2001, p. 173). Finally, the technical aspects of implementing the system were so complex and time-consuming that organizational aspects received little attention. The members of the self-managing teams in the project team could not turn this tide. Whilst the teams were authorized to take certain decisions, the key tasks of (local) production planning was centralized. In a second round of ERP implementation, the shop-floor teams' experiences were not taken into account and the new tasks were confined to data entry and providing feedback on production orders. Koch and Buhl stress that the outcome was not a necessity but "a mixture of intended and not intended actions both from the ERP-coalition" and members of the self-managing teams (2001, p. 174).

Their findings do not stand alone. At a more general level, Soh and Sia (2004) studied how ERP-systems were used in three hospitals in East Asia. They wondered whether empowerment or control would prevail in how these systems were used. The result of their study was that while both outcomes are possible, in praxis control tended to get the overhand. In terms of Orlikowski (2000), the 'control' potential of ERP-systems is apparently and in the course of time more easily enacted than the 'empowerment' potential (cf. Boudreau & Robey, 2005).

Koch and Buhl's study gives rise to the question why it is apparently so difficult to combine self-managing teams and ERP-systems. Answering this question calls for a more integrative view on organization design because teams are embedded in organization structures and information systems such as ERP-systems are to support decision-making in such organizations. This view remains implicit in Koch and Buhl's study, but is necessary if their recommendation of developing "practical templates" to support configuring ERP-systems for self-managing teams is to be realized. In a broader perspective, self-managing teams are seen as a hallmark of modern organization, for instance as part of "high performing work systems".

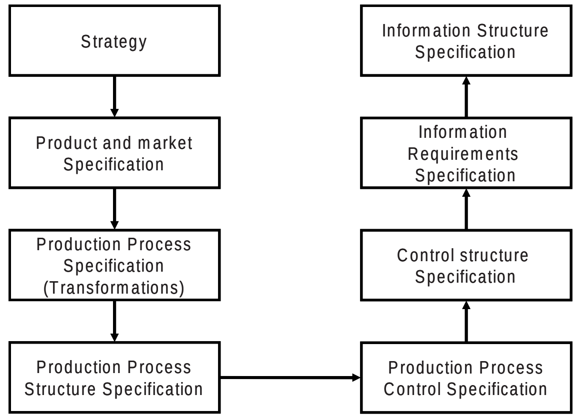
In the remainder of this chapter we first present an organizational design methodology that provides an integrated view on structuring organizations so that suitable organizational environments are created for self-managing teams and subsequently, after this structure has been designed, the informational requirements are analyzed so that information systems may be configured and implemented. This so-called "Modern Socio-technology" incorporates some organizational design principles which, as Koch and Buhl's (2001) work shows, tend to sit uncomfortably with ERP-systems in practice. These tensions are discussed after presenting Modern Socio-technology. This analysis is necessary as a first step for developing the templates for which Koch and Buhl signaled the need.

modern socIo-technIcal systems desIGn

What was to become socio-technical systems design (STSD) started with studies in the late 1940s in a number of British coal mines. In 1951, Trist and Bamforth published a founding article on STSD while the London-based Tavistock Institute played a key role in further developing socio-technical design into practical applications. During the 1950s and 1960s these notions were picked up in many countries, with Norwegian and Swedish researchers playing key roles. In the Netherlands a strand of socio-technical scholars and practitioners developed a widely accepted research based organizational design methodology (De Sitter, Den Hertog, & Dankbaar, 1997; De Sitter, 1998). This Dutch variant, called Modern Socio-technology (MST), builds on the classic STSD. In the 1970s Ulbo de Sitter played a key role in developing this socio-technical systems theory (with some roots in German sociology). During the 1980s this design theory was enriched with a proper design methodology based on action research. MST mainly differs from STSD by its integral approach. Whereas classic STSD provides a set of static and partial design principles, MST offers detailed structural principles in terms of design content, while at the same time specifying a theory of change by means of worker participation and training (Van Eijnatten, 1993). To emphasize the integral character of this approach, Van Eijnatten and Van der Zwaan (1998) labeled it Integral Organizational Renewal (IOR).

Since MST provides an integrated body of knowledge comprising analysis methods as well as (re)design rules (Van Eijnatten & Van der Zwaan, 1998), it is this Dutch variant of STSD we use for our analysis of the effects of ERP on organizational design. Team based organizations are a central concept in this approach aimed at meeting organizational requirements, as well as improving the quality of working life. To achieve this the design order principle as depicted in Figure 1 was developed (Groep Sociotechniek, 1986; De Sitter, 1998).

Figure 1. The Socio-technical design order principle (based on De Sitter, 1998)



the design order Principle: reduction of complexity

The production structure of an organization should reduce the variety and the number of possible interferences as much as possible. The principle is to effectively break down complex demand/transformation systems into a number of far less complex sub systems that are as independent as possible. In practice this implies parallelization and segmentation of order flows. Based on this, control structures can be governed by autonomous groups according to the principle of minimal critical specification. This actually follows Ashby's law of requisite variety (Ashby, 1969) holding that a system's control capacity should be at least equally as the variety it needs to control. By parallelization the number of interferences and dependencies between transactions can be drastically decreased. Parallelization can be contrasted with production specification into functional departments, in which every department is responsible for only one kind of transformation. Figure 2 illustrates the complexity reducing effect of parallelization in a functional organization (job shop like) compared to a set of parallel order flows.

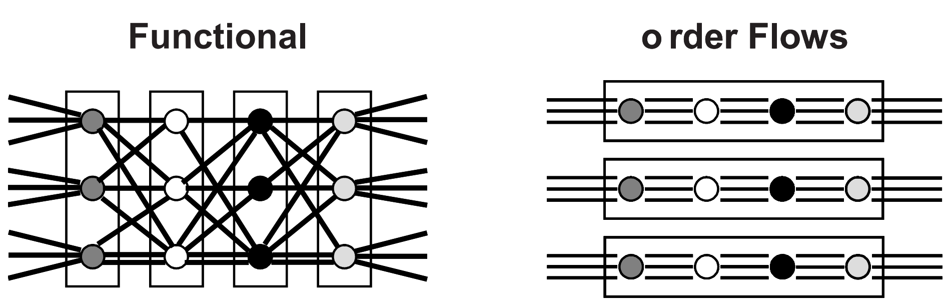
Socio-technical systems design implies a top-down development of the organizations' production structure, and a bottom-up development of the control structure needed. Starting at the left-hand side of Figure 1, the (top) management level, business strategy initially drives product and market specification. Based on this the required production processes and structures are designed. Within this top-down chain of actions, production process specifications consists of a large number of 'transformations' ranging from integrated production lines to traditional job shops. Depending on the scale and requirements of these transformations the production structure specification is defined. Each transformation has to be controlled towards a number of aspect related targets, such as quality, quantity, efficiency, costs, environmental impact and timely delivery. All these control activities can also be aggregated accordingly, ranging from task specialization in a bureaucratic hierarchical structure to self-directed work teams for specific product market combinations. At this first part of the MST design, basic decisions on production and job structure design ('what needs to be done?') are taken.

Moving to the right-hand side of Figure 1, the next steps particularly consist of the required information specification. These are derived from the control activities (information requirements specification) as specified top-down, and – bottom-up – developed into an aligned information structure (information system or set of information systems). Here, information structure specification implies the effective and efficient support of production and control activities. In this chain of the design different levels for control are to be distinguished. At the macro level strategic control of external relational are addressed. At the meso level inter-group coordination is concerned, while at the micro-level control teams and employees are responsible for controlling individual transformations. At this second part of the MST design, basic decisions on control and job design ('how should it be done?') are taken.

The Minimal Critical Specification Principle: s egmentation

Once parallel flows are created, task assignments allocated to units or groups should aim for an 'optimal' level of independency. This may be achieved by splitting the flow into a number of so-called "segments". This implies that tasks are grouped in such a way that the number and content of interfaces with other organizational units are minimized. Each interface creates the risk of interference and disturbance and hence a need for co-ordination. As shown in Figure 2, the reduction of the number of interfaces is achieved because incompatible grouping of transformations, such as welding and coating of metal parts, or nursing and operating in hospitals, are divided by flows into segments. In defining the number of transformations or people involved one should note that co-ordination and direct communication between segments or people will accumulate accordingly, leading to higher levels of required co-ordination. In this respect, the socio-technical design of teams by segmentation is also guided by the principle of minimal specification.

Figure 2. Functional Organization compared to Parallel Order Flows (based on De Sitter, 1998)



t he t ask c ompleteness Principle: q uality of w orking l ife

In an MST-design, segments are generally operated by self-managing teams. The preceding steps made sure that the tasks assigned to the teams may actually be carried out as independently as possible. The local control makes quick interventions possible in case of unexpected events.

The notion of maximum local control also applies at the level of individual employees. The organizational advantage of such local control lies in the potential for quick local interventions, but also in positive effects on employee behavior. This subscribes to Karasek's plea to balance job demands (i.e. control needs) and decision latitude (i.e. control capacity; cf. Karasek, 1979). A job is considered a 'good' job if it (1) consists of complete tasks and sufficient control capacity to deal with control needs conclusively, and (2) offers sufficient challenges to job holders. Creating such jobs removes a source of stress, namely that employees see undesirable events happen but are not allowed to intervene. By creating "good jobs", workers are to be motivated with positive effects on, behavior and absenteeism, and thus productivity.

modern soc Io-techn Ical Vs. er P-systems des IGn

As stated, deploying ERP-systems may have negative consequences for employees and organizations. Below, we aim to understand these negative effects by projecting the socio-technical principles on (explicit and implicit) design of organizations through ERP. We systematically confront the key MST principles discussed above with ways in which ERP-systems are commonly implemented.

er P-systems at o dds with design o rder Principle

A first and key difference between a socio-technical design and ERP implementation is the starting point. ERP, both as a business concept and an Enterprise Information System (EIS) automation concept, was originally developed to fully integrate different information systems that (particularly large) organizations deal with. Instead of creating middleware applications to connect separated Information Systems (for instance production planning and billing systems), ERP radically replaces them all. With ERP, the total information architecture needs to be redesigned in order to automate all processes in a similar way. The input and creation of information by users is designed to take place according to a one single point of entry principle, to avoid data redundancy. Business rules are formally translated in work and information flows throughout all of the ERP-modules, thereby similarly modelling departmental and functional roles. And finally the information representation is designed by standard templates and forms. In ERP-systems the traditional presentation, application and database layers are strongly integrated, with one single database and meta-model as its main core. Therefore, socio-technical organization design departs from design criteria, derived from a strategic position, to design the production structure and the control structure. The information structure is derived from the production and control structure. In the case of ERP, the information system provides the starting point and must be configured to fit organization structure and processes. These often follow the ERP-system rather than the other way around. In practice the complexity of ERP software enforces that organizations tend to 'stick to the standard' offered by the ERP vendor (Benders, Batenburg, & Van der Blonk, 2006).

This design order problem becomes particularly clear when multi-site organizations are considered. The central concern is about the fit between the systems to be integrated on the one hand, and the particular practice of organizational subunits on the other. The more subunits deviate from other subunits and the more these subunits are dependent on each other, the more likely that ERP implementations will need to depart from standardization of the information structure (i.e. the IS infrastructure or architecture). Customization of the ERP-software by bolt-ons, add-ons and spreadsheet workarounds are discouraged, while from a MST perspective these might be allowed to assist local decision-making and enhance control capacity. In other words, ERP violates the parallelization principle in cases these parallel flows demand differing information support functionality. This is problematic as ERP implementations usually entail the implementation of only one business model in the software to save on implementation and software maintenance costs (Swanson, 2003).

er P-s ystems at o dds with minimum Critical Specification Principle

In ERP-systems design there is a central database while integration by control is organized in functional software modules making use of one common IS/IT environment. The modular design of ERP-systems, however, also implies functional decomposition as there are separate modules for control domains such as finance, quality management, logistics and HRM. In addition, different functionalities, such as data input, query dialogues and management reports, are separated with ERP-systems. As modules are configured by functional specialists, the design of ERP-systems leads to a tendency to create tasks that are functionally decomposed as well. Obviously, this segregation of control aspects contradicts the fulfilling of the socio-technical requirement of integrating primary and supporting functions. In terms of Figure 2, the existing functional organization (similar operations grouped together) is maintained. The complex product flows in between different organizational units is followed by the software (as is the case with workflow management software). Figure 2 illustrates the risk of this approach, seen through a socio-technical lens. At the left, the functional structure is shown. A product that has to undergo various functional operations is taken from one functional department to the next, leading to complex routings through the organization. The socio-technical solution is, wherever possible, to place the operations in the same sequence as needed to make this particular product in multi-functional departments, as shown in the right-hand part of Figure 2.

Current ERP practices usually keep the complex functional structure intact, and follow the product through the different departments with an information system. From a socio-technical view this situation could be called 'technology-enabled complexity maintenance': instead of simplifying the situation to be controlled, the complex situation is maintained and the control possibilities are improved. In effect, this process orientation is the electronic equivalent of the 'chasseur', the French name for a person who used to be sent into a factory to track and speed up orders. The risk of using an ERP-system is that the symptoms of a complex structure are fought, but that the underlying problem of unnecessary complexity is not solved (De Sitter et al., 1997).

er P-s ystems at o dds with t ask c ompleteness Principle

ERP-implementations directly affect job decision latitude in various ways. During the configuration process, (future) users are authorized to take particular decisions. In granting authorizations, ERP implementers directly influence job decision latitude. However, as with other organizational changes, it appears that only in exceptional cases ERP-implementers take these effects on job content explicitly into account. Instead, predefined user groups and role structures tend to be used. The control perspective often comes back in the form of the "segregation of duties", a key principle in administrative organization which is to prevent creating opportunities for fraud. Control cycles are not closed, as modern socio-technical design prescribes.

A similar aspect concerns authorizations for data access and data entry. In standard authorization schemes, these are often concentrated with a limited number of users, generally those at higher hierarchical levels. This may cause problems at the shop floor, as work can not proceed in the absence of the authorized. A frequently used option to 'work around' these authorization problems is granting employees more access rights than controllers see as proper (Pollock & Cornford, 2004; Le Loarne, 2005). A user may formally or informally arrange access to additional user IDs and passwords to be able to perform all necessary tasks. In a socio-technical design user requirements would be the starting point for getting access. Obviously, data entry jobs within ERP-systems consisting of monotonous and short cyclical tasks are, in socio-technical terms, seen as "passive jobs" (Karasek, 1979). In a socio-technical design, data entry tasks would be integrated with other tasks into complete jobs. More broadly, ERP-users often need to put data in for other functions in the organization. A comment as "SAP creates work" (Le Loarne, 2005, p. 526) signals that this may not always be efficient and is certainly not always perceived to be efficient. The empirical examples described above support this notion.

Soh and Sia (2004, p. 25-26) see the ability to track products as a form of empowerment: what they call ERP's 'process orientation' allows employees to track the progress of individual products. Compared to a situation where this is not the case and hence employees are confronted with orders, insight into these orders' process statuses may be seen as progress for employees. However, as long as they are not authorized to take action, this may have the effect of increasing stress levels, because of lack of control capacity: seeing problems happen without being able to solve them, or insight alone is not sufficient. As a result, the control capacity needs to be adjusted as well.

Implications

Implementing ERP-systems goes along with organizational changes. Their breadth and depth, however, seem generally underestimated. As Koch and Buhl (2001) showed, organizational consequences are not always, and probably generally not, taken into account when implementing ERP-systems. Consequently, unintended and negative results are likely to occur. As Koch and Buhl's machine building case showed, organizational changes as a result of ERP and teamwork ask for contradictory directions for change. Whereas ERP-implementers strive for standardization and centralization, teamwork implies empowerment and decentralization, enhancing team autonomy. Especially in terms of job decision latitude, ERP may easily be at odds with team working. If the consequences of an ERP-implementation for job design are not explicitly considered, teams' potential to deal with environmental complexity and flexibility is not used or even negated. ERP's focus on standardization, authorization schemes and central control limits the job decision latitude (control capacity) at individual and team level (Karasek, 1979). As a result, the balance between control need and control capacity at individual and team level (an objective of MST and team working for reaching organizational goals) is disturbed and increasing stress levels and organizational inefficiencies may result.

However, these contradictory directions do not necessarily have to lead to negative results. As Buhl and Richter's use of participatory design tools shows, the implementation of an IT-system "can be productive and constructive if they are explained to other employees and if they, for their part, get room to and time to develop alternative models and their own perspectives" (Buhl & Richter, 2004, p. 270). These participatory design tools fit into MST's design methodology and action research approach. Starting from organizational requirements and building autonomous teams as the building blocks of the organization, the technical systems must fit this organizational design. Participation of team members in the configuration of ERP enhances mutual understanding between different groups in the organization and, as a result, the system's productivity and the worker's enactment of the technology (cf. Orlikowski, 2000). Furthermore, it does justice to the teams' autonomy and decision latitude.

Two points of special attention are attached to this participative approach. First, it requires that ERP-systems are truly open for configuration in terms of the underlying technology (as with customization), business rules (as with parameterization), and the financial barriers of these system adaptations. Scott and Wagner (2003) state that ERP can be customized to adapt the principles of socio-technical design. By longitudinal and participatory design analysis of an Ivy League University in the US they conclude that – in contrast to the opinion that ERP is uncontrollable (or even a "technological monster") – temporal turns and negotiations during the ERP project led to "a hybrid working rhythm that is inscribed into its socio-technical infrastructure" and hence a socio-technical information system was created. It should be noted however that the adaptability of ERP-systems in practice often deviates from the "anything goes" adage that SAP and other ERP vendors use in promoting their systems as total business or industry solutions.

The second point of special attention is that staff participation may result in single-sided attention for quality of working life. Following MST's design methodology, first and foremost the organizational structure must be built in order to meet organizational (corporate) requirements. Self-managing teams are the main concept in this design, but these teams' autonomy cannot be a goal in itself. In MST balancing organizational requirements and workers' needs (quality of working life) is essential and a logical consequence of the design process. As a result, participation of teams in, for instance, decisions about authorization schemes in ERP, rather than the technical specifications, seems highly important. For instance, Buhl and Richter (2004) show that shopfloor worker participation in accessibility rights in the system resulted in modifications that supported the teams' competencies and some autonomy to plan their own time and production capacities. These are important aspects of control capacity and therefore positively influence the balance between control need and control capacity (cf. Karasek, 1979).

Example: A Board Manufacturer

A solid board manufacturer delivers special products to a number of market segments and areas. The organization faced the problem that some clients demanded rather short delivery times but were willing to pay premium prices, whereas others accepted longer delivery times and ordered longer in advance. To serve both market segments a partial parallelization of order flows was suggested, namely of sales and order acceptance functions. Nothing changed in the manufacturing process, as the heavy machinery in the mill was too expensive to re-group.

The process of order acceptation was delegated from the central planning department to the regional sales offices. To minimize mutual interdependencies between sales offices or between sales offices and production, the production capacity was administratively distributed over contingents per area. The areas only needed to co-ordinate their activities in the occasional event of over- or underbooking.

However, the standard ERP-features did not allow for this tailor-made organizational solution. Thus, to facilitate this parallelization the ERP system was extended with a bold-on, a 'sales budget and order acceptance subsystem'. This interfaced with the sales forecast, the budgeting and production scheduling modules of the ERP software used by the organization.

Discussion and Conclusions

Our analysis is a first step in identifying some of the main potential causes of tension in implementing ERP-systems while creating suitable organizational environments for self-managing teams. As Koch and Buhl (2001) described the misalignment of ERP-systems implementation and teamworking, MST provides a useful lens to describe possibilities for aligning ERP and teamworking. Both include change programs aimed at dealing with organizational problems concerning lack (or loss) of effectiveness and flexibility. The existing literature shows that awareness of the organizational consequences of ERP implementation is an important condition for aligning ERP and teamworking. Centralization and standardization that go along with many ERP implementations are at odds with the three MST design principles we discussed. These are aimed at organizational structures that best respond to environmental complexity and in which the design and development of autonomous teams is the main concept. Being aware of these possible consequences opens the route to designing effective and efficient organization structures around autonomous teams that are supported by ERP-systems that are configured to meet the organization's requirements. Moreover, following MST design principles the work in teams or individual jobs should result in meaningful and complete jobs, due to the balance between job demands and job decision latitude. As Buhl and Richter (2004) show, communication, participation and cooperation of different participants, such as shopfloor workers, line managers, production planners and IT specialists, are important means to create the necessary awareness.

A limitation is that our chapter focuses on what one may call 'traditional' ERP implementations, i.e. the deployment of product software solutions within organizations to integrate, automate and support business processes. Several developments can be recognized that go beyond the standard type of ERP implementation. A major movement is that more and more organizations use ERP software to extend and virtualize their organization, their supply chains and corporate networks. Most ERP software offers e-business functionalities to support this virtualization by tools and modules for e-sales, CRM, e-procurement, e-sourcing and so on. These cross-organizational functions put new pressures to adjust ERP-systems to these new organizational settings. Boersma and Kingma (2005) presented an in-depth case study of mutual ERP adaptation and virtualization through enforcing supply chain conditions. This type of external adaptation will obviously multiply fast if organizations increasingly extend their information exchange and system integration with other chain and network partners. As a consequences new developments within the software profession emerge like Service Oriented Architecture (SOA). SOA particularly fits the idea of transformation of a static functional organization to a dynamic network of services. Flexibility is the key competence to achieve, by rapidly creating new services from existing ones, and by adjusting the services network onto the fast changing environment. Almost all ERP-vendors have announced a reshaping of their products towards this service orientation. Applying SOA can enable software solutions to dynamically support specific organizational needs, while combining and re-using product software and existing IT.

These developments might retune the disadvantages of classic ERP we here brought up in this chapter. They do not change the core characteristics of ERP as an integrative and control-oriented system however. Research is rightly to explore about the impact of fast-moving technological developments, such as e-business and SOA on the (inter-)organizational fit of ERP. This might actually be an interesting momentum for ERP-vendors and consultants to rethink their architectures and implementation methods taking the socio-technical principles here referred to into serious consideration.

The Modern Sociotechnical design perspective seems to sit comfortably with the adage "First organize, then automate". In sharp contrast, the current ERP-implementation praxis can be characterized as "first implement, then re-organize". This has a couple of implications for practitioners. These include various IT-specialists, consultants from "implementation partners', and at the demand site, managers and (end) users. These different "stakeholders are likely to have partially diverging interests. The MST-perspective probably serves managers and end users best: this perspective may strengthen them to point to critical aspects during implementation. Given the political realities in many organizations, the ERP-implementers will probably be in a strong position and argue against "first organize, then automate" as this may lead to questioning the wisdom of ERP-systems. Less radically, however, the socio-technical perspective may influence choices within the scope of ERP-systems. These include:

- business process analyses should precede ERP-implementation;
- be critical about maximal coupling and consider de-coupling organizational units;

- use the notion of "local control" in authorizing end users;
- allow, when needed, local support tools.

Within ERP-design, templates for implementing self-managing teams may be developed. These can assist implementers to resolve the dilemma between centralistic, top-down control and specialization tendencies inherent in ERP-system design on the one hand, and on the other the socio-technical ideas of reducing system complexity, maximum local control and minimal critical specification.

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key terms

Control Structure: The structure (logical set up and distribution among jobs) of control tasks that together try to safeguard the intended outcomes of an organization.

ERP-Systems: Enterprise resource planning (ERP) systems attempt to integrate several data sources and processes of an organization into a unified system. A key ingredient of most ERP systems is the use of a unified database to store data for the various system modules.

Information Structure: Information structure refers to all information that is relevant to the organization's strategic and operational processes and decision making, that can be stored, used and managed by Information Systems and Information Technology (IS/IT).

Modern Socio-Technology: Modern Socio-technology (MST) is a Dutch variant of the classical socio-technical systems design (STSD) that focuses on organizational design.

Organizational Design: The process of setting up (designing) the structure of transformations, its coordination, control and the information flows needed to manage the transformation according to the organizational strategy.

Production Structure: The structure (physical lay-out and interdependence relations) of the transformations that together result in the constitution of the goods and services that an organization intents to deliver to their customers.

Teamworking: Teamworking involves a group of workers, generally between 4 and 20 persons, responsible for a rounded-off part of the production process, and entitled to take certain decisions autonomously.

Chapter XXX
Being Face to Face:
A State of Mind or Technological Design?

Mary Allan
University of Canterbury, New Zealand

David Thorns
University of Canterbury, New Zealand

a bstract

The chapter introduces the Bourdieuean habitus and field theory as a framework for an alternative way of investigating how perceptions of Media Rich Conferencing Technologies (MRCT) such as video conferencing, Access Grid and Telepresence systems affect approaches to their design, implementation and application, and the ways in which they are utilized by end users. The habitus and field theory is utilized to provide a break-way from prevalent models of analyzing technology uptake and innovation diffusion and provides a new framework for positioning the MRCT as a social construct operating within interrelating social, economic, environmental, and technological systems. This new positioning opens the way for an alternative view of the role of MRCT and facilitates new approaches to their design

Technology is assumed to be designed, developed, and produced by engineers… The orderly image of technical development, so pervasive in all but the most recent technology studies, is not only too simple—it is wrong

—W.E. Bijker

Introduct Ion

Various Media Rich Conferencing Technologies (MRCT) such as Video Conferencing, Access Grid, and the more recently developed Telepresence systems all promise to enable geographically dispersed people to 'meet' in an almost true to life fashion and engage in an almost real face-to-face interaction without the need to travel or physically collocate.

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The notion of using electronic telecommunications for enabling geographically dispersed people to connect is not new, and has been around since the first days of the telephone. However, the convergence of multimedia aspects such as video and graphics with telecommunications triggered the notion that these could be used to facilitate a close to real life communication experience (Egido, 1988), and bring telecommunication closer to the gold standard of communication, the face-to-face (FTF) interaction. The reason for this highly regarded capacity of FTF is said to reside in their ability to provide the most robust form of interactions, entailing multiple channels of communication, and various forms of embodiment and practices. Since the début of video conferencing in the 1960s designers and engineers have been developing and trialling numerous solutions devised to enhance the performance of MRCT and bring them closer to producing FTF experience. Today, state of the art technologies offer high definition studio quality audiovisual signals to be experienced in specially fitted rooms designed to create an immersive surrounding that will emulate FTF. However, uptake of these technologies is lower than anticipated (Frost & Sullivan., 2005; Hirsh, Sellen, & Brokopp, 2005; Sankar, 2006; Vilaboy, 2007), implying that expectations have not been fully met and the FTF experience has not yet been satisfactorily transported to the world of telecommunications.

The concept of mimicking FTF experience spawned the notion that MRCT will reduce the need to travel to meetings. Proponents describe the technology as an effective solution for conducting a cheaper, greener and quicker alternative to business travel(Beattie & Greenberg, 2007; Irwin, 2004). These promises are especially attractive in today's Knowledge Economy, which is reliant on interdependent production processes and requires collaboration across often geographically dispersed sites(Toffler, 1990). Furthermore, the promise to reduce travel carries the prospect of diminishing carbon emissions which is an appealing argument in today's society concerned about global warming. However, although companies, governments, and other institutions are launching climate policies and strategies, the deployment of greener meeting practices remains a challenge. A Wainhouse Research[1] analyst in an interview to the International Herald Tribune pointed out that the level of purchases of low and medium price range MRCT systems is still lower than anticipated, and sales are growing at about 20 % a year. The top quality telepresence systems promising the ultimate experience make just one percent of the total videoconferencing sales(Burnham -Finney, 2007). Adopters of MRCT report a relatively low correlation between use of MRCT and travel reduction. Results of Chatsworth Communications' FTSE 100 companies survey released in May 2008 show that only 5 % of respondents claimed to be reducing business travel through the use of video conferencing (Maung, 2008).

Numerous attempts have been launched in search for the reasons leading to the low uptake of MRCT and the changes needed for improving the situation. Some studies focused on issues of infrastructure, cost, or user awareness as possible barriers to uptake (Frost & Sullivan., 2005; Hirsh et al., 2005; Sankar, 2006; Vilaboy, 2007), others studied the effect social presence and media richness have on user experience (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; Biocca, Harms, & Burgoon, 2003; Daft & Lengel, 1986; Dennis & Valacich, 1999; Goffman, 1963; Short, Williams, & Christie, 1976; Wainfan & Davis, 2004). Innovation diffusion studies looked at processes of adoption of MRCT (Molina, 1997; Voss, Mascord, Fraser, Jirotka, Procter, Halfpenny, Fergusson, Atkinson, Dunn, Blanke, Hughes, & Anderson, 2007). The plethora of approaches may indicate the complexity of the implementation of MRCT, however, the multiplicity of views is also contributing confusion to decision making processes attempting to implement the technology and diffuse its application.

Other approaches to the analysis of the level of uptake concentrate on improving the experience of the users and have invested considerable amounts of resources in enhancing the design of MRCT, improving the network infrastructure, developing a diversity of products to suit different budgets, and organising benefit awareness campaigns. However, the various efforts have not yielded the anticipated level of impact and no significant changes have taken place in tele-located meeting practices.

The utopia of a wonderful world of cleaner, greener, efficient, time, and cost effective future of tele meetings seems to be still an illusive and at best limited dream. Furthermore, the dream seems to be drifting further away on the waves of frustration emanating from the socio technical gap between what society expects and what the technology is able to perform (Molina, 1997; Whitworth, 2006).

Having reviewed the situation, we propose an alternative approach, one that shifts from the perspective of inquiring *why* the technology is unable to meet social expectations to investigating whether the perceptions attributed to MRCT are misconstructed. The investigation we propose here shifts the focus from investigating whether '*it is the design that is not living up to expectations',* to '*how expectations are constructing a perceptual design which may contribute to an actual design*. Our approach denotes what Bourdieu would consider an epistemological break which allows the investigation to leave behind any prior notions that operate in the field of the study and look at the subject with 'a new gaze' a '*sociological eye'*(Bourdieu & Wacquant, 1992 ,p. 251)

The next section introduces the Bourdieuean concept of *Habitus* and *Field,* and uses it to construct MRCT and analyse their position and relationships within society. The third section describes, deconstructs and challenges the paradigm suggesting that MRCT are simulators of FTF and exposes the complexities entailed in such assumptions. The fourth section expresses users' voices recorded in a survey conducted in New Zealand during 2007. The final section summarises the ideas raised and proposes some future recommendations.

t he bourd leuean breaka way

The Bourdieuean epistemological break with the common sense of technology allows researchers to leave behind the force of prenotions that are at play in the field they are studying and acquire a 'new gaze'. (Bourdieu, Chamboredon, Passeron, & Krais, 1991; Bourdieu & Wacquant, 1992; Sterne, 2003).

Viewing Media Rich Conferencing Technologies (MRCT) as simulators of face-to-face (FTF) could be perceived as the Bourdieuean *common sense*, which at times refers to 'those things commonly known or tacitly accepted within a collectivity'(Holton, 1997). Breaking away from the common sense perception of MRCT enables the 'construction of the object of study' rather than accept any prenotions that accompany it (Sterne, 2003). We propose that the thesis of MRCT as simulation of FTF is the lived *sedimented social history* embodied in the social life or in Bourdieu's terminology, it is the habitus, the historic outlook or disposition society holds about the technology and about its social practices (Sterne, 2003; Wacquant, 2006). We argue that this historic sediment in the social life has been articulated by McLuhan's view of technology as the extension of man's senses (McLuhan, 1994; McLuhan & Fiore, 1967). The 'technologically enhanced senses' approach creates a *cause and effect* paradigm suggesting that the enhancement of the MRCT to more closely resemble their perceived role as simulators of FTF, will result in greater uptake. This will facilitate dispersed collaboration required by the Knowledge Economy while at the same time help to reduce carbon emissions. We argue that the linear cause and effect paradigm needs to be broken away from because the model of "better technology more uptake" has not proved itself. To break away from the old there is a need to be able to "unite what is ordinarily separated or distinguish what is ordinarily confused" (Fauconnet and Mauss in Bourdieu et al., 1991, p.15; Sterne, 2003). We propose to distinguish what is ordinarily confused, that is, the idea that technology is a designed artefact and suggest that it should be regarded as a social disposition. To allow us to do so we use Bourdieu's *habitus and field* approach. This approach allows viewing the situation as a system of relations rather than that of cause and effect.

Bourdieu's habitus is a set of dispositions through which people perceive, judge, and act in the world (Wacquant, 2006) and at times, it can entail taken for granted assumptions(Lau, 2004) We propose the disposition, that is, the mental perceptions of the role of media rich telecommunications as simulators of Face-to-face interactions, as our habitus. Bourdieu's theory suggests that the *habitus* is conditioned by the *field* which is defined as a network of relations among objective positions within it, a set of positions expressed and performed by interacting agents comprising it (Bourdieu & Wacquant, 1992; Fuchs, 2003; Ritzer, 2000). In our case the *field* entails global businesses operating in the Knowledge Economy conditions, requiring collaboration across locations, and fast decision making processes; governments' sustainability and international climate policies such as the Kyoto Protocol; environmental movements expressing demands for reducing business and trade travel and help decrease gas emissions and minimise carbon footprints; and manufacturers and vendors of MRCT.

The *field* conditions the *habitus*, and the *habitus* constitutes the *field*, as they mutually define one another (Ritzer, 2000). Furthermore, the *habitus* is shaped and is shaping the social world around, and it is doing so through *practices* which mediate between the *habitus* and the social world. The *habitus* is created by *practices* and at the same time it is *practices* that create the social world (Ritzer, 2000). *Practices* in our context are the design and manufacturing processes promising to create technological tools that will simulate FTF interactions and these are linking the *habitus*, the social view of technology as simulating FTF and the users, that is the social world. Figure 1 illustrates the interrelations of habitus, field, practice, and the users, the social world.

The *habitus*, in which MRCT are perceived as simulating FTF is strengthened by the *field* which is expressing demands for carbon footprint free global collaboration. In other words, the social perception of technologically mimicking FTF is seen to serve the positions expressed in the *field*, and both *habitus and field* are in agreement. Furthermore, their positive relationship is partially reinforced, but also being challenged by the practices of the designers and manufacturers of MRCT, as the next section shows.

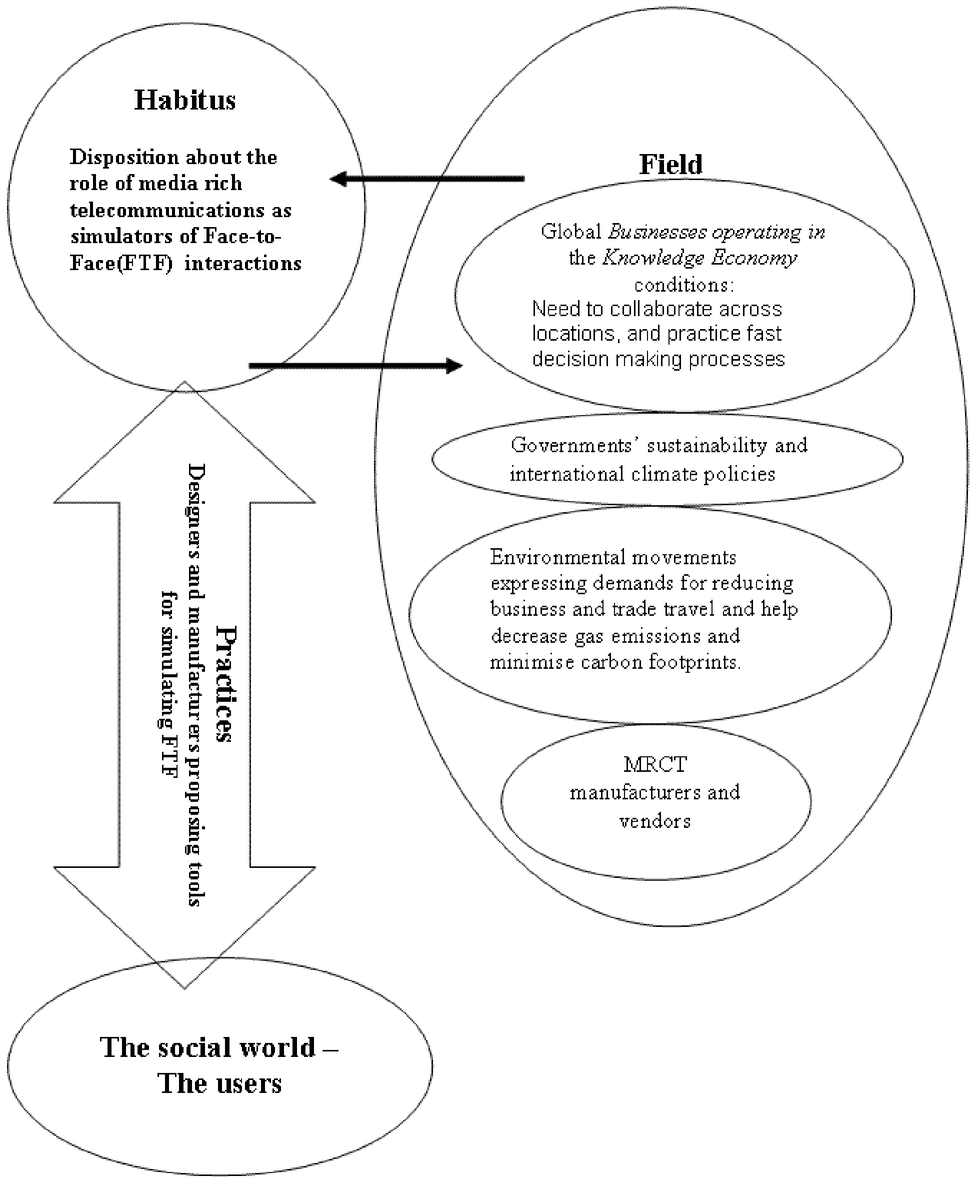
t he *PRACTICES* o F technolo GIcal des IGn

The thesis underlying the design of Media Rich Conferencing Technologies (MRCT) draws on notions such as those expressed by Mehrabian (1971), who argued that up to 93% of meaning is contained in facial and vocal cues, and also on those of Media Richness Theory, also known as 'Information Richness theory', which argues that task effectiveness is improved when task needs are matched to a medium's ability to convey information. The theory argues that media richness is based on four criteria: feedback; multiple cues; language variety and personal focus (Daft, Lengel, & Klebe Trevino, 1987; Valacich, Mennecke, Wachter, & Wheeler, 1994). Media Richness Theory suggests that the greater number of these attributes that are displayed in a medium, the richer it is, and therefore the closer it gets to the richest media of all, the face-to-face (FTF) (Baltes et al., 2002; Wainfan & Davis, 2004). Figure 2 builds on Baltes et. al (2002) and Wainfan and Davis (2004), and illustrates the levels of richness attributed to different media.

Figure 2 depicts telepresence systems second to face-to-face; implying that they are the richest technology media out ranked only by the gold standard medium of FTF. When doing a broad-brush deconstruction of the components entailed in FTF communication, these could be aggregated around three key clusters:

1. Synchronicity- the ability to engage in temporal turn taking interactions that enable the smooth alternation of speaker and listener who are co present(Bosch, Oostdijk, & Ruiter .J.P. (de). 2004)
2. Multimedia information incorporating Mehrabian's '3V's'—verbal, vocal, and visual(Mehrabian, 1971)

Figure 1. The Habitus and Field *of telecommunications*

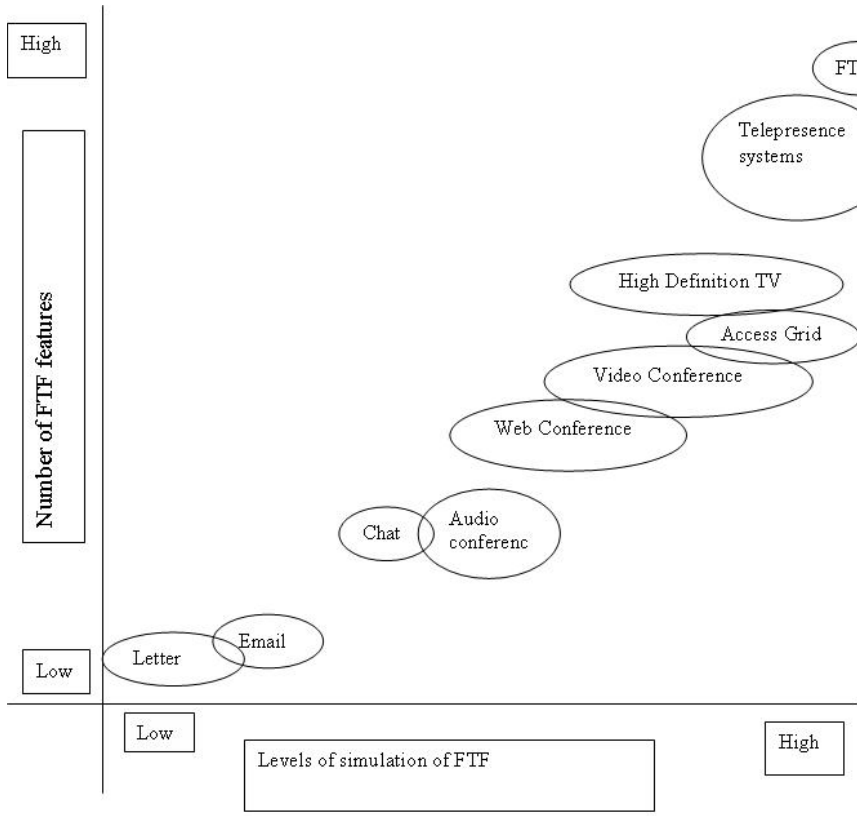


3. A sense of being with one another, a sense of presence (Heeter, 1992), and co-presence (Goffman, 1963; Schroeder, 2006)

Transferring the functions of these broad clusters to be performed through technological means requires breaking them down into separate tasks which will be performed by a variety of technologies.

The different tasks can be categorised in Mcluhanian notions, as those performing the extension of the senses of man, and those dealing with the collapse of time and the transformation of space (McLuhan, 1994; McLuhan & Fiore, 1967; McLuhan & Powers, 1989). A forth category is comprised of tasks of correction needed to compensate for the limitation of technology in comparison to humans. Lichtman (2006) from the Human Productivity Lab (HPL) produced a comprehensive list of all the features supported by telepresence systems. Table 1 builds on this list and adds features identified elsewhere

Figure 2. mimicking FTF



in the literature. The table categorises the features according to their respective tasks, some features overlap and appear in more than one category.

Table 1 shows that each of the features supported in the telepresence systems needs some kind of compensating, or correcting design to make the feature more plausible as mimicking FTF. We suggest that this observation demonstrates the complexity of transferring FTF to telecommunication environments, and challenges any simplistic notions suggesting that the mere addition of multi media features to telecommunication tools will enable a straightforward shift converting them to technologically designed face-to face communication spaces. Addressing the issues of the compensating design requires complicated and expensive development and manufacturing, which increases the cost of the product. This scenario is often used for explicating the reasons for MRCT not becoming more widely used. However, we would like to return to the root of the situation and challenge the assumption that an unmediated FTF communications can easily be replicated through technological design. Furthermore we would like to challenge the assumption that technology is 'the extension of man' in a straight forward manner, and propose that perhaps we should perceive technology as merely aiding tools for humans to perform tasks. Posing these questions suggests possible changes to the *habitus*, which according to Bourdieu is created by the *practices*, hence changes to the *habitus* will imply changes to the *practices* that is, changes in the approach to the design. But before further exploring these issues and the affects they may have on the constitution of the *habitus* we will explore the current relationships between our initially defined *habitus and field* as two entities which are mutually defined by one another (Ritzer, 2000).

The *habitus* as a social construct of MRCT as simulators of FTF is constituted not only as a histori-

Table 2. Tasks and design features[2]

Extension of man	Time–synchronicity	Space and presence	Compensating design
Audio–signals	full -duplex audio enables to talk and listen at the same time	Studio quality acoustics	A consistency of quality between disparate locations
Visual/ video images		• Life-size participants • Fluid motion • Video • Studio lighting	• Accurate flesh tone • Fluid motion • Studio lighting • Screen size and HDTV • A consistency of quality between disparate locations
Gaze, eye contact		Gaze , eye contact	True eye contact (gaze) or the approximation of eye contact in large group settings
		Proximity	mirrored environments
		Immersive and or mirrored environments where participants feel as if they are in the same physical space	Standardised furniture and room décor design
Intuitive		The absence of visible technology	The absence of visible technology

cal sediment of the extension of man, but beyond their physicality as concepts shaped by the relations of power within the *field*, which on the one hand pushes for greater global collaboration requiring travel, and the growing environmental demand for reducing the carbon footprint.

The call for greater collaboration in the Global Knowledge Economy arises from its interrelating production processes occurring across globally spread businesses, needing geographically dispersed teams to collaborate and consult with cross site located experts (Carlaw, Oxley, Walker, Thorns, & Nuth, 2006; Drucker, 1969; Drucker, 2003; Dunning, 2000; Toffler, 1990). The Global Knowledge Economy is about fast and effective decisions making processes, it is about mobility and connectivity. However, it is operating within a growing awareness that carbon emissions are related to human activities (Wiedmann & Minx, 2007). This link between human activities and the environment has paved the way for making the connection between business and trade travel generated by the needs of the Global Knowledge Economy and the growing carbon footprint. Manufacturers and vendors of MRCT highlight this connection as a key aspect in business cases promoting the technology as a solution.

“Save money on long distance meetings with Video Conferencing” is the opening catch phrase on Telecom’s New Zealand website (Telecom, 2007). Davis and Weinstein from Wainhouse Research (WR), an independent market research firm based in the States, argue that MRCT “*can play a critical role in helping organisations develop more effective work teams, manage dispersed global resources, shorten product development cycles, maintain higher levels of integration with suppliers and customers, and lower operating costs*”(p.1). Furthermore, the authors note that many large software and infrastructure vendors have set up entire business divisions to provide their customers with the conferencing and collaboration products, recognising that “ the time to invest in conferencing and collaboration solutions is NOW” (Davis & Weinstein, 2005p, 1). Davis and Weinstien in ‘The Business Case for Videoconferencing’ argue that these tools are increasingly infiltrating today’s work place and are gradually being perceived as essential components in the work environment just like the PC and email in their time (Davis & Weinstein, 2005). However, when talking to the International Herald Tribune Davis painted a rather different picture pointing to the fact that level of purchases of these systems is still lower than anticipated. (Burnham -Finney, 2007).This discrepancy between the busi-

ness case portrait and the newspaper interview is an interesting observation depicting the struggles of power and capital within the *field*.

Satisfying the collaborative business goals of the Knowledge Economy on the one hand while appeasing the sustainability policies and environmental pressures on the other, will require some use of telecommunication technology. This may invoke tensions between the requirements and expectations entailed in shifting to teleconferencing practices, and the capital available for investment in the purchase and maintenance of the technology. Engulfing the whole of these interrelations within the *field*, and between the *habitus and the field* are the users' perceptions, attitudes, and applications of the technology. The next section shows how the users, as the social world within which the technology resides, influence the relationships between the different systems in the Bourdieuean model illustrated in figure 1, and how the users are reconstructing the *habitus* and reconstituting the *field*.

users ' Vo Ices

The New Zealand high speed internet connection the Kiwi Advanced Research and Education Network (KAREN) became operational in February 2007. The new network linked up all the eight universities in the country and opened the way for more intensive use of Access Grid (AG) technology which had already been operating in universities as part of a national Social Science project, BRCSS[3]. The prospect of increased uptake of the technology was one of the triggers for researching the use of the AG, and in 2007 we launched a Web survey of Access Grid (AG) users. We sent a total of 454 invitations to potential participants from a group of research students and faculty members who have had some experience with the AG technology, and received 137 (30%) completed questionnaires.

The findings of the 2007 survey show that the overall attitude towards the use of the AG was positive, with 90% acknowledging its potential for increasing collaboration, and 66% perceiving AG as enabling frequent communication with colleagues. When asked to compare AG to FTF, comments describing dissimilarities were as high as 78.3%, these also tended to be more elaborate then those describing similarities. However, when asked if "it is **possible** to participate in an Access Grid session in the same way as one would in a face-to-face session", a significant proportion of respondents, 82.4%, agreed with the statement to varying extents while only 17.6% disagreed. This seemingly contradicting result may indicate a gap between the perceptions respondents have regarding the potential of the AG, and the actual experience (Thorns, Allan, Barclay, Chamberlain, Kerr, & Scott, 2008).

Respondents noted that the most prominent aspect of similarity between AG and FTF was the ability to 'see participant's body language and reactions to ideas'; however, comments made by the respondents in the open ended sections of the survey pointed out that this potential implied additional aspects beyond the simple ability 'to see'. The respondents noted that poor quality of the projected images can lead to "*Difficulties in discerning body language"* which as respondents argued *"resulted in a feeling of the Access Grid session being more formal and lacking the sense of spontaneity that a face to face interaction may have".* The notion of formality of Access Grid sessions appeared time and again across the survey (ibid, p.43).

Nevertheless, in summing up their experience, the respondents described the AG as *"better than nothing at all,"(p.30),* "*It is not a natural experience, but it is getting closer to being the next best thing"(p.41) , "ok when you can't meet in the 'real world'(p.30),* "[*it is] a very good way to meet, discuss, work with colleagues across the nation",* and one can *"pop into a local room and connect up to people many miles away"*, and feel *"as if they were in the same room" (p.35)* (Thorns et al., 2008).

The comment referring to feeling in the *same room* prompted another aspect which MRCT and the AG are proposing to solve, and that is the ability to collapse distances and enable people to 'share space' without the need to physically be in the same space. Although questions regarding the potential of the AG to reduce travel were not included in the questionnaire, 34% commented that the major advantage of the AG was the ability to interact with fellow researchers without having to travel, saving money, and time. Surprisingly many respondents alluded to the benefits of ICT for the environment, and acknowledged the positive impact of the Access Grid in enabling reduction of Carbon Footprint as people did not need to travel far to attend meetings or presentations: *"Fantastic CO2 savings by not travelling"* (ibid).

The findings reveal that although the users point out the limitations of MRCT to simulate FTF, they are aware of the benefits it entails, and meeting across AG or other similar technology has its place although they agree that it is not suitable for all tasks. The respondents proposed that "[the AG is] *good for presentations and questions"; "Great for meetings"*. However, they were less positive about its effectiveness for meetings and focus groups where *"there is a need to get group interaction* (ibid)*."*

The model of use emerging is that of complementary, rather than substitution, not replacing but supplementing FTF communication. The benefits noted by the respondents are that the technology enables the enhancement of the experience of the users, however it cannot replace the FTF feel, but all-the-same it can increase the frequency and flow of information without increasing the Carbon Footprint.

The survey findings help position the MRCT within the wider context of society, and reveal that the users are in agreement with some of the forces at work in the *field*, as they acknowledge the benefit of using the technology for maintaining frequent communication while reducing the need to travel. Moreover, the survey points to the fact that users are primarily interested in the content of the meetings (89%) rather than the marvels of the technology (45%), alluding to the fact that users may not be overwhelmingly impressed by technological wizardry but are more concerned with getting on with their tasks. This particular finding can be seen as the passage for a break away from the causal model of 'better technology resulting in higher uptake'.

The findings show that the views of the respondents seem to challenge the disposition expressed in the *habitus* and question the similarity between media rich telecommunications and FTF, but agree with the positions in the *field* that acknowledge the need to use the technology in the face of the looming environmental crisis. Furthermore, the users challenge the assumptions and practices of the designers about the MRCT acting as the extension of our senses, and propose that although they enhance the communication experience, they cannot act as FTF substitutes. Their greater advantage lies in their ability to enable people to perform tasks that would otherwise require travel.

In challenging the *habitus* and the *practices* while agreeing with the main notions of the *field*, the users break the state of agreement between the *habitus* and *field* and so break the circle of reinforcing forces. By creating this discord the users are opening the way for innovation (Wacquant, 2006). Changes to the *habitus* will trigger changes across the whole system. As the *field* conditions the *habitus* and the *habitus* constitutes the *field* they mutually define one another (Ritzer, 2000). Furthermore, because the *habitus* is shaped through the social world, that is, the users, and is doing so through the *practices*, then we can assume that changes in the *habitus* will lead to changes in the *practices*, eventually altering the whole of the system. The significant influence the users hold in this system, where they generate a cyclic movement affecting all parts of the system, leads to the need to revisit the Media Rich Conferencing Technologies as entities of technological design and to view them as constructs of social, economic, technical and environmental systems.

Summary and Recommendations

Since the debut of the first videoconferencing systems about 40 years ago, Media Rich Conferencing Technologies have been battling low uptake and socio technical gaps leading to users' disillusion and manufacturers' frustration. Solutions to the situation were thought to be found in improved design to enhance user experience, lower costs, improved infrastructure, and user awareness. A close look at all of these solutions reveals that they all circle around the technology being an entity that needs to be improved in order to be used. This is a 'cause and effect' model in which the technological ability to produce and transmit audiovisual signals was seen as the extension of the audio visual senses and hence it was assumed that improving the signals would result in the ability to experience technologically mediated FTF experiences. This assumption became the core paradigm guiding the search for ways to increase uptake, however, to no avail.

Positioning the technology as a socially constructed entity shifts the locus of power from the quest for the ultimate design that will deliver the ultimate FTF experience, to investigating how users perceive the use of the technology rather than the features of its design, and how they rank the different features and deploy them in their tasks. Looking back at the history of technology it is usually the users that determine the use of an artefact- not its design, or as Sterne (2003) sums it up—"use', 'function', or 'role' are derived in reaction to the practices affiliated with the technology—the practices that essentially *make* the technology in the first place" (P.373).

Adopting the *Habitus and Field Theory* allows one to break away from the old paradigm and view the technology as a social entity constructed through its use. Furthermore, the cyclic movement of the *habitus and field* paradigm enabled how users through *practices* are redefining the *habitus*, shifting it dispositions about the role of MRCT as an FTF simulator, and so created a disagreement between the *habitus and the field*. This, according to Bourdieu allows for innovation to occur and bring about the innovation needed (Wacquant, 2006). Moving away from seeing technological design as the trigger for change to the notion that it is users' practices that are generating change, alters the paradigm guiding the search for solutions to technological uptake. It allows for a view that looks at the perception of the (perceptual) design constructed by the users as the key for activating the design features offered in the technology. This approach also opens the way for users to be the decision- makers in what features they need for the task they are about to perform.

r ecommendations

We propose that designers need to shift their approach and let users' practices lead the way in which technologies will be constructed. It may be that by over promising, designers and vendors may have created a socio technical gap between expectations and experience. Designers may look to previous telecommunication technologies and study the history of their adoption. Historically communication technologies permeated everyday use beyond designers' expectations. People will more readily adopt technologies which are simple to operate even if it means compromising some applications and features. Technologically simulating FTF interactions is proving to be a complex task, hence operating video conferencing tools is proving to be either too complex for comfort, or too expensive to purchase.

We suggest moving away from the notion that MRCT will one day replicate FTF and focus on designing easy to use, inexpensive suits of teleconferencing tools that will allow users to choose the tool and its configuration to fit a specific task. Working with a suit of tools will enable shifting between tools whenever the needs change. Switching between the different tools in a seamless and intuitive manner within a single teleconferencing session could provide users better fit between task and tool in a flexible, informal and intuitive way, features which are at the heart of any FTF interactions and are currently absent from available MRCT. Enhancing telecommunication is not so much about better views and sounds but rather about the ability to interact and collaborate in a flexible rather than structured and limiting environment, even if that means losing some of the immaculately pre-designed experience. The goal of telecommunication is primarily to connect people by offering tools designed to provide a comfortable and rewarding interactive experience.

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Key Terms

Access Grid: A collection of resources assembled for the purpose of supporting collaboration across different locations. Access Grid provides a near-real face-to-face experience in which people can experience "being there" in a shared space with others without having to travel. Generally Access grid 'nodes' are specifically equipped rooms. Desktop applications are also sometimes used where specifications allow this for individual users.

Bourdeuian Habitus and Field Approach: A dialectical analysis of practical life, offering the potential to exhibit the interplay between personal practice,(agency) and the external world of social practice(structure) (Bourdieu,1980/1990; Harker, Mahar, & Wilkes, 1990)(Allan, 2005)

Carbon Footprint: The term is rooted in the language of *Ecological Footprinting* (Wackernagel 1996), and stands for the amount of gas emissions causing climate change and are related with human production or consumption activities(Wiedmann & Minx, 2007)

Field: A space of conflict and competition in which participants fight to establish monopoly over the species of capital effective in it(Bourdieu, [1980]1990) (p.17). Or in other words a field is constituted by the relational differences in position of social agents, and the boundaries of a field are demarcated by where its effects end.

Habitus: An infinite capacity to generate products, thoughts perceptions expressions and actions whose limits are set by the historically and socially situated conditions of its production(Bourdieu, [1980]1990) (p. 55)

Knowledge Economy: Described as the intangible economy , where electronic blips transmitted across worldwide computerised networks are replacing capital(Bell, 1973; Binde, 2005; Fuchs, 2006; Toffler, 1981; Toffler, 1990), it is a dematerialised economy, where materials have been replaced by intellectual resources and services(Block & Hirschhorn, 1979; Carlaw et al., 2006; Castells, 1996; Drucker, 1969; Toffler, 1990), and the workers produce intangible, intellectual rather than manual or material products, (Drucker, 1969; Drucker, 2003; Thorns & Wang, forthcoming).

e ndnotes

1 An independent market research firm that focuses on the critical issues in rich media communication based in the States.

2 To view list of studies consulted in constructing this table—see **Appendix A: Studies of Tasks and Design**

3 Building Research Capabilities in the Social Sciences

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Chapter XXXI
Applying Bourdieu to eBay's Success and Socio-Technical Design

Rebecca M. Ellis
University of Essex, UK

a bstract

This chapter introduces the work of sociologist Pierre Bourdieu and his concepts of "the .eld" and "capital" in relation to eBay. In any given field, there is competition for various sorts of "capital"—power and resources. This chapter considers eBay to be a "field" in its own right—a socio-technical system with its own set of social norms and rules. eBay is used as a case study of the importance of applying a Bourdieuean approach to create successful socio-technical systems. Using a study of eBay users as empirical illustration, this chapter argues that much of eBay's success is in the affordances for social translucence of eBay's Web site in supporting the Bourdieuean competition over capital and status. This exploration has implications for socio-technical systems design— in particular, the importance of creating and maintaining socially translucent systems, informed by Bourdieu's theoretical insights, which support competition for "capital" and status.

…understanding how to design digital systems so that they mesh with human behaviour at the individual and collective levels is of immense importance. By allowing users to… make inferences about the activities of others, to imitate one another, we believe that digital systems can become environments in which new social forms can be invented, adopted, adapted and propagated…

—Erickson and Kellogg (2000, p. 80)

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Introduct Ion

eBay, the 'world's largest personal online trading community', was initially set up in 1995 with collectors in mind. It enabled easier access to collectibles (Bunnel & Luecke, 2000)—where the traditional inef. ciencies of person-to-person trading such as geographical fragmentation and imperfect knowledge (*ibid.*) could be offset through computer mediated communication. eBay initially aimed to improve the market liquidity for collectables, which are more problematic to exchange than mass-produced consumer items (Chircu & Kauffman, 2001). But the Internet auction site developed into the way for users to generally establish prices for goods with uncertain values (*cf.* Smith, 1989), including second-hand mainstream items, and later even diversified into selling new and old goods at fixed prices (Zukin, 2004). eBay's success, however, did not alone hinge on making the market more efficient, or creating a platform where items, formerly hidden in limited geographic markets, were made public to the world. Using a two-year qualitative study of eBay users, this chapter argues that a large part of eBay's success is the affordances eBay's Web site offers in terms of supporting various social and cultural actions and practices. It is both a system affording social translucence (Erickson *et al.*, 1999) and 'social navigation' (Dieberger *et al.*, 2000) in relation to 'capital' and status, which contributes to its success. eBay is used here as a case study of the importance of applying a Bourdieuean approach to create successful socio-technical systems. This Bourdieuean approach has implications for wider socio-technical systems and e-commerce design which this chapter will discuss.

'Socially translucent systems' are described as those digitally-based systems which provide social cues which afford accountability, awareness and visibility (Erickson *et al.*, 1999). These social cues in turn allow people to draw upon their expertise and social experience in structuring their interactions with others (Erickson and Kellogg, 2000). Erickson *et al.* (1999) describe certain actions which are possible in socially translucent systems—such as noticing, creating and conforming to social conventions; engaging in peer pressure and imitations of others' actions through observation (*op. cit.*). Of particular relevance for this chapter, Erickson and Kellogg (2000) describe elements of making status socially translucent in terms of knowledge management systems—where systems which make knowledge work visible and reveal skill allow credit to be given to those responsible. Social translucence as a design approach is also articulated in Erickson *et al.* (2002). The 'social' in social translucence refers to providing socially salient cues. Translucence is a term used in preference to 'transparence'—it is not an intention to make all socially salient cues visible, just some of them. Erickson and Kellogg (2000) note a tension between visibility and privacy in such systems. One system of social translucence involves the notion of social proxy, a minimalist form of visualisation of people or their activities (Erickson and Kellogg, 2002). 'Social navigation', in terms of the online world, involves your decisions being informed and guided by information about what other people have been doing online (Dieberger *et al.*, 2000). In relation to eBay, this is particularly important in terms of reputation (*op. cit.*)—other people have been shown to have successful transactions with particular eBay users, and this guides future activity. Wexelblat and Maes (1999) examine navigation in complex information spaces, and highlight the importance of interaction history to guide our actions. In online spaces, problem-solving work by users is said to leave traces which should be accessible to users in the future to make solving problems easier (*op. cit.*). Wexelblat and Maes (1999) suggest that, following Norman (2002), objects that are rich in the history of use acquire new affordances which we can use for new ways of interaction. They describe different sorts of interaction history—knowing what was done, knowing who did it, knowing why it was done and knowing how it was done. These are all important for different reasons in future actions and problem solving—for example the 'who' may be important as the views of domain experts have greater legitimacy as a 'trace' than that of an amateur (*cf.* Dieberger *et al.*, 2000). Internet strategists have already formed a consensus that supporting the social component in this way is the best method to make Web sites 'sticky' (Cohen, 2002). This chapter aims to explore and deconstruct some of the social and cultural affordances of eBay that make it so 'sticky'. The notion of 'stickiness' is shorthand for attracting visitors and keeping them there (*op. cit.*). Haywood (2006) relates 'stickiness' to Miller's use of Gell's notion of the 'aesthetic trap' (Miller, 2000). Miller characterised Web sites as creating 'aesthetic traps'—where Web site visuals are also used to align the Web site's audience with its creators (Ellis & Haywood, 2006; Haywood, 2006). eBay has been regarded by the likes of Nielsen/ Netratings as "the standard-bearer in web site stickiness" as far back as 2001 (Mancey, 2001).

In using the terms 'affordances', this chapter seeks to present eBay as a socio-technical system and an adaptable one. The social system that emerges from the technical system is in part dependent on what that technical system can offer in terms of such things as tools, features and capabilities. However, the resultant social system is also a product of how the technical system is appropriated, which may be different from that intended by the Web site designers. Norman (2002) has written on the notion of affordances, and notes the origin of the term in Psychology, "the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (Norman, 2002, p. 9). The term 'affordances' is contentious, and Norman notes that designers often confuse the notion of 'affordances' with conventions (Norman, 1999). This chapter aims to be sensitive to Norman's definition of affordances. However, it uses the term affordances in the sense of its earlier origins—what is possible given the properties of the thing, in this case a Web site. This sense of 'affordance' is used to understand the social system that eBay as a technical system supports and makes possible, the social construction of the technical. Indeed eBay, as a case study, illustrates the highly complex interrelationships between technical and social systems, and that the arrow does not neatly flow from a technical to a social system in such an iterative system. eBay has been very active in user research (Ellis & Haywood, 2006), leading to the site going through many iterations of change. This chapter argues, therefore, and seeks to illustrate that there is no simple separation of the technical and social systems in relation to eBay—both are mutually constitutive.

In deconstructing and specifying the nature of eBay's social and cultural affordances leading to its 'stickiness', this chapter draws in particular on the work of the Sociologist Pierre Bourdieu. This chapter argues that applying the insights into 'stickiness' generated by a Bourdieuean approach can inform successful socio-technical systems design. Sterne (2003) suggests that Bourdieu's terms 'the field' and 'capital' are important in thinking through how "a technology becomes a technology through social practice" (2003, p. 375). Bourdieu developed the concept of the 'field' to denote the fact that agents act in social situations which are governed by objective social relations between people (Bourdieu, 1993). According to Sterne (2003), we might consider a field as being where technological production and consumption come together—as with our mutually constitutive technical and social system. Social formations are structured by a series of fields, with each being a structured space with its own rules or laws (Bourdieu, 1993). As we have seen, these are actions which are regarded as possible to represent in 'socially translucent' systems, such as creating and conforming to social conventions (Erickson *et al.*, 1999). In any given field, there is social struggle where agents vie for control of 'capital' (Bourdieu, 1993). 'Capital', for Bourdieu, concerns "the set of actually usable resources and powers" (Bourdieu, 1984, p. 114), and there are various sorts of capital: economic, social, cultural and symbolic. Economic capital refers to money and assets; whereas social, cultural and symbolic capital involve resources which are not material (*cf.* Bourdieu, 1993). Important here is a notion of distinction, where social differences are expressed through systems of power and competition, which happen in areas of cultural practice and symbolic exchange (Bourdieu, 1993). This chapter argues that it is useful in terms of

Web site design to think of such socio-technical systems as 'fields' in which there is competition for 'capital' of various sorts. It is also important for Web site designers to create socially translucent systems which have the affordances to support the competition over 'capital' and status as an important form of social interaction. It is an inherent part of social processes for this sort of 'struggle' to occur, and people will use Web sites to compete for capital—a new way to perform old social forms. eBay is considered in this chapter to be a 'field' in its own right and a 'socially translucent system' (Erickson *et al*., 1999)—a space of technical production and consumption (Sterne, 2003) with its own set of values, social norms, rules and competition over the possession of capital (*cf.* Erickson *et al*., 1999) supported by the technical system.

This chapter draws on qualitative fieldwork on eBay carried out over a two-year period from 2004-2006.[1] The fieldwork took a multi-strand approach in order to get a wide variety of data—including questionnaires when the researchers acted as buyers and sellers themselves, seven focus groups, 30 in-depth telephone interviews held with vintage radio and stamp collectors, 10 in-depth telephone interviews with eBay sellers and 11 diaries with 'key' eBay buyers and sellers. Extensive observation of the eBay site across a wide range of categories and community pages was also carried out. Finally, an online discussion forum used by the vintage radio collectors to talk about eBay items was also observed and participated in by the researchers.

This chapter begins with an overview of the qualitative evidence for eBay being 'a field' and a 'socially translucent' system (Erickson *et al*., 1999). It then examines in detail the affordances of the eBay site in terms of cultural and symbolic capital, and secondly social capital—which contributes to its 'stickiness'[2]. Finally, the chapter reflects on the implications of a Bourdieuean approach for socio-technical systems design.

eBay as a Social and Technical Field and Socially Translucent System: Overview

I think there's the two, there's the two expressions. There's 'going to eBay it,' …or being an eBayer. And an eBayer is somebody, I suppose it's a bit like you being given the knowledge, isn't it? […] So you're part of this, what to a lot of people is a bit of an unknown quantity, a bit of a secret society, so us lot who have been using it for a time, we're serious eBayers [laughter]. […] So I suppose in the end you're part of this whole, massive, community—aren't you? (Peter, vintage radio collector).

The research showed eBay buyers and sellers describe a sense of a shared experience of eBay as being part of an attractive and exclusive "secret society"—a strong 'community of practice' (Wenger, N.D.). As seen from Norman (1999), online conventions require a 'community of practice' for their widespread adoption. The above quotation gives an overview of what constitutes eBay as a social and technical field with various social norms and values, and the role of various types of capital there. The evidence of these social norms in eBay use collected from fieldwork data shows eBay to be a socially translucent system. eBay is recognised as having its own in-group language, such as the term 'going to eBay it' and 'eBayer'—terms which most effectively distinguish people in offline environments as belonging to this community. Being an eBayer, as we see from the quotation, is about being "given the knowledge"— and eBay is socially translucent in terms of knowledge display. eBay 'knowledge' and cultural capital is complex and multi-faceted, it is both social and technical in nature—about having a sense of eBay's rules, appropriate actions, etiquette and language; as well as how to do and perform things 'technically' within the site. There is a shared domain of interest, knowledge exchange, and a shared repertoire of resources including vocabulary (*ibid.*)—which invokes other notions of 'discursive community' (Hutcheon, 1995). eBay is shown through qualitative fieldwork to have its own cultural knowledges, yet the affordances and conventions of the eBay site also allow the expression of more traditional forms of cultural capital that we see in other fields such as collecting and art. This chapter now explores eBay and cultural and symbolic capital in more detail.

eBay and Cultural and Symbolic Capital: Creating 'Stickiness'

In the cultural sphere, competition often involves symbolic power or capital (Bourdieu, 1993). Cultural capital is seen to be based on cultural knowledge, dispositions and competences, and acquiring cultural capital builds authority and power (*op. cit.*). Cultural capital is inculcated and acquired through education, the family and social institutions—which allows social agents to decipher cultural artefacts and understand their internalised codes. The research also shows eBay's cultural capital and competencies, as distinct from wider cultural capital, are acquired in slightly different ways from those proposed by Bourdieu—but that the same mechanisms apply and that family and social networks are shown as very important in eBay usage. However, the research suggests that eBay cultural capital is also importantly built through critical observation of the site itself.

Symbolic capital, also important in the cultural sphere, is said to refer to a: "degree of accumulated prestige, celebrity or honour and is founded on a dialectic of knowledge (*connaissance*) and recognition (*reconnaissance*)" (Bourdieu, 1993, p. 7). Symbolic capital on eBay works in similar ways to society in general, but tends to be more public and tangible on eBay due to the particular affordances and conventions of the site as a 'socially translucent' system (Erickson *et al.* 1999). This section begins by examining one of the most renowned aspects of eBay's Web site design—the feedback system—before looking at the other affordances of the eBay site that support the signalling and performance of cultural and symbolic capital.

eBay's Own Cultural and Symbolic Capital and Conventions

The Distinctions of eBay's Feedback System: Symbolic Capital

'Feedback is each user's reputation on eBay. It fosters trust between people by acting as both an incentive to do the right thing and as a mark of distinction for those who conduct transactions with respect, honesty and fairness' (eBay.co.uk, n.d., a).

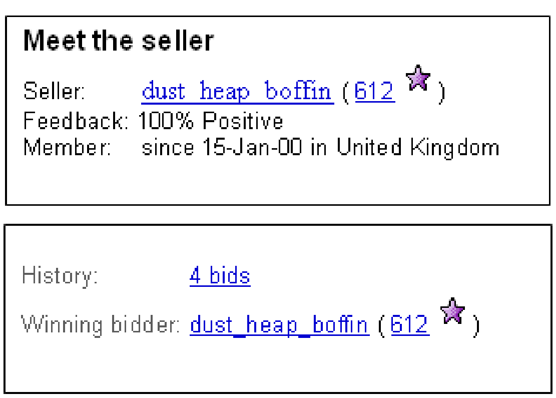
As we have already seen, 'eBayers' believe that eBay has its own appropriate practices and behaviours, and is therefore a 'field' in its own right and a 'socially translucent' system (Erickson *et al.*, 1999). eBay use has its own markers of symbolic capital within the eBay 'field', as seen from the quote on the eBay feedback system above. These are 'designed' into the system. As eBayers buy and sell, they gain star ratings next to their user IDs for a number of positive reports (see Figure 1), and a number corresponding to the number of positive feedbacks they have.

As they gain more positive reports, their stars change colour. Shooting starts are introduced at 10,000 positive feedbacks. According to Cohen (2002), this system was developed to allow the Web site itself to spot its most outstanding buyers and sellers, and so that users could identify others with good reputations on the site. However Boyd (2002) pushes the argument into a more social domain, suggesting stars are valued as part of a user's identity. In Erickson and Kellogg's (2002) terms, they are a 'social proxy' of people and their activities.

The changing of star colours, and from simple to shooting star, is the eBay Web site design's symbolic and highly visual way of representing the level of symbolic capital in eBay use garnered through the number of unique positive feedbacks (*cf.* Haywood, 2006). eBayers are therefore encouraged to keep buying and selling on eBay by the kudos they get from being a visibly experienced eBayer, as a symbolic form of distinction in relation to other eBayers (*cf.* Bourdieu, 1984). This encourages continued participation with buying and selling on eBay, contributing to its 'stickiness'. Having stars of certain colours which denote having positively completed many eBay transactions are highly prized within the eBay 'community of practice' (Wenger, N.D.)—since it requires considerable buying and selling efforts to get them. It also denotes how experienced you are as an eBayer, which is regarded as a proxy for the amount of eBay cultural capital you have. In Erickson and Kellogg's (2000) terms, they are visibly being given credit for their skill as a future incentive for use and 'good' behaviour. Having this form of symbolic capital on eBay can also help eBayers build economic capital through getting higher prices for the items they sell compared to new eBayers with no feedback (*cf.* Resnick *et al.*, 2002). Negative feedbacks, on the other hand, quickly destroy an eBayer's symbolic capital and the amount of economic capital gained per item. Standifird (2001) comments that three or more negative feedback ratings affected the closing bid price in his study by 3.6%. eBay feedback scores are therefore a form of 'social navigation' system in which decisions of eBay users can be informed by the earlier decisions and experiences of other eBay users (*cf.* Dieberger *et al.*, 2000).

Some eBayers, however, have been known to sell their user ids to others who wish to acquire the symbolic and cultural capital signalled by a particular

Figure 1. How eBay 'stars', denoting symbolic capital, are represented in selling (top) and buying (bottom)



feedback profile, often in order for the acquirer to reap economic capital. Theft of eBay identities often occurs for similar reasons, and thus eBay feedback profiles take on a life of their own, independent of the user—what we might call 'feedback capital'. In a similar way, Castronova (2005) talks of 'avatar capital'—the skills, experiences and powers of an avatar. Avatars may be sold to gain economic capital, through the handing over of user name and password. Malaby (2006) suggests the avatar itself is an object of cultural capital, and a similar argument could be proposed for eBay feedback profiles and user names. The technical system is thus inculcated with social values which are stored and accumulated there for future use, with the potential to be independent of the user's cultural capital. Strong policing of such activities is therefore necessary by eBay to maintain eBay as a 'socially translucent' system (Erickson *et al.*, 1999) where 'social navigation' (Dieberger *et al.*, 2000) is not based on misinformation and divergent identities.

eBay Language in eBay's Feedback System

eBay's feedback system plays a vital role in fostering trust and ultimately eBay's success, and there is an extensive literature on the eBay feedback system considering questions such as the effect of feedback on trust and fraud. However, this chapter wishes to consider eBayers' use of the eBay feedback system to denote and signal the presence or absence of eBay cultural capital—through exploring eBay's affordances for cultural conventions in terms of users having their own eBay etiquette and language through feedback. The research shows that the affordances of the eBay site in allowing distinctions in *how* you give feedback with the feedback system, means that certain ways of giving feedback denote having the 'appropriate' eBay knowledge of the experienced eBayer—as possessing eBay cultural capital. However, as with many such subtle signifiers, their meaning shifts. But it is eBay's affordances to support such subtle and changeable signifiers as part of a 'socially translucent' system (Erickson *et* *al*., 1999) which maintains it as an engaging social space.

The content of comments left as part of the eBay feedback system is important in signalling eBay cultural capital and an eBay user's level of experience. The eBay system allows users to type a comment up to 80 characters long. eBay users quickly realise that there is an etiquette and standard feedback responses for this limited space such as 'A+++++' and 'Good eBayer', and using these signals an entry level engagement with eBay and a certain amount of reflection on eBay's social norms and conventions: "But look at the feedback—all this kind of like A+++++…. It takes a little while to realise that there's, sort of, standard responses to things and standard ways of expressing things." (Rea, Focus group 2E) (see Figure 2).

However, some eBay users in the study soon became frustrated with these standard feedback responses as their eBay experience increased. eBayers quickly came to realise that the eBay environment tended to be overly-enthusiastically nice in both feedback and other interactions between buyer and seller as a form of defence mechanism against negative feedbacks: "…I think everyone's scared about getting bad feedback. I'm always *extra nice*" (Crystal, Essex focus group 1E). Resnick and Zeckhauser (2001) talk of the so-called 'pollyanna effect', where the eBay feedback system is biased against the negative. However, the research shows both eBay buyers and sellers tend to move away from bland standard feedback responses towards more 'informative' feedbacks which are less about signalling a basic level of eBay cultural capital and more a concern with giving buyers and sellers the feedback they 'deserve'. This often involves buyers giving 'neutrals', but not negatives, because of fears of retaliatory 'negs'. Giving these 'informative' feedbacks and neutrals is a way to signal more advanced eBay cultural capitals (see Figure 3). However, these signifiers are now likely to shift again with eBay's recent feedback system changes where buyers can no longer receive negative feedback.

ebay and cultural and symbolic capital in consumption

eBay, 'Social Translucence' and Expertise

eBay sellers need have relatively limited knowledge about eBay or what they are selling to participate there. If we apply Bourdieu's ideas, there is no explicit need for buyers or sellers to have a certain amount of cultural capital to participate on eBay, as there are no barriers to entry based on cultural capital and competence. However, this chapter argues that the affordances of eBay's Web site design allows both sellers' and buyers' consumption-related cultural capital to become 'translucent' through eBay's 'socially translucent' system (Erickson *et al*., 1999) as a form of symbolic capital—which importantly allows for social navigation through revealing information about the 'who' behind the listing and their expertise (Dieberger *et al*., 2000). The research shows these factors are important for eBay's 'stickiness' and for sellers to be successful. The affordances of the eBay site actually allow cultural knowledge and competences, or the lack of them, to become 'translucent'. At its simplest, the research has shown eBayers as browsers and buyers with cultural capital in terms of their consumption area, recognise eBay sellers that have similar cultural capitals and knowledges—purely through how the item has been listed. eBay is operating in the same way as the 'aesthetic traps' Miller (2000) refers to—aligning audience and content creator. eBay is composed of thousands of item descriptions which are entirely constructed by sellers themselves— and the affordances of the site means they can write as much as they like in a freeform text box and upload multiple images. Users assess the cultural capital in the listing of an 'amateur' through the failure to cite particular listing conventions for the type of item. Some eBayers in the study who are part of various 'communities of interest' such as vintage radios, cited and evaluated actual eBay listings on third party discussion forums. Part of eBay's success and 'stickiness' comes from the satisfaction

Figure 2. Standard feedback responses signalling entry level eBay cultural capital (anonymised)

	received today great thanks a+++	lazyxxxx (761)	03-Apr-07 17:59
	-- (#120099501xxx)		
	.•:*¨¨*:•.Thank you.•:*¨¨*: •.Great.•:*¨¨*:•..Ebayer.•:*¨¨*:•.A+++++++++.•:*¨¨*:•.	michaelxxxx (327)	15-Mar-07 06:46
	-- (#120093943xxx)		
	good ebayer, good communication regarding collection, very helpful A*********	beardyxxxx (53)	21-Nov-06 21:31
	-- (#120052419xxx)		

Figure 3. Showing more sophisticated eBay cultural capital—neutral feedback (anonymised)

	Although full refund given,the Bvlgari was fake and most inconvenient.	bornxxxx (1493)	22-Apr-08 13:07
	-- (#4959019xxx)		
	not happy re condition of ring needs cleaning and stone loose within setting	catgirlxxx(78)	Aug-08-02 20:57
	-- (#4947739xxx)		
	not real opal. $150 of $600 was refunded. nominally acceptable outcome. thanks	gardengrnxx(1519)	Feb-24-03 20:03
	-- (#2609565xxx)		

'expert' consumers derive in assessing eBay item descriptions through the lens of their own cultural capital in a 'socially translucent' system (Erickson *et al*., 1999). They use particular markers and cues as a form of 'social navigation' (Dieberger *et al*., 2000) for themselves and others in deciding what to buy and what not to buy.

eBay and Social Capital: Social Navigation for Problem Solving and Finding the 'Like-Minded'

Bourdieu's term 'social capital' is defined as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition" (Bourdieu cited Portes, 1998, p. 3). Bourdieu's social capital focuses on the benefits accrued by individuals through participation in groups, including the purposive construction of sociability for social capital advantages (Portes, 1998). Actors, through social capital, can also gain access to economic capital and cultural capital. The notion of social capital in inextricably linked in the literature to building trust. However, this chapter, having already touched on trust, instead wishes to explore more fully the affordances of the eBay site in building social capital through notions of 'communities'. Building eBay as a 'community' was seen as one way that it increased its 'stickiness' (*cf.* Cohen, 2002). The eBay site has certain affordances which aid the building of social capital (and therefore other forms of capital) and certain sorts of community, which this chapter explores below. However, it is important to note that those affordances are appropriated in very different ways by eBay users to build social capital, and the research reveals that some eBay users are not at all interested in building social capital on eBay—eBay is therefore variably 'sticky' in terms of notions of building communities.

The affordances and constraints of eBay's Web site design in terms of social capital is complex. eBay introduced a 'checkout' system which helped 'automate' some aspects of a transaction. Previously, buyers and sellers tended to write e-mails to each other. eBay's 'checkout' system is seen by some users to limit the social interaction of the past, whilst sellers particularly say: "you don't make huge lasting relationships". This is an arguable less successful part of eBay's iterative changes from a user perspective of building social capital. However, this chapter argues that eBay does still afford the building of social capital in particular ways, contributing to 'stickiness', which is explored in detail below. Evidence from our research suggests there are three meta-concepts of community being outworked by eBay users in their building of social capital on eBay: a community of commerce/ transaction; a community of practice and communities of interest. These eBay 'communities', in practice, tend to overlap—ultimately predicated on a community of commerce. The eBay system affords the building of social capital in particular ways, and these are noted in detail below through the perspective of these meta-concepts of 'community'. eBay's socio-technical system fosters 'social navigation'(Dieberger *et al.*, 2000) towards people who can provide various sorts of social capital advantages, based on what others have previously been doing on eBay—from solving problems to being the 'like-minded'.

ebay, social capital and a 'community of Practice'

eBay, themselves, recognise the business benefits of having a 'community of practice' (Wenger, N.D)—in having a self-sufficient community who can solve each others' difficulties (Cohen, 2002). A 'community of practice' is defined as "…groups of people who share a concern or passion for something they do and learn how to do it better as they interact regularly" (Wenger, N.D.: 1). Interactions in such communities facilitate trust and other beneficial aspects of building social capital (Smith, 2003). The research shows it takes time to master eBay's cultural capital, and this may be learnt through interaction on the community boards. The technical system of eBay and its interrelationship with other aspects of e-commerce such as payment and postage is also complex enough to require a 'community of practice' to answer some of the questions that result. eBay users recognise that with eBay knowledge, the 'right' answers are often found through consulting the people with actual experience of the problem.

The eBay community boards which eBay set up so that the eBay community could solve its own problems (*cf.* Cohen, 2002) were used directly by a minority of eBay users in the study, and much more often by those who invested greater time in eBay as both buyers or sellers. One of the affordances of the eBay site that sellers often took advantage of *vicariously* is the social capital benefits generated through indirect social interaction on the community boards. The boards allowed for the documentation of current eBay 'happenings', problems and issues so well through the use of discussion threads and a keyword search facility, that direct social interaction was unnecessary. The community boards are therefore another 'sticky' element of eBay, because cultural capital can be acquired passively through 'free riding' on other people's sociality. This is archetypal 'social navigation' (Dieberger *et al.*, 2000) in practice—with decisions and knowledge informed by what others have done before. In addition, some eBayers were using the affordances of the eBay community pages and chat boards to 'make friends', independent of the need to solve eBay problems. In particular, the study showed that one eBay seller, who had given up regular work in the banking sector to be a full-time eBay seller, was using the eBay community pages in order to seek out some 'virtual' work colleagues, which often made eBay more 'sticky' than television:

Some girl was saying she had to take her dog to the vet to be put to sleep…, and how upset she was, and I started conversation with that one, because I was going through the same thing as her. […] *You know when you do a day-to-day job, …you have a chat with …your work colleagues. Well, of course, working from home you haven't got that* […] [M]*y mum says to me: 'I don't know how you find the time to do that.' And I'm thinking: 'sometimes I spend more time looking at the community pages than I do say watching something on the television.'*(Valerie, eBay seller interview)

The full-time eBay seller later joined two of eBay's interest groups to gain the benefits of human interaction from building social capital there—in the form of the 'cat love' and 'book' group—'communities of interest'. eBay's affordances allowed social navigation towards the 'like-minded'—a theme further developed below in relation to consumption interests.

eBay, Social Capital and 'Communities of Interest'

Within the 'community of commerce' and 'community of practice' are found to be numerous 'communities of interest'—lifestyle enclaves (Bellak cited Fernback, 1997) who share common interests. These are described by eBay users in geographic terms, related to specific collecting interests: "I suspect there's a set of smaller communities, a bit like mini-villages… a mini-village for stamps… And I imagine there's a set of housing estates within the villages as well" (Gerard, stamp collector). Unique to eBay, and built on eBay's particular affordances and technical system, is social capital constructed around subsets of these communities of interest—'bidding circles' or 'communities of bidding'. The eBay site afforded this at the time of the study's fieldwork by showing the user IDs of eBayers engaging in the bidding process, and eBayers frequently saw the same eBay user IDs crop up in bidding (see Figure 4 for how this looked on the eBay site). As well as eBay user IDs creating a recognisable identity, eBay user IDs enable other eBay users to go back through feedback profiles to see what people have bought and sold, and you can contact other eBayers using the 'contact member' facility of the eBay user's own page. The IDs also reveal the 'who' of social navigation and the 'what' of buying and selling (*cf.* Dieberger, 2000). 'Communities of bidding' may contain what are regarded as 'arch rivals', which mitigates against social interaction. However, the research also shows friendship is a possibility as bidders navigate towards like-minded people collecting the exact branch of material culture they do:

> *Funnily enough, I made a very good friend in Brazil... Um, and he's been to my house a couple of times.* […] *We were bidding on the same thing, pushing the prices up. So in the end, I can't remember if I e-mailed him, or he e-mailed me, and it was just a case of: 'what do you collect?' And then we realised we collected exactly the same kind of thing... two people who wouldn't normally talk to each other from opposite sides of the world...* (Frederick, stamp and cover collector interview).

As well as the social capital advantages of free accommodation in each country when visiting, there are also economic capital advantages—they have a protocol as to who bids for what item, creating a form of auction ring in order to keep prices down. These are all attractive aspects of building eBay social capital, which helps eBay maintain its position as "the standard-bearer in web site stickiness" (Mancey, 2001). However, this policy of revealing bidders' user ids has now stopped on the eBay.co.uk site—a policy eBay implemented to stop bidders being targeted by fraudulent second chance offers. Erickson and Kellogg (2000) note a tension between visibility and privacy in socially translucent systems, and eBay have now opted for an approach more reminiscent of the 'footprint' approach of anonymised use (Wexelblat and Maes, 1999). This does, however, lead to problems with trust, since shill bidding is undetectable by buyers in such a system. This represents a further change in the eBay site away from 'social translucence' (Erickson *et al*., 1999) and the capabilities of 'social navigation' (Dieberger *et al*., 2000), towards security.

The Implications of a Bourdieuean Approach for Socio-Technical Systems and Website Design

This chapter has introduced the concepts of the 'field' and 'capital', as part of a Bourdieuean approach to understanding Web site 'stickiness' in terms of their social and cultural affordances and conventions. It has argued, using the results of qualitative fieldwork, that a large part of eBay's stickiness is in its social and cultural affordances for social translucence and navigation in supporting the building, control of, and competition over, various sorts of 'capital'. So what are the implications of this approach for socio-technical systems and Web site design—in particular for designing socially translucent systems which support social navigation? Chalmers *et al*., (2004) suggest that a major research question involves how social texture can be accumulated to help users socially navigate and use space. A reflection on the empirical insights of this chapter would suggest much of this texture is related to building or competing for 'capital'. It could therefore be argued that applying a Bourdieuean approach is vitally important in creating successful socially translucent and socially navigable systems. A Bourdieuean approach enables us to better design Web sites to be 'sticky' through the incorporation of particular affordances, features and tools which support competition over capital. Secondly, a Bourdieuean approach also allows us to predict how certain affordances, features and tools may be appropriated by users as part of their control over building social capital—often in ways unintended by Web site designers as technology evolves in use. In terms of more specific advice for the creation of socio-technical systems and in particular Web site design, the eBay case study, seen through a Bourdieuean perspective, suggests that certain social and cultural practices and processes should be supported in order to create 'stickiness' and ultimately success.

The starting point for stickiness is to develop your Web site into a 'community of practice', and a 'field' in its own right. For this to happen, the technical system or Web site, its conventions, and the practices that go on there, must be sufficiently complex and different to generate its own set of knowledges. This knowledge often concerns etiquette, language, a sense of 'appropriate behaviour' and technical competency in knowing how to do certain things on the site. The community of practice is a 'field' because there are hierarchies of knowledge involved—some people know more and

Figure 4. eBay's affordances allowed the building of social capital around 'bidding circles'—where the same user IDs kept cropping up in relation to specific collectable items. eBay members can 'click through' from user ids to both contact the member and see other items bought and sold

dust_heap_boffin, you're the winner.

Bidder	Bid Amount	Bid Time
dust_heap_boffin (612)	**£56.50**	**04-May-08 15:15:47 BST**
bornxxxx (1493)	£55.50	04-May-08 15:15:36 BST
gardengrnx (1519)	£35.01	04-May-08 09:33:10 BST
catgirlxxx (78)	£35.00	29-Apr-08 13:03:11 BST
lazyxxxx (761)	£33.01	04-May-08 09:32:37 BST
michaelxxxx (327)	£31.01	04-May-08 09:32:07 BST
beardyxxxx (53)	£29.01	04-May-08 09:31:09 BST
gardengrnx (1519)	£25.00	28-Apr-08 11:21:34 BST
lazyxxxx (761)	£20.00	27-Apr-08 08:40:04 BST
Starting Price	£19.99	24-Apr-08 15:15:54 BST

some people know less. There must be numerous ways for this to be expressed, signalled and read in a socially translucent system—the cultural and symbolic capital related to the technical system. eBay has both its community boards and feedback system to do this. Other Web sites would also benefit in terms of stickiness in having boards or discussion forums where its own set of knowledges could be exchanged and to enable social navigation towards those with similar problems or the like-minded. Social proxies (Erickson and Kellogg, 2002) are also important in Web site design. Feedback stars are a form of distinction and a display of symbolic capital which are prized to the extent that there is 'feedback capital'. They are also a proxy for cultural capital. Websites should find ways of making cultural capital translucent through using visual social proxies (Erickson and Kellogg, 2002) for expertise.

Another important aspect of eBay's stickiness is the flexibility of social interaction possible there—dependent on what aspect of users' identity or interests is uppermost for them at that time. In terms of social capital, the affordances of the eBay site mean that it has a number of filtering and sorting mechanisms for social navigation that make interaction relevant and 'attractive'. The eBay experience suggests Web sites should have or enable a number of filtering and sorting mechanisms that can make user interactions meaningful for any one of a number of aspects of their personality or identity—that the site should have affordances which reveal the 'who' and 'what' of social navigation (*cf.* Dieberger *et al.*, 2000) to enable a path towards those with similar problems or the 'like-minded'.

Overall, eBay's social and cultural affordances and conventions are important to eBay success because they offer many things to many people—a range of attractive engagements, interactions and performances for people with different subjectivities and backgrounds, in both buying and selling. Much of the eBay system is open to user appropriation, and when users appropriate the eBay technical system, such as through constructing their own item pages or interacting on the community boards, competition and control of capital often comes to the fore. In addition, the eBay feedback star system is specifically designed to be a form of symbolic capital, out of recognition of the importance of these processes. Where eBay had reduced opportunities for gaining social capital for commercial reasons or security, it has arguably not been well-received by some users. This suggests that the Bourdieuean approach is a valuable perspective for successful Web site design, and that technical systems should be designed to support the building, control and competition over capital. The 'struggle' over capital is an inherent part of social processes, and people will ultimately use Web sites to compete for capital in ways both intended and unintended by the designed affordances and conventions of technical systems. However, it is also necessary to be vigilant that the pursuit of 'capital' does not go too far as technology evolves in use. The selling and stealing of eBay user IDs and feedback profiles, capitalising on 'feedback capital', shows a potential contradiction in designing for success through a Bourdieuean approach and that of social translucence and social navigation. The importance of displaying and acquiring capital at any cost may lead to social proxies bearing no correlation to the user behind them or their future actions. Successful Web site design therefore involves the alignment of all three approaches, and in this the importance of applying a Bourdieuean approach is that it helps users constructively and enjoyably use online spaces.

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Affordances: The term ‘affordances’ has its origins in Psychology, “the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used” (Norman, 2002, p. 9). The term was coined by a perceptual Psychologist, J. J. Gibson (Norman, 1999). However, Norman pushed the notion of affordance beyond properties into experiences, noting affordances have a historical basis—users know what to do with things because they have used them before—they know to turn a knob or push on a door plate (Norman, 2002). Norman’s contribution was in setting out perceived affordances. In product design, Norman notes that there are both real and perceived affordances, but these need not be the same (Norman, 1999). There is a perception of what is possible which is different from what is actually possible. In screen based interfaces, he notes interface designers primarily control only perceived affordances (*op. cit.*). The physical affordances of the computer, screen, keyboard and mouse are already built in. There are differences between real affordances and perceived affordances on the screen. Real affordances may not have a visual presence, and perceived affordances sometimes do not support real affordances. Norman (1999) also suggests that designers often confuse the notion of affordances with conventions or constraints. He contends that virtual worlds are often more about constraints and conventions, and the physical world more about affordance. He suggests there are three kinds of constraints on behaviour: physical, logical and cultural. Physical constraints are related to real affordances—you cannot move a cursor outside a screen. Logical constraints involve reasoning to determine alternatives. It is how users know to scroll down to see the rest of the page. Cultural constraints are conventions shared by a group. They are cultural and learned conventions, such as dragging the scroll bar down with a cursor which changes shape on the scroll bar, to see the bottom of the page. But the system does not have to be designed in this way. Conventions are constraints that prohibit some activities and encourage others, affordances concern the range of possible actions and relate to properties of the world. Physical constraints cannot be overcome, but logical and cultural constraints can be ignored. Conventions evolve and require a ‘community of practice’ to be adopted (*op. cit.*) and are artificial and learned, with learning them helping us to master everyday life.

Capital: ‘Capital’, for Bourdieu, concerns: “the set of actually usable resources and powers” (Bourdieu, 1984, p. 114), and there are various sorts of capital: economic, social, cultural and symbolic. Economic capital refers to money and assets; whereas social, cultural and symbolic capital involve interests and resources which are not material (*cf.* Bourdieu, 1993).

A (social and technical) ‘. eld’: Bourdieu developed the concept of the ‘field’ to denote the fact that agents act in social situations which are governed by objective social relations (Bourdieu, 1993) between people. McNay notes that modern society in increasingly differentiated into distinct fields (McNay, 1999). According to Sterne (2003), we might consider a field as being where technological production and consumption come together—as with a mutually constitutive technical and social system. Social formations are structured by a series of fields (such as the cultural, educational and political), with each being a structured space with its own rules or laws which require mastery (Bourdieu, 1993). In any given field, there is social struggle and competition, where agents vie for control of ‘capital’ (*op. cit.*).

Cultural Capital: Cultural capital is seen to be based on cultural knowledge, dispositions and competences, and acquiring cultural capital builds authority and power. One may need certain skills, powers or knowledges to enter particular fields and be seen as legitimate. In the field of cultural production, there are producers, and those who legitimate and consecrate cultural products as consumers (e.g. critics, galleries, the public) (Bourdieu, 1993). Cultural capital is inculcated and acquired through education, the family and social institutions—which allows social agents to decipher cultural artefacts and understand their internalised codes. Cultural capital is unequally distributed, often differentially amongst different class fractions (Bourdieu, 1993). Malaby applies Bourdieu's concept of cultural capital to online and synthetic worlds. He defines cultural capital as: "the resource that participants develop and acquire in the form of competencies and credentials and that they also invest in valued cultural objects, or artifacts" (Malaby, 2006, p. 146). Malaby sees the cultural competencies of synthetic worlds as in greater flux than in the 'offline', and are part of a process of 'becoming', rather than reproducing existing socioeconomic differences. Malaby suggests certain competencies may relate to technologically mediated environments, but are not essentially different to those developed in other technical domains—such as flying a plane. However, he argues that there is a need to research such 'synthetic world' competencies in more detail.

Social Capital: Recent interest in the term social capital has its origins in the writings of Pierre Bourdieu (Schuller, Baron & Field, 2000). Bourdieu's term 'social capital' was best articulated in his chapter 'Forms of capital' in 1983 (*op. cit.*), having remained often elusive and marginal in other works (*op. cit.*). The concept was defined as: "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition" (Bourdieu cited Portes, 1998, p. 3). Bourdieu's social capital focuses on the benefits accrued by individuals through participation in groups, including the purposive construction of sociability for social capital advantages (Portes, 1998). Actors, through social capital, can also gain access to economic capital (loans, markets) and cultural capital (through experts or others with cultural capital). James Coleman is also associated with the concept of 'social capital', and is best known for using the term in educational contexts (Schuller, Baron & Field, 2000). He also defines it in terms of a set of resources which facilitate the actions of actors. The resources comprise of entities which have as part of them some elements of social structures, but the resources facilitate acting within the structure. Coleman sees social relations as providing social capital resources through creating information channels, establishing obligations and social norms (*op. cit*). Robert Putnam's work on social capital is currently the most cited across a range of disciplines and fields (*op. cit*). In *Bowling Alone*, a book that charted the decline in community organisations and civic engagement in the US, Putnam suggested that the core of social capital theory was that social networks have a value, with social contacts affecting group and individual productivity (Putnam, 2000). Putnam talks of norms of generalised reciprocity—that you do someone a favour and expect that someone else will do something for you later on. Schuller, Baron and Field (2000) also point out Putnam's definition of social capital as involving aspects of social life—trust, norms and networks—which help people pursue joint objectives and act more effectively together. Putnam (2000) suggests computer mediated communication (CMC) can support dense, large and fluid groups across the boundaries of geography and organisations, and allow for networks based on shared interests instead of just shared space. He talks of CMC increasing people's 'intellectual capital' as information is capable of being shared at virtually zero cost. But he also argues that a lack of social cues means that computer-based groups are generally worse at trust and reciprocity and may indulge in 'flaming' and disinhibited behaviour.

Social Navigation: The term 'social navigation' was first used by Dourish and Chalmers in a short paper presented at the HCI conference in 1994 (Chalmers, Dieberger, Höök and Rudström, 2004). In terms of the online world, social navigation involves your decisions being informed and guided by information about what other people have been doing online (Dieberger, Dourish, Höök, Resnick and Wexelblat, 2000). Wexelblat and Maes (1999) examine navigation in complex information spaces, and highlight the importance of interaction history or traces to guide our actions. In online spaces, problem-solving work carried out by users is said to leave traces which should be accessible to users in the future to make solving problems easier (*op. cit.*). Wexelblat and Maes use analogies to the physical world to describe the benefits of creating online spaces which can support social navigation. They suggest that following Norman (see the definition of 'Affordances')—objects that are rich in the history of use acquire new affordances which we can use for new ways of interaction, for example a library book with annotated notes is interacted with differently than a new book (*op. cit.*). They describe different sorts of interaction history—knowing **what** was done, knowing **who** did it, knowing **why** it was done and knowing **how** it was done. These are all important for different reasons in future actions and problem solving—for example the 'who' may be important as the views of domain experts have greater legitimacy as a 'trace' than that of an amateur (*cf.* Dieberger, Dourish, Höök, Resnick and Wexelblat, 2000). Dieberger, Dourish, Höök, Resnick and Wexelblat (2000) suggest that systems software is only slowly adopting social navigation. Social navigation systems exploit social behaviour and practices in order to help users explore and navigate (Chalmers, Dieberger, Höök and Rudström, 2004). People are said to transform space from their use and behaviour. However, the traces which are left behind can be sedimented and alter social practices—space is transformative and impacts on society (*cf.* Dieberger, Dourish, Höök, Resnick and Wexelblat, 2000), as well as society impacting on space.

Social Translucence: The term 'social translucence' was developed in by Erickson, Smith, Kellogg, Laff, Richards and Bradner (1999). 'Socially translucent systems' are described as those digitally-based systems which provide social cues which afford accountability, awareness and visibility (*op. cit.*). These social cues in turn allow people to draw upon their expertise and social experience in structuring their interactions with others (Erickson and Kellogg, 2000). Erickson, Smith, Kellogg, Laff, Richards and Bradner (1999) describe certain actions which are possible in socially translucent systems—such as noticing, creating and conforming to social conventions; engaging in peer pressure and imitating others' actions through observation (*op. cit.*). Social translucence as a design approach is also articulated in Erickson, Halverson, Kellogg, Laff and Wolf (2002). The 'social' in social translucence refers to providing socially salient cues. Translucence is a term used in preference to 'transparence'—it is not an intention to make all socially salient cues visible, just some of them. Erickson and Kellogg (2000) note a tension between visibility and privacy in such systems, which also impacts on systems employing a social navigation approach—where there is a trade-off between allowing users to see the paths of others versus seeing the footprints of anonymised and merged use (Wexelblat and Maes, 1999). Cues are differentially available through space and are made use of in interactions (Erickson, Halverson, Kellogg, Laff and Wolf, 2002). One system of social translucence involves the notion of a social proxy, a minimalist form of visualisation of people or their activities (Erickson and Kellogg, 2002). These are part of bringing social cues into digital systems through an abstract approach of simple text and graphics (Erickson and Kellogg, 2002).

Symbolic Capital: Symbolic capital is said to refer to a: "degree of accumulated prestige, celebrity or honour and is founded on a dialectic of knowledge (*connaissance*) and recognition (*reconnaissance*)" (Bourdieu, 1993, p. 7). In *Distinction* (1984), Bourdieu refers to symbolic capital as: "the acquisition of a reputation for competence and an image of respectability and honourability…" (1984, p. 291). Bird and Smith (2005) note the convergence between Bourdieu and consumption theorist Veblen (1994) in that a seeming lack of interest in building economic capital in the form of conspicuous consumption or generosity attain the highest profits in terms of symbolic capital. There is a cost to building symbolic capital in terms of time, wealth or energy.

Communities of Practice: 'Communities of practice' as defined by Wenger, involve: "…groups of people who share a concern or passion for something they do and learn how to do it better as they interact regularly" (Wenger, N.D.: 1). Hildreth, Kimble and

Wright (1998) note that definitions of 'communities of practice' are wide ranging. Wenger (1998) sees the concept as a new term for a familiar experience, and relates it to a social theory of learning. The origin of the term is in Lave and Wenger's (1991) book *Situated Learning* (Stamps, 1998). They propose a theory of situated learning where learning: "is an integral part of a generative social practice in the lived-in world" (Lave and Wenger, 1991, p. 35) and: "the mastery of knowledge and skill requires newcomers to move toward full participation in the sociocultural practices of a community" (Lave and Wenger, 1991, p. 29). In essence, this concerns the process by which newcomers or 'apprentices' engage with and become a part of a community of practice which consists of other apprentices, 'young masters' and masters. In looking at gender and language as community-based practice, Eckert and McConnell-Ginet (1992) take Lave and Wenger's notion of community of practice to mean: "an aggregate of people who come together around mutual engagement in an endeavor. Ways of doing things, ways of talking, beliefs, values, power relations—in short, practices—emerge in the course of this mutual endeavor. As a social construct, a community of practice is different from the traditional community, primarily because it is defined simultaneously by its membership and by the practice in which that membership engages" (Eckert and McConnell-Ginet, 1992, p. 464).

Stickiness: The notion of 'stickiness' is shorthand for attracting visitors and keeping them there (Cohen, 2002). Festa (1999) notes NetRatings analyst Peggy O'Neill's definition of stickiness as: "a measure of how engaging you are." Sanchez (N.D.) similarly sees 'stickiness' as involving Web sites: "you want to go back to again and again". Sanchez argues there is a cycle of stickiness—the more people visit your site, the more they rely on it and trust you, and the more you generate revenue. For Sanchez, then: "Stickiness = relationships = loyalty = revenues". Haywood (2006) unpicks this notion of stickiness and relates it to Miller's use of Gell's notion of the 'aesthetic trap' (Miller, 2000). Miller examined the commercial and personal Web sites of Trinidadians, and noted the importance of the social in the design of the Web sites. Miller characterised the Web sites as creating 'aesthetic traps', where the notion of aesthetics refers broadly to the visual characteristics of Web sites: "as attempts to create aesthetic traps that express the social efficacy of their creators and attempt to draw others into social or commercial exchange with those who have objectified themselves through the internet" (Miller, 2000, p. 6). Miller also suggests that Web site visuals are also used to align the Web site's audience with its creators, as a signal for an 'appropriate' audience (Haywood, 2006; Ellis and Haywood, 2006).

endnotes

1 This fieldwork was conducted with funding from the UK Economic and Social Research Council (ESRC), from the large grant award RES-000-23-0433 *Virtually second-hand: Internet auction sites as spaces of knowledge performance*, which is gratefully acknowledged.

2 Economic capital tends to have a complex and variable interrelationship with cultural, symbolic and social capital on eBay and is therefore considered *within* these sections.

Chapter XXXII
Relationships and Etiquette with Technical Systems

Christopher A. Miller
Smart Information Flow Technologies, USA

abstract

This chapter focuses not on technology mediation of human relationships, but rather on human-like relationships with technology itself. The author argues, with supporting reasoning and data from his work and that of others, that humans have a natural tendency to generalize social interaction behaviors and interpretations (that is, domain-specific "etiquette") learned for human-human interactions to interactions with any complex, semi-autonomous and partially unpredictable agent—including many machines and automation. This tendency can affect human trust, perceived workload, degree of confidence and authority, and so forth—all of which can in turn affect performance, safety, and satisfaction with a machine system. The author urges taking an "etiquette perspective" in design as a means of anticipating this phenomenon and either encouraging or discouraging it as appropriate.

Introduct Ion

In the description of this volume, "socio-technical systems" were defined as "computer technologies that enable social interaction of any type." Several examples were provided in all of which a machine mediates social interactions between humans. By contrast, my interest is not focused on computer-mediated human-human interaction, but rather on the ways in which humans interact with complex computer systems and automation on a social level—as if the technologies themselves were social actors.

In this chapter, I will describe my personal introduction to the idea that humans interact with machines on a social level—and the resulting origin of the idea that social "etiquette" informs humans expectations and interpretations of the behaviors of both other humans and of complex machines and automation. Then I will define the notion of etiquette as it applies to human-machine interaction. In subsequent subsections, I offer various arguments and demonstrations of the relevance of such etiquette to human-machine interaction—first by illustrating its importance in human-human

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interactions (including those in work domains), then by offering analyses and case study evidence for the relevance of etiquette in human-machine interactions, and finally by providing experimental evidence of etiquette's relevance to human-machine work. In the final subsection, I describe our work with a specific type of etiquette—politeness behaviors—and a model which provides links from aspects of culture to perceptions of politeness and from there to impacts on decision making and responses to directives. Finally, in the conclusion, I offer some preliminary thoughts about how this study of human-machine etiquette may be applied to the design process to yield better, safer and more pleasing systems.

hu Man -Mach Ine et IQuette : or IGIns o F the Idea

In 2000, while co-chairing a AAAI Spring Symposium on Adaptive User Interfaces, I produced a soapbox polemic on the topic of Human-Computer Etiquette (Miller, 2000). I wanted to draw attention to a perceived flaw in much of the exciting work in adaptive and intelligent user interfaces. Specifically, that they all too often behaved like little children: interrupting ongoing conversation or work to show off what they can do, exhibiting capabilities primarily for the sake of showing off rather than to help advance the goals of their human users (their "betters"?), and persisting in exhibiting the same behavior long after it had ceased to be useful or interesting. While this pattern of actions was tolerable in young children and, perhaps, in young systems fresh from the lab, such systems needed to grow up and participate in the rules and conventions of the societies into which they hoped to be accepted.

In fairness, I wasn't just pointing a finger at the work of others, and I wasn't completely original. Eric Horvitz had written about a similar concern with regards to personal computer systems (e.g., Microsoft's Office Assistants^{TM}) a year earlier (Horvitz, 1999). And I had noticed similar tendencies in my own projects: for example, pilots deemed initial versions of the Rotorcraft Pilot's Associate (RPA) (Miller and Hannen, 1999) far more willing to provide aiding than was necessary.

Interestingly, however, in that rotorcraft project we had noted that human pilots spent nearly a third of their time in inter-crew coordination, discussing their intent and plans. We designed and implemented a simple interface which allowed RPA to participate in that conversation, taking instruction and declaring its intent all in ways that were functionally similar (though usually much simpler in form) to the ways pilots communicated among themselves. This modification seems to have resulted in improvement in human + machine system performance, as well as larger gains in user acceptance (Miller and Hannen, 1999).

It seemed as if designing complex automation that fit the existing etiquette of a helicopter cockpit made it easier and more pleasant to interact with. In hindsight, this is probably not surprising—after all, pilots had evolved this etiquette over years, trained newcomers in it, and expected it from new participants. The interface we implemented did not exhibit "etiquette" in the general sense of politeness, but it did behave according to the established rules and conventions of the role for which it was intended. Furthermore, it did so without much in the way of human characteristics. While others (including Horvitz above) have been involved creating interfaces which explicitly anthropomorphize or "embody" (Cassell, 2000) interacting agents, operators in real world work domains are generally adverse to such "cute" interfaces. The RPA interface described above interacted by means of buttons capable of displaying only two words of alphanumeric text at a time.

These factors led me to think more deeply about the etiquette of human-machine relationships in work domains. What began as an extended metaphor embedded in a rant is now leading me to the suspicion that we are systematically missing, or at least failing to give proper consideration to, an important aspect of the way complex systems are used. Humans seem intuitively, naturally and largely unavoidably to interact with some forms of technology via the same assumptions they bring to interactions with other humans—and yet we rarely consider the engineering of a social relationship between humans and machines in most work domains. Below, I will discuss reasons for believing that such relationships should be considered in design, and then discuss some work which is striving to do so.

Etiquette Definitions

As mentioned above, the term "etiquette" was first suggested as a metaphor for machines which behaved appropriately in their "society" of use. We stuck with it in part to be provocative but also because of its association with protocols that carry substantial social meaning even though they may be unwritten and largely implicit. The American Heritage Dictionary (Morris, 1978, p. 451) offers two alternate definitions of etiquette, both of which seem relevant:

1. The body of prescribed social usages.
2. Any special code of behavior or courtesy: "In the code of military etiquette, silence and fixity are forms of deference" (Ambrose Bierce). … Synonyms: etiquette, propriety, decorum, protocol. These nouns refer to codes governing correct behavior."

We combined these meanings in a definition used for a workshop on human-machine etiquette (Miller, 2002):

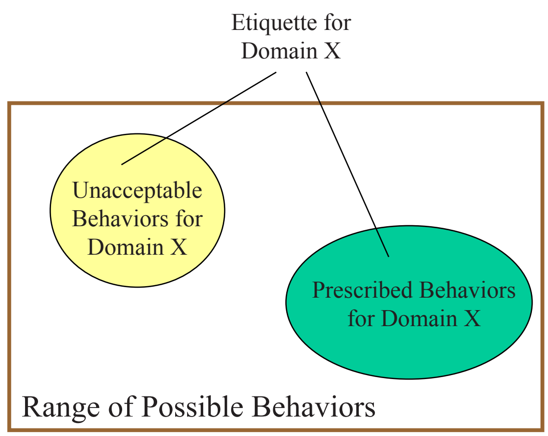
By 'etiquette', we mean the defined roles and acceptable behaviors and interaction moves of each participant in a common 'social' setting—that is, one that involves more than one intelligent agent. Etiquette rules create an informal contract between participants in a social interaction, allowing expectations to be formed and used about the behavior of other parties, and defining what counts as good behavior.

Etiquette, in this sense, need have little to do with politeness or the social niceties, though those are one source of "prescribed social usages" and "codes of behavior." There are others, however. Specific environments, work "cultures," even individual teams of humans will all have their unique sets of expected behavioral norms or etiquettes. Essentially, an etiquette for a specific domain is formed by prescribing some subset of the possible behaviors as appropriate and expected for those who participate (see Figure 1). Other behaviors may be explicitly proscribed, with the remainder falling into a neutral category subject to acceptable variation. Prescriptions and proscriptions may be further tuned as to the role or context in which they apply. For example, it may be acceptable (neither prescribed nor proscribed) for a judge to interrupt anyone else's discourse in court, but it is clearly proscribed for anyone else to interrupt the judge. These pre-/proscriptions may pertain to speech, dress, movement, etc., or to more specific protocol behaviors (e.g., "in this plant, we always empty a vessel when it's not in use"). Even more interesting are behaviors expected in specific circumstances or corresponding to specific intentions: (e.g., "when you detect a problem during landing approach, you are expected to notify the captain and persist until s/he acknowledges"). As such, these are the behaviors that any human or automation agent should strive to adhere to if it wants to be accepted into that milieu.

Etiquette's Relevance in High-Criticality Domains

A subtle example of human-human etiquette can be drawn from the work of Ward and Tsukahara (2000) on "back-channel responses" in English and Japanese—the use of, for example, "uh huh" in English and "hai" in Japanese by a listener to signal attentiveness. In both English and Japanese, a low pitched tone of voice and a suitable pause by the speaker signals to the listener that he or she is expected to provide a back-channel response before

Figure 1. Etiquette for a domain defines acceptable and unacceptable behaviors for that domain



the speaker continues. In this sense, the etiquette for turn taking in both English and Japanese is similar. However, the duration of the pause is about 350 ms in Japanese and about twice that long in English—indicating a difference in etiquette that can lead to misinterpretations even when speakers share each others' language. For example, a Japanese native, even when speaking English, may appear to native English speakers to be pushy and bored with a conversation by adhering to native Japanese etiquette since their back-channel responses will come faster than expected for an attentive listener in English cultures. Similarly, a native English speaker may appear slow and inattentive when adhering to their native American English etiquette.

This example shows that adherence or non-adherence to an expected etiquette has implications on at least two levels. First, humans will interpret behaviors (or their lack) in keeping with the etiquette they expect in the domain—and this can lead to mismatches with anything from comical to embarrassing to dangerous results. Above, the consequences were being seen as pushy or bored, but if others expect me to exhibit alarm in a given situation and I fail to do so, or fail to exhibit an alarm etiquette they associate with the severity I intended, they may well make erroneous assumptions about dangerous situations. Such seems to be the case in the in the 1982 crash of Air Florida flight 90 (described in Tannen, 1994) where the use of indirect presentation of evidence (a common method of conveying deference but apparently confused here for lack of severity) produced catastrophic effects:

On January 13th, 1982, Air Florida Flight 90 took off from the Regan National Airport, only to crash soon after killing 74 people on board due to a buildup of ice on the wings during an extended wait after de-icing. Analysis of the black box showed that just prior to take-off, the Co-pilot repeatedly called attention to the bad weather and ice build up on other planes:

Co-pilot: *"Look how the ice is just hanging on his, ah, back, back there, see that?*

…

Co-pilot: *See all those icicles on the back there and everything?*

Captain: *Yeah.*

The Co-pilot expressed concern early on about the long waiting time between de-icing:

Co-pilot: *Boy, this is a, this is a losing battle here on trying to de-ice those things, it* [gives] *you a false feeling of security, that's all that does.*

Shortly after they were given clearance to take off, he again expressed concern:

Co-pilot: *Let's check these tops again since we been sitting here awhile.*

Captain: *I think we get to go here in a minute.*

When they were about to take off, the co-pilot called attention to the engine instrument readings, which were not normal:

Co-pilot: *That don't seem right, does it?* [three-second pause] *Ah, that's not right.*

...

Captain: *Yes, it is, there's 80.*

Co-pilot: *Naw, I don't think that's right.* [seven-second pause] *Ah, maybe it is.*

Captain: *Hundred and twenty.*

Co-pilot: *I don't know.*

In this case, the disaster might have been avoided if the Co-pilot had communicated more directly or assertively, if the Captain had been more sensitive, or even if the Captain had recognized the danger himself. Alternatively, it might have been avoided if Captain and Co-pilot had shared an etiquette for conveying the level of danger the Co-pilot perceived along with deference to the Captain's authority. Indeed, such techniques have been increasingly used in aviation training (under the heading of Cockpit Resource Management) which enhances both general sensitivity to interpersonal differences and provides explicit protocols for specific high-criticality interactions (Wiener, Kanki, and Helmriech 1993).

Another implication conveyed by mismatches between etiquette expectations is that some rethinking of the situation by those who detect the mismatch is likely to occur. If I burst into your office without knocking, interrupt your telephone conversation and begin to speak, chances are I have violated several expectations you had about the office etiquette we both (presumably) shared. Hence, you will rethink several of those assumptions: perhaps what I am conveying is more urgent than what you would normally assume about office communications, perhaps I don't believe I need to adhere to those conventions with you (perhaps because I think I'm more powerful than you, perhaps because we're old friends who don't "stand on ceremony"), perhaps because I don't share your etiquette rules because I'm from a different culture, etc. The unwritten and implicit nature of most etiquette rules makes it difficult to predict which interpretation will be arrived at, but some rethinking is inevitable.

Etiquette can convey or destroy (correctly or incorrectly) assumptions about group membership. If I use the correct dinner fork at a fancy meal, you are entitled to assume that I am trained in sophisticated culture—and you might make further assumptions about my education and income levels. Such assumptions of group membership can have profound implications on trust formation (Lee and See, 2004): if I use pilot jargon and cadences, you will be increasingly likely to trust my knowledge and advice about piloting situations (also cf. Miller, 2005).

HUMAN-HUMAN ETIQUETTE AND ITS RELEVANCE TO HUMAN-MACHINE INTERACTION

The above discussion described etiquette in human-human interactions, and illustrated its relevance to real world and high-criticality environments. Does etiquette exist in human-machine relationships? Clearly, a long tradition of explicitly anthropomorphizing interfaces (Andre, Rist and Muller, 1998; Cassell, 2000; Breazeal, 2002; Fong and Nourbakhsh, 2003) indicates that many believe literally "putting a human face" on technology will evoke increased degrees of user acceptance and interest. But do such effects persist even when the technology is not explicitly personified? These questions are important in domains such as aviation, power generation, navigation and manufacturing where technology is pervasive (though rarely explicitly personified) and correct interaction is critical for safety and productivity. Below, we turn first to arguments for the relevance of etiquette to human-machine interactions in general, and then address etiquette effects in high criticality domains in particular.

For many years, I have worked designing sophisticated automation to support high criticality real-world tasks such as piloting aircraft, operating oil refineries and commanding military troops. In these domains, highly-trained human operators generally believe (rightly or wrongly) they will not benefit from embodied interfaces with explicit humanlike characteristics. Nevertheless, I began to suspect that operators were approaching sophisticated automation with expectations similar to those they used with human colleagues. Eventually, I found both a theoretical framework and experimental data for this claim in the work of Clifford Nass (e.g., Reeves and Nass, 1996).

Nass's research paradigm generally involves taking a well-documented finding for human-human interaction from sociology or social psychology, and then substituting a computer in one of the roles. As one example among many, Nass cites the work of Finkel, Gutterbock and Borg (1991) documenting that people tend to be less critical when providing feedback directly to a person than "behind their back." When asked about aspects of observed performance, ratings are consistently higher if the performer does the asking than if some third party does so with the performer absent.

Nass then constructed a test of this phenomenon in human-computer interaction by having participants use an information browsing and retrieval system. The system asked how much they knew about various topics ("little", "some", "lots") and then suggested various materials that they read to improve their knowledge. In fact, the materials suggested were identical regardless of the human's response. Participants then took a test on those topics and, subsequently, filled out a survey on how good they thought the recommending system was. The only difference between two experimental conditions was whether the subject filled out this survey on the same computer on which they had performed the task, or on a different computer across the room. Subjects taking the survey on the same computer rated that computer's performance significantly better than those taking it on a different computer.

Note that the participants were largely computer science undergraduates and could therefore be presumed to be familiar with computers. Note also that the computer system was not overtly embodied in any way. Nevertheless, in this and in many other experiments Nass has reported, participants seemed to interact with the machine using their patterns of human-human interpersonal behaviors.

Nass's explanation is that technological media trigger behavioral patterns that we originally learn and more frequently apply to other social actors, namely other humans, in human-human interaction. A related phenomenon is what Dennett (1989) calls the "intentional stance"—our tendency to regard many complex, unpredictable and uncontrollable phenomena as intentional agents with goals and goal-directed behaviors. Dennett points out that humans have taken this stance toward animals, crops, the weather and, of course, fortune and fate. It's not that we can't break out of these patterns of interaction. If a computer scientist stops to think about the piece of silicon and plastic before her, it is quite clear that it won't take offense at being scored poorly on a survey. It's just that these patterns are easy to fall into if we don't stop to think about it.

High Criticality Systems as Intentional Agents

Work like Nass's argues that humans interact with their technical systems according to patterns and schema that are generalized from their interactions with other humans. But is this only the case in simple, relaxed, more "social" domains (such as information retrieval)? In domains where highly-trained workers regularly interact with machines to conduct their high-criticality jobs, mightn't we expect such effects to diminish or vanish?

We suspect this is not the case because, although etiquettes differ in work settings from informal ones, they are nevertheless present and, if anything, play an even more important role when decisions, information flow, trust and timing are important and mismatches can have critical consequences. Examining human-machine interaction accidents through the perspective of etiquette can show traces of such effects. One example is the grounding of the *Royal Majesty* cruise ship in 1995 (NTSB, 1997). Note that this case has been extensively analyzed in the human factors literature (e.g., Degani, 2003) from a variety of perspectives (trust formation, over trust in automation, change blindness, basic visualization principles, training, etc.). My intent here is to show how taking an "etiquette perspective" can augment, perhaps even predict and explain, some of these other perspectives.

The *Royal Majesty* was sailing from Bermuda to Boston with 1509 passengers. During the cruise, the ship lost GPS signals used in navigation. This fact was indicated on the navigation display, but not in a very salient fashion and the crew continued to navigate for more than 27 hours in "dead reckoning" mode without corrections for wind or tides. On the last day of the cruise as the ship neared port, it ran aground on a shoal near Nantucket, MA. There was no loss of life or serious injury, but the collision cost the shipping lines more than $7 million.

The navigation display was intended and trained to be an occasionally-checked device; not continuously monitored. It was located behind the position and orientation normally occupied by deck officers. It accurately conveyed loss of GPS signal via textual indicators "DR" (to indicate that it was now in "dead reckoning" mode) and "SOL" (to indicate that the current navigation solution is invalid), and by a series of short auditory beeps. The auditory tones lasted a total of under one second and are described as being similar to a wristwatch alarm. While the textual indicators were shown continuously once the system entered dead reckoning mode, they were only about 1/8" tall and about 1/7 the font size of the latitude and longitude (see Figure 2) and were generally difficult to notice. Indeed, all of the watch officers testified that they had not heard the beeps nor noticed the DR or SOL indicators prior to the collision.

Figure 2. Approximate relative size and orientation of the lat/long indicators and the 'SOL' solution invalid indicator.

Various factors may explain this accident. It is obvious that the display was poorly designed for conveying loss of signal. Change blindness (Simmons and Rensink, 2005)—the human tendency to miss changes if not attended to and/or in foveal vision—was also clearly a factor. This accident is also cited as an instance of "over-reliance" or "over-trust" in automation (e.g., Degani, 2003). But it is worth asking why the designers did a poor job on this display, why it was prone to change blindness and why the generally seasoned mariners onboard the *Royal Majesty* trusted their automation too much? In fact, all evidence is that the mariners were scrupulous in adhering to the required procedural checks of the systems as they understood them—providing some evidence that they did not "over" trust the automation, but instead cross-checked it when and how they thought they should.

Instead, we suggest that a contributing factor to the mariners' "over-trust" may be a subtle and certainly unconscious assumption of human-like etiquette from the automation—that is, an expectation that automation behaviors should be interpreted as if they had come from a human. The GPS navigation automation is performing a task formerly performed by a human officer, after all. So, what would human etiquette be in a similar situation? A human navigation officer would certainly inform the captain about the loss of a significant source of navigation data, just as the automation did. But s/he would expect some acknowledgement. Furthermore, if the captain continued to rely on that increasingly faulty data—especially for more than 27 hours and in a busy and treacherous location such as the port of Nantucket—the officer might well be expected (or even required) to issue further warnings and expect more explicit acknowledgements that they had been received and understood.

The GPS navigation display did none of these things (which might stem from a lack of consideration of etiquette effects during design). Instead, its overt behaviors were not different from the etiquette a human officer would employ if there were nothing (or nothing much) wrong. Furthermore, if a human had exhibited etiquette similar to the GPS (i.e., quiet and non-repeated notification of a problem), the crew and captain would have interpreted the behaviors as signaling a minor problem of little consequence (if they had noticed them at all), or as the non-existence of any problem (if they had not). In other words, they "over-trusted" the automation precisely because the automation exhibited etiquette cues consistent with there being little or no problem to worry about.

EXPERIMENTAL EVIDENCE FOR ETIQUETTE EFFECTS

While the above account suggests that etiquette interpretations might have had an effect in a real-world accident, it was hardly a controlled experiment with hard data. Does such evidence exist?

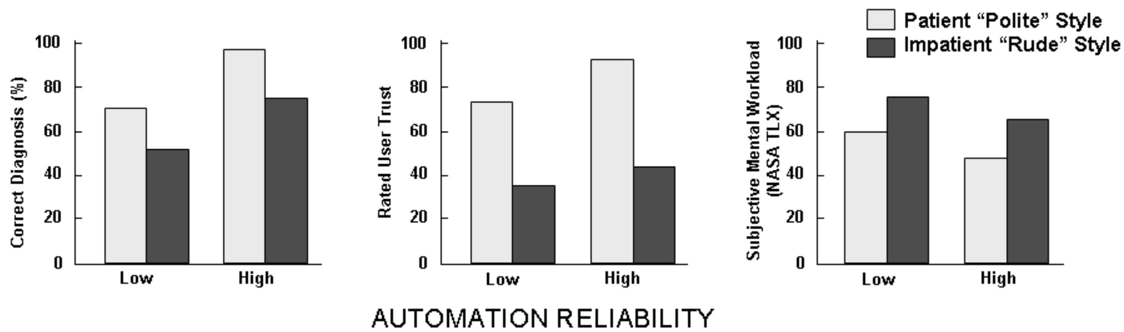
One such instance is the RPA system described above (Miller and Hannen, 1999). There, an analysis of prevalent cockpit "etiquette"—specifically, the emphasis placed on explicit intent communications to maintain shared situation awareness (Salas, Prince, Baker and Shrestha, 1995) and crew coordination—led us away from an exclusive reliance on automated plan recognition to infer pilot intent. Instead, we augmented that with a more interactive and conversational approach to intent "declaration." This was precisely because intent declaration was expected in the "etiquette" of this cockpit. The result was improved user acceptance and arguably, improved overall human-machine performance (Miller and Hannen, 1999). Interestingly, users reported significant reductions in perceived workload on NASA TLX ratings in spite of incurring the added work of intent communication. They also universally rated the intent communication interface as 'considerably' to 'extremely' useful.

A more controlled, laboratory study, Parasuraman and Miller (2004), indicates that a decision aid perceived as "pushy" or "interruptive" will negatively impact both perceptual variables (trust and perceived workload) and objectively measured human-machine performance. In this experiment, participants interacted with an aviation task simulation—the Multiple Aptitude Task (MAT) battery (Parasuraman and Riley, 1997) including an engine performance monitoring and problem diagnosis task. To aid this task, the MAT included an automated advisory system modeled after the Engine Indicator and Crew Alerting System (EICAS) used in most modern commercial airliners. This aiding system monitored engine behavior, advised the operator about potential faults and suggested steps to diagnose them.

Parasuraman varied both the reliability and the etiquette with which diagnostic advice was given. In a "rude" style condition, advice was given with no warning and even when the operator was already interacting with the EICAS-like advisory system. Furthermore, new advice was given while the operator was still working on the previous advice or step. Thus, this automation was "interruptive and impatient". In the "polite" condition, these behaviors were omitted or replaced with more polite ones. Advice reliability was also varied between 60% and 80% correct—levels shown to produce significantly different trust and usage decisions previously (Parasuraman, Molloy and Singh, 1993).

Subjects interacted with automation in a 2x2 between-subjects design. They were asked to rate their degree of trust and perceived workload, and their diagnostic success on the malfunctions was objectively assessed. As might be expected, diagnostic performance, trust and workload were all better when automation reliability was high (cf. Figure 3). Somewhat unexpectedly, good etiquette also produced better diagnoses, trust and workload ratings. Most interestingly, good etiquette was strong enough to overcome low automation reliability. Human + machine performance in the high reliability/poor etiquette condition was about the same as, and not significantly different from, performance in the low reliability/good etiquette condition. Etiquette effects on subjective measures were even stronger. Good etiquette improved subjects' perceived trust by 40-50%. Interestingly (perhaps alarmingly), this dramatic shift in trust ratings meant that users' trust

Figure 3. Objective (diagnostic performance) and subjective (trust and workload) results under two levels of politeness and automation reliability



was substantially less than performance (i.e., true reliability) would warrant in poor etiquette conditions, and substantially better than warranted in good etiquette conditions. Good etiquette was associated with about a 20% reduction in perceived workload in both conditions.

Various explanations for these findings are possible. The relationship between pleasant vs. frustrating experiences and their impact on perceived workload is well researched (e.g., Matthews et al., 2002). Norman (2004) reviews work claiming that pleasing experiences can actually aid in the performance of tasks which require broader thinking—a category into which diagnostic performance might fall. Lee and See (2004) review extensive literature on trust formation and argue for an "affective" pathway to trust building which relies solely on experiences producing positive affect. We are not yet in a position to describe the mechanism which produces these results; we suspect that all of these channels are contributors. Nevertheless, this experiment seems to provide strong evidence that etiquette styles can dramatically affect human performance with automation.

Etiquette, Culture, Politeness and Directives

We have recently focused on politeness and its role in human-human and human-machine interactions (Miller, et al., 2004, 2006, 2007) as a particular, though rich and pervasive, aspect of etiquette. Substantial work and theory in this area comes from sociolinguists Penelope Brown and Stephen Levinson (1987), who provide us with a model of politeness that generalizes not only across human cultures but also, potentially, to human-machine interactions. Their claim is that whenever two agents which are believed to have "face" interact, there is the potential for face threat. "Face" is the "positive social value a person effectively claims for himself" (cf. Cassell and Bickmore, 2003, p. 6). It is the desire to have one's will and interests be seen as important and valuable. Face can be saved or lost, threatened or conserved in interactions.

In the their model, the degree of "face threat" in an interaction is a function of three factors:

1. The Power (P) that the Hearer has over the speaker. An interaction will be seen as more threatening if uttered to a Hearer who is more powerful vs. less powerful.
2. The Social Distance (D) between Speaker and Hearer. Social Distance is roughly the inverse of familiarity. An interaction will be seen as more threatening if it is done between two strangers vs. old friends.
3. The raw Imposition (R) of the act or topic being discussed. An interaction for a big favor or a sensitive topic will be more threatening than for a small favor or nominal topic.

In the model, the face threat must be "redressed" by the value or weight of polite behaviors—the use of "please" and "thank you", taking off one's hat, using an honorific or apology, etc. Note that behaviors need not be verbal—gestures, tone of voice and even subtle cues like body position can be included in the model. If an adequate amount of redress is used, the interaction will be perceived as nominal. If less redress than needed is used, it will be seen as rude; if more, then it will be seen as overly polite. Note that assessments are done from an individual's perspective and based on cultural knowledge, admitting the possibility of mismatches in perception of an interaction. When off-nominal interactions are perceived, we seek to reinterpret our understanding of the event so that balance is maintained. This is one reason why a complete stranger can burst into my office, yell "Get out now!" and not be perceived as rude—if s/he is telling me about an imminent threat to the building, then this is to my benefit and less of an imposition (R) than I might initially have assumed.

Another aspect of the Brown and Levinson model is the identification of five different classes of politeness strategies as follows, listed in order of their redressive power:

1. The least threatening (most polite) approach is simply not to do the action. Some actions, in some contexts, are simply too threatening, regardless of the redress offered. The only polite strategy is to avoid the act.
2. If one does an act, then the least threatening way to do it is off record. Off record strategies are done with "plausible deniability" using innuendo and hints. An off record method of asking for salt might be "I find this food a bit bland."
3. If one does the act overtly, then the threat can be undercut by offering redress. Brown and Levinson suggest that "negative redress" will be more effective than positive. Negative redress focuses on the hearer's negative face needs—independence of action and attention. They minimize impact by being direct and simple, offering apologies and deference, minimizing the magnitude of imposition and/or explicitly incurring a debt. "I'm sorry, but I'd be very grateful if you could just pass me the salt" illustrates many negative redress strategies (apology, incurred debt, minimization of the imposition).
4. Positive redressive strategies target the hearer's positive face needs—the desire that his/her needs and wants be seen as desirable. These strategies emphasize common ground by noticing the hearer, invoking in-group identity, joking, assuming agreement and/or explicitly offering rewards/promises. "Hey buddy, you're gonna pass me that salt, aren't you?" uses positive redressive strategies including an in-group identity marker and assumed compliance.
5. Finally, the most threatening way to perform an act is baldly, on record, without any redress. "Give me the salt" is a bald, unredressed act.

We performed an initial test of this model (Miller, Wu and Chapman, 2004) in a human-machine interaction context—the design of a medication reminder for a smart home system: Honeywell's Independent LifeStyle Assistant (I.L.S.A.). I.L.S.A. maintained awareness of the user's medication schedule and, via sensors in the home and an instrumented medicine caddy, detected possible missed medication events. When detected, the aid would telephone the user and issue a reminder.

I.L.S.A.'s designers were concerned about the impact of politeness on user compliance with these reminders—and how one could predict perceived politeness in general. We performed a simple validation exercise where we crafted five candidate reminder messages in accordance with the Brown and Levinson categories (strategy 1 was not tested but we substituted a message actually used in I.L.S.A.'s field tests— a largely bald approach with a small amount of positive politeness). We asked three groups to rate textual presentations of these alternate reminding strategies: elders (age > 60 years), a group of nominally aged (20-50 years) individuals who had not been involved in the project, and a group of project engineers. The results are presented in Figure 4.

While these results are qualitative only, it seems apparent that the model reasonably predicts perception of politeness in the reminders for all except the "off record" strategy. This may be a result of the subtle and context-sensitive nature of such "implied" strategies, or it may just be that we crafted a bad example. At any rate, this study provided preliminary support for the claim that a model developed to account for perceptions of politeness in human-human interactions could also predict perceptions of machine-to-human politeness.

The Brown and Levinson model accounts for, indeed predicts, several aspects of politeness that may be important for work settings, including:

- The power or authority of the speaker may affect perceived politeness—and vice versa. When unexpectedly high levels of politeness are used, the model predicts, hearers are likely to interpret the utterance as either coming from a less powerful individual or as being less imposing or urgent. Hence, it may be inadvisable to recommend to a pilot "Could you please shut down engine #2?" if this request is urgent.
- Perceived politeness changes over time due to increased familiarity. What is appropriate for the first interactions among strangers, will be distinctly inappropriate after months of working together. Some focus group interactions involving users who had lived with I.L.S.A. prototypes illustrated this fact: a level of politeness deemed rude initially was deemed acceptable after 3-6 months interaction, and one deemed appropriate initially was deemed overly polite (and wordy) after time.
- Perceived politeness is culturally determined—while Brown and Levinson claim their model is culturally universal, they agree that it operates over specific expectations about what counts as power, social distance, imposition and specific redressive behaviors in each culture. This is certainly true in work domains as well. The way one signals urgency in aviation is only approximately similar to the method used in a particular oil refinery.

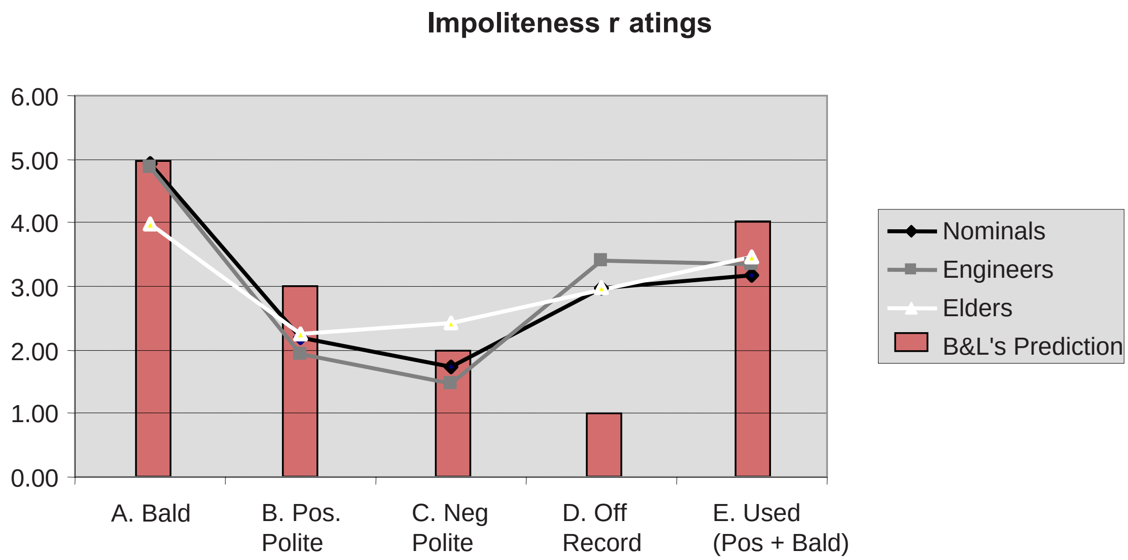
My team has subsequently developed a quantitative version of this model, and has validated its predictions in a variety of human interactions (Miller, et al. 2006, 2007). This model enables simulated characters in a language training game to perceive, react and make use of culture-specific politeness in keeping with their goals. Initial results (see Miller, Wu and Funk, 2008) indicate that it provides accurate predictions over multiple scenarios for both trained and untrained raters.

We are now conducting experiments exploring how variations in the politeness with which a directive is issued impact the hearer's compliance (Miller and Smith, 2008). Directives in this sense are meant to cover any utterance who's intent is to direct the hearer to take an action—though the force and intention may make that directive a request, an instruction, a beseeching, an order, a command, etc. Directives together with queries account for the vast majority of human-machine interactions. I expect that etiquette will impact compliance behaviors ranging from actual compliance decisions to reaction time, affect, trust, and memory for the context of the directive itself. This work is initially focusing on human interaction with other (simulated) human directive givers, but we hope to be able to carry the lessons learned there into human-machine interaction experiments soon thereafter.

conclus   Ion

In this paper, we have provided arguments and evidence for the claim that humans bring the same set of etiquette-based expectations to their interactions with complex machines as they do with other humans. The question of whether human-computer interactions can have "etiquette" seems increasingly moot—we behave as if they do and, it appears, investigating types of etiquette that lead to productive

Figure 4. Ratings of alternate politeness strategies vs. model predictions



and unproductive work provides useful insights into how to design such systems.

This does not necessarily lead us to embodied interfaces, or to human-machine interactions which are always "polite" or "nice". Instead, it urges taking an "etiquette perspective" on design. How does one do this? First, one must realize that machines at even moderate levels of complexity and autonomy are not "just" machines to their human users—that is, they will not always be regarded as inanimate, unintentional entities. Instead, they will (sometimes subtly and unintentionally) be regarded as social agents whose behavior will be interpreted via the same etiquette conventions that human agents in the domain adhere to. These interpretations are highly likely unless we strive to remind users that they are interacting with a machine with its own behaviors and conventions. Even then, machines may provoke frustration and love, trust and suspicion, in circumstances that may not warrant those reactions. It is our responsibility as designers to understand this tendency and use or overcome it as appropriate for the safe, efficient and pleasant operation of the systems we build.

The dimensions and implications of human-machine etiquette are the subject of ongoing research by ourselves and others (Hayes and Miller, forthcoming), but we can offer the following heuristics for etiquette-based design. When creating a human-technical system, we find it helpful to ask ourselves the following:

- If this system were replaced by capable, informed and well-intentioned human, how would we like that human to behave differently?
- If a human were to provide this information/recommendation/action in this way, how would s/he be perceived by colleagues?

The first question invites designers to consider deficiencies between system behavior as designed vs. how a capable and well-intentioned human would do it. Whenever possible, system behaviors should parallel the expected and desired behaviors which an ideal human would exhibit. The second question acknowledges that it is not always possible for systems to exhibit the same interaction behaviors and modalities as humans. For example, truly interactive natural language with its assumed range of "common sense" knowledge would solve a host of problems in human-machine communication, but will remain infeasible for the near future. So, if our capable and well-intentioned human from the first question were constrained to interact via, say, lights and buzzers to notify us that a car door is ajar, how would we like them to do it? Chances are they would be capable of noticing when we've left the car vs. are still in it saying goodbye to a friend and sound the buzzers in the first case but not the second. Furthermore, the human controlling buzzers and lights might well come up with a way to signal tentative and minimally intrusive "you might have forgotten your door" conditions vs. serious "Hey! The car's moving and that door's not closed!" There is no guarantee that such fine, human-like distinctions can be achieved given sensors and reasoning capabilities available, but it is quite likely that if they could, the result would be more pleasant, effective and even safe human-machine systems.

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KEY TERMS

Etiquette (as used in this chapter): The defined roles and acceptable behaviors and interaction moves of each participant in a common ‘social’ setting—that is, one that involves more than one intelligent agent (cf. intentional agent). Etiquette rules create an informal contract between participants in a social interaction, allowing expectations to be formed and used about the behavior of other parties, and defining what counts as good behavior.

Etiquette-Based Design: Design of systems and interfaces which takes into account the fact that humans are likely to interact with complex system according to the patterns of expectations and interpretations they have formed for interacting with other intentional agents—primarily other humans

Face: The "positive social value a person effectively claims for himself" (cf. Cassell and Bickmore, 2003, p. 6). It is the desire to have one's will and interests be seen as important and valuable. Face can be saved or lost, threatened or conserved in interactions. All agents which are believed to be intentional are believed to have face.

Intentional Agent: Any agent, whether human or machine (or even hidden and abstract such as the weather, luck or fate), that is deemed to sufficient intelligence and personal consciousness so as to have intentions (after Dennett, 1989).

Politeness: One (pervasive) type of etiquette which embodies a culture-specific code of verbal and non-verbal behaviors with varying weight to redress face threat and thereby signal, maintain or disrupt social relationships based on power difference, social distance (i.e., familiarity) and the raw imposition of interactions (after Brown and Levinson, 1987.)

Redress: Threats to one's face are inherent in social interactions between intentional agents. Politeness behaviors can "redress" or mitigate and offset face threats.

Section V
Socio-Technical Implementation

How socio-technical systems are put into practice

This section discusses socio-technical systems that have been developed and put into practice, with questions like:

1. What are some of the problems faced by socio-technical implementations?
2. How are technical functions actually connected to social processes?
3. How do socio-technical implementations differ from other types of implementation?
4. What are the theory issues raised by socio-technical implementations?
5. What are some of the benefits of socio-technical implementations?

Prologue
Socio-Technical Implementation

Anton Nijholt
University of Twente, The Netherlands

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.

—Mark Weiser, Scientific American, September 1991

Socio-Technical Systems in the Context of Ubiquitous Computing, Ambient Intelligence, Embodied Virtuality, and the Internet of Things

In which computer science world do we design and implement our socio-technical systems? About every five or ten years new computer and interaction paradigms are introduced. We had the mainframe computers, the various generations of computers, including the Japanese fifth generation computers, the role of artificial intelligence and the hype of expert systems. Moreover, we had the advent of personal computers, the first hobby and ‘garage’ computers, leading to companies such as Atari, Apple and Microsoft. Before that, there was already ARPANET (1969) leading to Internet and the TCP/IP protocol suite in the 1970s. Tim Berners-Lee introduction of the World Wide Web and the introduction of graphical web browsers in the early 1990s were other milestones. Moreover, we saw the development of telecommunications networks and the further rise of Internet and World Wide Web use, due to professional and, most of all, non-professional use and users. Embedding computer power in all kinds of appliances, including mobile and other wearable appliances, lead us away from desktop and keyboard and mouse applications. Global and local networks of such computing devices, using sensors (including microphones and cameras) and wireless network technology are an impetus to research on applications such as virtual educational and game communities, virtual workspaces, and virtual meeting facilities. Rather than this technology just allowing people to communicate with each other (in the context of these applications) we now have the possibility to make this mediated communication (more) natural, since the intelligent sensors that are now available allow the mediating of verbal and nonverbal social cues that are known

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to be important in human face-to-face or human multi-party interaction.

In the nineties of the previous century Mark Weiser introduced the idea of 'disappearing computers'. In his now famous Scientific American paper (Weiser, 1991) he started the explanation of his ideas by saying: *"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."* He and his colleagues at Xerox Parc introduced the ideas of ubiquitous computing and 'embodied virtuality', the process of drawing computers out of their electronic shells and into the practical world. In this vision, computers are everywhere and also nowhere: *"Hundreds of computers in a room could seem intimidating at first, just as hundreds of volts coursing through wires in the walls did at one time. But like the wires in the walls, these hundreds of computers will come to be invisible to common awareness. People will simply use them unconsciously to accomplish everyday tasks."*

These views became more accepted in the beginning of this century. We started talking about pervasive and ubiquitous computing, mobile and wearable computing, and the notion of Ambient Intelligence (AmI) was introduced. There is a very well known quotation from an ISTAG report (ISTAG, 2005) that tells us: *"According to the ISTAG vision statement, humans will, in an Ambient Intelligent (AmI) Environment, be surrounded by intelligent interfaces supported by computing and networking technology that is embedded in everyday objects such as furniture, clothes, vehicles, roads and smart materials—even particles of decorative substances like paint. AmI implies a seamless environment of computing, advanced networking technology and specific interfaces. This environment should be aware of the specific characteristics of human presence and personalities; adapt to the needs of users; be capable of responding intelligently to spoken or gestured indications of desire; and even result in systems that are capable of engaging in intelligent dialogue. Ambient Intelligence should also be unobtrusive—interaction should be relaxing and enjoyable for the citizen, and not involve a steep learning curve."*

It is interesting to note that while Weiser contrasted ubiquitous computing with the use of interface agents and, obviously, with the use of personal computers, in this AmI description there is much concern about the interfaces. Clearly, we want 'attentive', 'pro-active', and 'anticipating' environments, and indeed there are many situations where the environment can provide support without having to bother the user with questions or expecting the user to give commands. But there will of course remain situations where the user or inhabitant of a smart environment will need to issue commands and will need results or advice acoustically, visually or in a tactile way to be displayed on devices in the environment. As mentioned in (Nijholt et al., 2004): *"…, most of the research in ambient intelligence does not take into account that people may feel lost in ambient intelligence, may not know who to 'talk' to and may not be able to build some kind of relationship with the anonymous environment that nevertheless supports them, observes them and keeps track of their activities."* For that reason it was argued in (Nijholt, 2004) that humanoids (virtual humans and human-like robotic devices) have a future in AmI environments as personal assistants, butlers and buddies. Maybe, to put it more generally, we want devices and environments that know what we want, like, and feel, and act accordingly.

Weiser also contrasted ubiquitous computing with (immersive) virtual reality: *"Perhaps most diametrically opposed to our vision is the notion of "virtual reality," which attempts to make a world inside the computer. …. Indeed, the opposition between the notion of virtual reality and ubiquitous, invisible computing is so strong that some of us use the term "embodied virtuality" to refer to the process of drawing computers out of their electronic shells. The "virtuality" of computer-readable data—all the different ways in which it can be altered, processed and analyzed—is brought into the physical world."*

Nevertheless, when we look at the development of interest in 3D virtual communities (Nijholt, 2001) in educational or recreational settings, then we can conclude that with the development of worlds like *There* and *Second Life* 'making a world inside the computer' is even getting more attention than in the nineties of the previous century. Arguably, these are not exactly the worlds Weiser was referring to, but nevertheless they show that computer scientists are not always strong in predicting social use of computers.

In particular wireless and display technologies allow us to have web interfaces everywhere. Web technology allows us to design all kinds of interactive web applications and, moreover, it allows the development of tools that provide non-professional users with the ability to develop their own interactive web applications or to adapt existing applications to their own needs and preferences. Web access, whether it is a computer screen, the surface of a table, a physical robot, or a virtual pet will allow us to communicate using different modalities, providing access and allowing interaction with multimedia content and mediating agents. It also allows us access to mixed and augmented reality environments where we can have individual experiences, for example, recalling something from the past, or where we can meet and have joint activities and experiences with friends, relatives, and family, or with gamers that want to compete or other people that we want to join or that we allow to enter our world and that also are looking for joint entertaining activities. Hence, future everyday life recreational activities can be supported and profit from the convergence of web and ambient intelligence technologies (Nijholt, 2008), provided a human centred social environment is maintained.

With these observations on the convergence of web and ambient intelligence technologies in mind, we can now look at current and future developments in information and computing technology in which we can embed research on socio-technical systems. Obviously, there are important issues related to the development of standards, such as the UMA (Universal Multimedia Access) initiative and the ongoing FIPA standardization of (multi-)agent technologies. Also, EU initiatives are launched on developing standards for Metaverse, that is, standards for interconnected virtual worlds such as those described in Neil Stephenson's science fiction novel *Snow Crash* and the now existing Second Life. But, more importantly, we can see a convergence of ideas, made possible by nowadays and future (foreseen) technologies, in particular internet, wireless sensors, multimedia, display, and multi-agent technologies (NEM1, 2007; NEM2, 2007). This convergence is about connecting virtual and real worlds, or better, about the integration of virtual (including augmented and mixed-reality) and real worlds, i.e., in such a way that we can experience natural face-to-face interaction, human multi-party interaction, and, of course, interaction with all kinds of synthetic partners, in a seamless perceptual coherence. For this to occur requires a common context, inevitably social, that reduces the likelihood of harmful interactions. Such trust, as created by friendships, groups and social roles and structures in general, gives the predictability critical to social participation. The tight coupling of on the one hand the so-called 'Real World Internet', which is socially embedded, and on the other hand the 'Virtual World Internet', which is evolving its social context, is necessary for them to co-exist. Making this social level intersection work will pose many challenges for designers, but will also allow the many innovations we will see in future socio-technical systems.

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Chapter XXXIII
Augmenting Actual Life Through MUVEs

Laura Anna Ripamonti
Università degli Studi di Milano, Italy

Ines Di Loreto
Università degli Studi di Milano, Italy

Dario Maggiorini
Università degli Studi di Milano, Italy

abstract

The necessity of supporting more and more social interaction (and not only mere information sharing) in online environments is the disruptive force upon which phenomena ascribed to the Web2.0 paradigm continuously bud. People interacting in online socio-technical environments mold technology to their needs, seamlessly integrating it into their everyday life. MUVEs (Multi User Virtual Environments) are no exception and, in several cases, represent a new frontier in this field. In this chapter the authors analyze if and how MUVEs can be considered a means for augmenting the life of real communities and of people in general. The authors trace a framework of analysis based on four main observations, and through these lenses we look at Second Life and at several projects they are currently developing in this synthetic world.

The Interplay between Virtual and Actual: Identity, Relationship, and Place

The relationship between online and offline life (but we rather use *synthetic* and *actual*—see Castranova, 2005 and De Cindio et al., 2008) has been widely studied in recent years, adopting several different approaches and through the lenses of different disciplines (e.g., psychology, computer science, sociology, economy, architecture, etc.).

An exhaustive analysis of each of the aforementioned research branches is almost impossible; nevertheless, within each of them, some key features

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naturally emerge denoting particular or remarkable facets of the complex relation which binds together the *synthetic* and the *actual* worlds.

Three key concepts, in particular, seem to be fundamental for investigating how synthetic and actual worlds overlap, intersect, and interact to "augment" each other, instead of being counterpoised (Mitchell, 2003; Wellman & Haythornthwaite, 2002). These concepts are: *identity*, *relationship*, and *place*. It is through these dimensions that we analyze how MUVEs (Multi Users Virtual Environments)—among which synthetic worlds are one of the more "extreme" products of the cyberculture movement—are becoming more and more an extension of people everyday life. MUVEs does not provide their users with an alternate reality, but augment and add "value" (which should be implicit in the notion of augmentation) to their actual life.

Our framework of analysis is based on four major observations:

Observation 1: online identity is an extension of personal actual identity, which is socio-culturally constructed and evolves over time in both worlds.

Observation 2: online social networks emerge, in the space of possibilities created by the Internet, as extensions of actual ones; in this process "online identities" can be involved as well.

Observation 3: synthetic places are the extension of actual, public, and private spaces. They augment people's possibility to interact in online social networks and, at the same time, are affected and shaped by social interactions.

Observation 4: online identity, relations, and places can interact to augment effectively people actual social life. A careful and exhaustive design of the online social environment is required for this to happen: this means that critical factors affecting social interactions among users must be taken very seriously, and need a consistent amount of study, to guarantee the success of a synthetic world.

Observation 1: Online Identity is an Extension of Personal Actual Identity

The Cyberculture movement (Markham, 1998; McKenna & Bargh, 1998) assumed that technology allows people to detach from the actual world, inventing a completely different "virtual" identity. This new identity is completely unconnected to the actual one, since the physical/actual world is cast aside when entering the cyberspace. However, it has emerged (see, for instance, Graham, 2002) that personal identity is based on the interaction between physical and virtual elements even when identity is considered in terms of the online world, thus leading to a completely different conclusion compared to the Cyberculture perspective. Indeed, in the actual world, our body is a *mediator* in creating our personal identity, but when the body is abandoned—precisely as in online social interactions—"technology" replaces it. Paraphrasing Marshall McLuhan (1964), we can consider "technology as an extension of man" (Lister et al., 2003). Just as our corporeal bodies are integral to our personal and social lives, digital self-representations (e.g., avatars) are central to our experience in synthetic environments (Polsky, 2001).

In this vein, Manuel Castells says that people with online identities are nevertheless "bound by the desires, pain, and mortality of their physical life" (Castells, 2002, 118), while several case studies support the assertion that online identity extends offline identity: see, for instance, the analysis of RumCom.local newsgroups (Rutter & Smith 1999). Hence we can say that identity is socio-culturally constructed for both the virtual and the actual environments.

Identity in the actual world is continuously evolving, due to the interaction with the multiple socio-cultural contexts we come across during our lives (Maffesoli, 1996). Online, this phenomenon is enforced by the fact that the Internet is intrinsically "global," thus supporting and multiplying worldwide cross-cultural social interactions. However, people's virtual personality tends to stay increasingly the same, or at least to change over time at the same pace as actual personality (Schiano & White, 1998; Becker & Mark, 1999; Cheng et al., 2002). Online and offline impression management works in very similar ways too. The "cyberselves" are built through *presentation*, *negotiation*, and *signification* (Waskul & Douglass, 1997) and evolve over time due to the ongoing interactions with others, exactly like our "actual selves". Studies in this area seem to indicate that, although people like to indulge in some experimentation with their self-projection, identity play decreases with time. In other words, the longer people use online environments, such as MOOs or chats, the more likely they are to produce self-presentations that are more "authentic" and, even when some "false" element is present in people first online self-presentations, over time "their true self will seep through" (Leary, 1993; Turkle, 1995; Curtis, 1997; Roberts et al., 1996).

o bservation 2: o nline s ocial n etworks e merge a s e xtensions of a ctual o nes

The online world has relevant effects also on *relationships*, on the natural tendency of people to gather in associations, and—more in general—on community life.

These effects can be seen through dystopian or utopian lenses. On the one hand, the Internet is seen as a mean to increase social alienation and the erosion of community life (see e.g., Dreyfus, 2001; Putnam, 1995), even though it acknowledgedly helps building social relations, because such relationships cannot be compared to those of actual life, from which they subtract time. On the other hand, the Internet is seen as a social glue, binding collective intelligence, the matrix on which the global village germinates and develops (de Kerckhove, 1997).

Both positions appear too deterministic. As it is often the case, the truth may lay in the middle: the Internet could be looked upon as a "space of possibilities" supported by technologies that are unable—on their own—to built or disrupt social networks (Wellman, 2005). This happens, as an example, in synthetics worlds, that—by an active exploitation of (all) our senses—can create a psychological sense of presence, or, in other worlds, the illusion that "I'm *in* the virtual world and not in my house" and, as a consequence, that "I'm *there with other people*" (Biocca, 1997).

o bservation 3: o nline Places a re the e xtensions of a ctual Public and Private Places

The Internet has tickled the interest of a large number of different disciplines (geography, architecture, urban planning, computer science, etc.), from which alluring suggestions can be drawn about the role of actual vs. synthetic *space* and *place*. The "sense of place" is defined by cultural geographers, anthropologists, sociologists and urban planners as those characteristics that make a place special or unique, as well as those that foster a sense of authentic human attachment and belonging (see e.g. Relph, 1976; Norberg-Schulz, 1980): a well-known phenomenon in human society, in which people strongly identify with a particular geographical area or location. The term space, on the contrary, can be viewed as a set of dimensions in which objects are separated and located, have size and shape, and through which they can move.

In the virtual world, people generate a "sense of place"—exactly as it happens in the actual world (Mitchell, 1995)—and tend to interact with virtual space using the same metaphors adopted for the actual world. Cyberspace, like its actual counterpart, can be zoned, trespassed upon, interfered with, and split up into small landholdings similar to actual property holdings.

These effects are sometimes emphasized when they involve online communities: just as actual communities need an appropriate mix of private and public places to prosper, their online versions need analogous places, carefully designed to effectively support the social interactions that underlie community life. It is through the balance of these two kinds of place that we encourage spontaneous conversation and social-network building among 'neighbors.' Such interaction is the terrain upon which strong relationships, sense of community and identification germinate (Wenger et al., 2002).

Observation 4: Online Identity, Relations and Places Can Interact to Augment Actual People Social Life

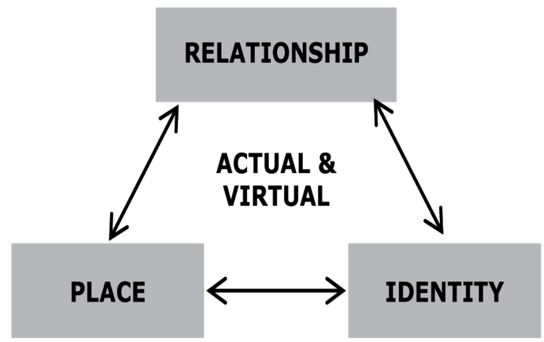
We observe that the three concepts—identity, relationship, and place—are strongly linked and enforce each other in both environments (the actual and the virtual—see Figure 1). The use of effectively designed spaces enforces (and is enforced by) the building of social networks—that is to say a net of relationships—but social networks constitute an ideal environment for expressing and evolving personal identities. Last but not least, spaces are shaped by identities and social networks. This implies that an appropriate "use" and mix of these three elements may serve as a fulcrum to achieve noteworthy results when dealing with online communities.

In the following paragraphs we will see to which extent this can be empirically proved, investigating through these lenses the case of a MUVE: Second Life.

MUVEs, MMORPGs, MUDs and Other Synthetic Worlds

MUVEs are online, multi-user virtual environments, also known as "virtual worlds". This term has been used till recently to refer to the evolution of more traditional 3D chats, Multi-User Dungeons/Domains/Dimensions (MUDs), MUDs Object Oriented (MOOs) and Massively Multiplayer Online Role-Playing Games (MMORPGs), but now it is widely used to indicate Massively Multiplayer Online Games (MMOGs) that not necessarily present the whole set of characteristics of a game (e.g., they have no specific goals to reach). Among the more known MUVEs we can list Second Life, There,

Figure 1. Actual and virtual place, identity and relationship



and Active Worlds, beside them there are also some intriguing research projects going on, such as Harvard's Rivercity Project (a MUVE aimed at "learning scientific inquiry and 21st century skills") and Croquet.

MUVEs derived from the combination of two technologies: virtual reality and text-based chat environments.

Traditionally, MUDs were designed for adventure games played by distributed users. Social use of MUDs subsequently developed and, at times, they became environments for chatting. They were commonly referred to as *virtual worlds*, whereas, because of the unfortunate history of the "virtual reality" scientific research paradigm, the "virtual" tag was opposed to the "real" one. This is the main reason for which we prefer to call them "synthetic worlds": it conveys an idea not of a different and detached "other" reality (often also connoted with negative meanings), but of something perhaps unnatural, but nonetheless bounded to our everyday life.

Technically speaking, MUVEs are online persistent virtual worlds represented using 3D isometric/third-person graphics, that allow for a large number of simultaneous remote users to interact. This means that they generally offer (more or less) realistic 3D graphics and physics to bring the users in a space populated by objects that may or may not recall those of the actual world. They are not necessarily games, but they are always social environments, inhabited by avatars (usually two or three-dimensional graphical representations of humanoids), that may have "demigod" abilities, such as being able to fly and change their appearance at will.

If we dig a little deeper in MUVEs characteristics, we discover that they are not simply the last ring of the online social environment evolutionary chain. Some MUVEs (e.g., Second Life) have some evident—and some more implicit—characteristics that subtly trace a fracture between them and the previous generation of MUDs, MMORPGs, etc., and pave the way to an unforeseen possible convergence with the Internet (and the web) communicative potentialities, since they effectively couple content diffusion and social interaction.

t he synthetic world of second l ife

Second Life (SL for short) is one among several virtual worlds that have been inspired by the cyberpunk literary movement and in particular by Neal Stephenson's novel "Snow Crash" (Stephenson, 1992). SL adopted Stephenson's idea of *Metaverse*, a user-defined world in which people can interact, play, do business, and otherwise communicate. Actually, SL was intentionally designed to be an environment completely constructed by its users (Ondrejka, 2004). Created in 2001 by Linden Lab and launched in the public in 2003, it registered a skyrocketing diffusion, and in a very short period its users outnumbered those of any other similar environment (at the moment SL counts about 13 millions registered users from all over the world, among them more than half a million are very active).

SL users are represented by motional avatars, which are the medium used to interact, explore, socialize, participate in individual and group activities, etc. SL users define themselves as "residents": it is noteworthy that this term suggests an idea of "citizenship". As a matter of fact, early residents strongly felt their belonging to the synthetic world, and they organized in-world public demonstrations to counteract specific policies or rules adopted by Linden Lab they did not agree upon (this happened, e.g., when residents were being charged for objects they created in-world: a protest has been set in-world, sending out a Thoreau-style proclamation against Linden Labs, see Rymaszewski et al., 2007 p. 282).

Since SL was conceived as an empty world, its internal building system is powerful and easy to use (compared to other similar 3D development tools). It allows manipulation of geometric primitives: residents—alone or collaboratively—can mould these "prims" into new shapes, change their texture and physical qualities, link them together for creating objects as complex as they like, add contents (e.g., text and multimedia) or make them interactive through a scripting language. Content creation in SL involves skills like graphic design, three-dimensional modeling, and programming. The ability of users to learn the relatively easily programming language and to create objects on their own made *Second Life* particularly popular. Creation and crafting is an intriguing component of SL: it attracts so many users and has played a relevant role in SL success. Actually, it was by engaging its users in the act of creation that SL produced an environment different from other virtual words: residents become a sort of producer-consumer (similar to the thousands of people who are mixing their own music, making their own movies, or publishing their own art or texts on the Internet). Many MUDs and MMORPGs have contents that were—and continue to be—built primarily by their users (Lastowka & Hunter, 2004; Turkle, 1995), but they imply at least two major constraints to creativity: objects and contents should often be tuned with the environment (e.g., medieval or science fiction) and the creator does not have any intellectual property right on them. On the contrary, following a farseeing suggestion by Lessig (Rymaszewski, 2007; Lessig, 2004; Lessig, 2001), SL residents preserve their intellectual property rights on each object or content they create in-world, and these objects can be sold or bought using a synthetic currency (Linden Dollar), that can be traded for US Dollars according to a fluctuating rate of exchange.

Some Technical Insights About Second Life

SL is implemented as a client-server system; the clients will connect to a server holding the metaverse content. Content inside the metaverse is made up of basic shapes (also named primitives or prims) which can be linked together to create complex objects. Due to the limited number of prims and the relative ease to describe them, SL can use a relatively low-bandwidth streaming-like system to push environment data first and multimedia (like textures and sounds) later to the client. This system has been proved to improve user experience while being less demanding in term of network resources.

The SL metaverse is not located on a single server, but resides on the implementation of a huge distributed system. This distributed system, or *grid*, is made up from a federation of nodes, each one taking care to simulate the environment inside a given virtual space of 256 by 256 meters. Due to this function, these nodes take the name of "Simulators" (or SIMs for short). Each SIM acts as a virtual machine: it takes in input actions from avatars and objects within, applies them to the current virtual environment together with physical rules and local policies, and provides back a new environment. The global SL grid is the result of a 2D distribution of SIMs, glued together by a global messaging system, where avatars can walk or fly between virtually adjacent SIMs. As for January 2008 the current "geographical" extension of the SL grid was about 26 millions acres.

Despite the fact SL is a completely distributed system, in order to ensure data consistency between SIMs and some other features unique to SL, there are a number of operations performed in a centralized way. Authentication, profile management and economic transactions are managed by a back-end service, whereas in-world objects management is achieved by means of a dedicated server (*asset server*). The asset server is in charge to assign a unique ID to all objects present in-world, to provide consistency for objects uniqueness between SIMs, and to apply access policies to preserve resident's intellectual properties.

As already mentioned before, in-world objects can be "augmented" by user-created programs using a special purpose programming language (the Linden Scripting Language or LSL). Using LSL, a resident can describe objects reactions to stimuli or interactions, from an avatar or the surrounding environment.

Interaction between avatars and objects is governed by a messaging system, which can be local to a SIM or global to the grid. Local interaction is initiated by the interface (like mouse clicks or keyboard press) and by text messages (like chat). When one of these events is triggered, the simulator will distribute a number of messages to involved avatars and objects; reception of these messages might imply the visualization of a text message and/or a state change for a program inside an object. Global interaction is essentially text-based and is mainly intended as an inter-SIM instant messaging system; both avatar and objects can benefit from global communications.

Communication is a key point of SL: the messaging system can be intertwined with all other in-world operations. Relationship between avatars will extend in-world with no distance boundaries and will also span off to real life, because messages will be relayed via e-mail when the user is not online. Expressing personal identity can be performed not just by avatar reshaping, but also by wearing (attaching) scripted prims, which in turn will be able to interact and send messages to nearby objects and avatars. In this way attachments will be playing a role in how the surrounding environment will perceive the user presence, even at a distance. Places can be filled with interacting and active scripted objects, which will send messages to users no matter where they are, thus, helping creating a social network without the constraint of being "there".

To some extents, SL communication is not limited to the grid itself: scripted objects have means to reach the Internet and use data from it to augment the virtual environment; it is possible to access web content as well as send (and receive) e-mail messages.

Multimedia content from the Internet is supported in an indirect way; a real-time media stream can be set as part of the environment and the SL client will take care to independently retrieve the content and perform the playout without interfering with the grid.

t he It.net and o thers o ngoing Projects

Our experiences with SL has begun during late winter 2006 and firstly concretized in a cycle of seminars in the framework of a course on online communities building for undergraduate students in Computer Science. From this first positive experience (students were enthusiast of having classes and meeting teachers in the synthetic world) bud several projects, among which the most relevant are:

- a project with a local body, aimed at building an in-world presence supporting the activities of its sector devoted to touristic promotion. This project unfortunately aborted few weeks before its official inauguration, due to political discussion about online presence that, in the meantime, grew among public officers;
- a study about how SL can be exploited to sustain and improve companies communication activities. This project is under development in partnership with a company working in the advertisement and marketing industry;
- a project aimed at investigating if and how SL could be a mean for supporting emerging young musicians (thus also comparing it with other very popular tools for music sharing). This project involves a non profit organization, whose main goal is helping young musicians in the actual world.
- the It.net project: an ambitious initiative, whose main goal is determining commonalities and differences between approaches necessary at building web-based and MUVE-based communities;
- a collaboration with a course of virtual reality for undergraduate students in Computer Science. As part of their homework, several students of this course should create—using advanced 3D graphical editors such as Maya—buildings for the It.net project.

The It.net project was born during late summer 2007 as a comprehensive environment in SL aimed at collecting several in-world experiments under development by a group of students graduating in Computer Science. It consists of an area where different aspects of the synthetic world are explored through different lenses, nonetheless they are knit firmly together by a common idea: the creation of a shared social network.

In the following we will use our experiences in the It.net project (although it is currently still under development) to test our approach to the adoption of SL and—more in general—of specific MUVEs as means for effectively augmenting people's everyday life.

second l IFe dIst InGuIsh InG character Ist Ics

According to our observations, three major aspects are the basis upon which communities can eventually germinate: how people presents their identities, how those identities are used to interact in social networks and to which degree people and their networks are able to mould spaces into places and are—vice-versa—influenced by them. SL features strongly supports each of these aspects.

Identity c reation and Management in sl

MUVEs (and *Second Life* between them) generally effectively support creation and management of online identities. Participants are usually registered members, identified in the synthetic environment by their pseudonym (nickname, username) and by an avatar. Other information about them (such as age, interests, etc.) may be provided and made publicly available in a user profile. The username they choose, the details they do or don't indicate about themselves, the presented information, and the avatar they assume in the online community —all are important clues about how people manage identity in synthetic environments.

Since SL offers a visual environment where practically each detail is customizable, at least two aspects are fundamental for identity building and management: your name and your avatar. In our actual lives these characteristics are persistent (except for very particular cases) and we should adapt to whichever choice *others* have done for us. This is not true for SL: its residents can invent the name that better suits their personalities and adopt or even *create* no matter which self-representation they like. They can be a dog, an elf, a human, a dragon, a can of Coke, etc.; no constraint limits their creativity. Their appearance can be further customized by adding e.g. special textures, clothing, and "animation overriders" (scripts that add much more natural movements to the avatars). These features of SL are very relevant and "make the difference" with other MUVEs and MMOGs—where users can only *choose* their identity among a set of pre-defined avatars and change their clothing—since, like in the actual world, the avatar/body is the "suit" used for self-presentation in social environment.

Avatars choices in SL, however, generally conform to cultural standards of what is considered attractive or normative (Lastowka & Hunter, 2004): that is to say, the particular cultural view of the more influential or numerous groups of users impacts the virtual space. This is largely visible in SL, where it is quite difficult to find an avatar that really diverges from the standards. As a matter of fact, it is not straightforward to undertake a conversation with a puzzling avatar such as a flying metal ball, while a plump inoffensive teddy is by far more reassuring.

While SL residents can change their appearance as many times as they like, they are not allowed to change their avatar's name: a name chosen at registration time is *the* name, and the only way to reappear in SL with a new identity is creating a new account. SL identities should be composed by a first *and* a last name: while residents can pick up whichever name they fancy about, they have to select their surname from a (very long) list provided by Linden Labs. This procedure have some implications: the similarity to what happens in actual life (at least in western cultures) makes the choice of names such as "amy48" or "starry_night_47"—a normal praxis for email addresses—sound quite "strange" in SL; moreover, aroused the necessity to bring, under some circumstances, actual names into *Second Life*. It's the case of the novelists Ellen Ullman and Cory Doctorow, of the game designer Harvey Smith, creator of the games Deus Ex; again, of the singers Suzanne Vega and Duran Duran (who appeared as themselves in an island on which they performed live concerts), and the politicians Mark Warner and Hillary Clinton.

A publicly accessible profile is associated to each SL resident. Profiles are a powerful mean of self-presentation and impression management: they are essential to declare to the world who you are, which are your interests, what your avatar looks like, and what you think is worth of seeing in SL. They may even contain details of your actual life (your name, contact details, portrait, etc.). Profiles, last but not least, inform about the groups you belong to and about your favourite places in SL, and may contain advertising about your business and "profession" in SL.

Although explicit tools for supporting reputation building and tracking are not provided by the SL client, it is undeniable that the combination between identity representation (name, avatar customization, user profile information) and the retention of the creator/owner by user created contents create a powerful mix, able to strongly characterize through virtuous circles residents both in the synthetic and in the actual world.

The main features of SL that act as enabler for effective identity creation and management are summarized in Table 1.

r elationships c reation and Management in sl

SL is a synthetic society where residents engage in a multiplicity of different activities and are involved in a variety of social relations. Similarly to what happens in the actual society, SL social relations can be of different kinds: some more formal than others, some transitory and some other connected to friendship networks. For many SL residents the synthetic world is simply a place to hang around and meet new friends, for others is a place for gaming or doing business. Residents organize all sorts of events in SL: movie festivals and shows, scientific conferences, parties, literary meetings, etc. All these activities are supported by an appropriate set of socio-technical features, that impact both at individuals and groups level.

From the individual point of view, the creation and management of social relations is enabled primarily by the elements discussed in the previous paragraph, that are further enforced by other specific features of avatars. As an example, SL avatars can use gestures: a gesture is a 3D implementation of chat emoticons, that is to say a way to support *phatic communication* (Stewart & Williams, 2005; Caron & Caronia, 2001), thus reinforcing linkages among people and building common grounds upon which interaction can take place easier (Rintel & Pittam, 1997; Bickmore & Picard, 2005). Technically, gestures are a combination of animation, pose, text, and sound. Once assembled, residents can use a gesture by triggering it via text or shortcut keys. Users-created gestures and animation can be applied to the avatar, further personalizing it, and making it a bit more resembling an actual being. Other relevant affordances for social interaction are more "common" tools such as chats (SL client supports both textual and voice chat), instant messaging, buddy list, online presence indicators, etc.

Social interaction among individuals inevitability leads to the creation of groups and the consequent agreement onto a set of shared behavioural norms. Harrison and Dourish (1996) pointed out that the appropriateness of social behaviour in a particular multi-user virtual environment depends on the interpretation of it by individual participants and on the social construction of knowledge. Similarly to what happens in other online communities, SL has rules and policies that limit residents' activities. A fundamental set of formal rules (the so-called "six big no-no") must be signed by every new resident when subscribing to the service. These rules are valid all over the synthetic world, but, beside them, other formal rules—usually defined by users or groups—can regulate behaviour e.g., in specific regions or among specific social networks. This is precisely what we have done for regulating students behaviour during the classes in our earlier experiment: we defined a specific netiquette residents whishing to visit our area (during or outside class hours) are expected to respect. In general we could say that different places in SL are devoted to different activities, supported by different groups and, thus, are regulated by more or less formal rules, which can be varying between very simple netiquette (the "six big no-no") to very complex structures (sometimes documented in appropriate libraries and supported by classes in "proper behaviour"—as it is the case for the Mentor group).

Groups are generally created by residents, and collect people sharing similar interests. As actual

Table 1. Several SL synthetic world distinguishing characteristics–Identity

SL Characteristic	Notes/implications
Avatar detailed personalization	SL residents can deeply *customize* their identity, while users of other MUVEs can only *choose* their identity among a set of pre-defined avatars
Unconstrained avatar personalization	SL residents can create and adopt whichever representation they like for their avatars, no constraint exist
Resident detailed profile	A publicly accessible profile is associated to each SL avatar. It contains information about the resident that can be automatically generated (e.g., groups subscribed) or provided by the users themselves (e.g., information about real life, about favourite sites in SL)
Persistent user-chosen name and identity	When a new account is created in SL, the user chooses a name (whichever) and picks up a surname in a pre-defined list of several hundreds. This name cannot be changed for any reason and will be indissolubly linked to the avatar and to every object she eventually creates
Gestures and animations	Users-created gestures and animations can be applied to the avatar, further personalizing it

groups, they are a collection of members playing different roles, and endowed with certain special privileges, including sharing land and money. They can build in the land owned by the group, and communicate in a more private way, using a group messaging system. Similarly to what happens for individual identity, groups too have profiles, which can be partially or totally public. Group profiles contain information about the group (logo, mission, etc.), members list, shared notices and activities, polling tools, etc. The subscription to the group can be open or restricted and for free or subdued to a fee. Belonging to a group can be explicitly shown: a member title can be made publicly visible near the avatar name. This group visibility impacts also on identity creation and management, as well as land sharing in a group impacts on places management.

It is noteworthy that social interaction taking place in SL is supported also by tools that are not in-world. Many discussions about SL take place in web-based forums, and can include knowledge that exists inside or outside the boundaries of the synthetic world. Residents have also created several tools that—in perfect Web2.0 style (O'Reilly, 2005)—allow to import and export contents from/into SL. A website called SLProfiles acts as a kind of MySpace for SL residents, Snapzilla is the SL version of Flickr, BlogHUD allows SL people to post directly to their blogs, and so on, in a perpetual attempt to create a seamless conjunction between in-world and the rest of the Internet.

The interplay between actual and virtual relationships in SL emerges also from several residents projects, such as the "Better World Island" with touching exhibits about life in a Darfur refugee camp. A number of renowned not-for-profit organizations, including Techsoup.org, Creative Commons and Omidyar Network have their in-world "versions".

The main features of SL that act as enabler for effective relationships creation and management are summarized in Table 2.

Places c reation and Management in sl

From Table 3 it is quite immediately perceivable that—from a spatial perspective—actual life and the synthetic world can overlap and interact. Actually, the notions of places and spaces—as conceived by architects and urban planners—can be applied (quite) straight away to the SL environment: anyway, in SL the notion of *space* progressively looses its meaning in favour to the one of *place*. This fact is due to several intertwined features of SL and how they interact and intersect with residents' behaviour. New land in SL is born naked: residents create the whole content of every SL island, and are endowed with the capability to customize even the tiniest details of their land. Residents can design not only buildings, but also oro-geographical and weather conditions of their land, and the flora and fauna it contains. Moreover, avatars do not need a lot of the infrastructures that are indispensable to human

Table 2. Several SL synthetic world distinguishing characteristics—relations

SL Characteristic	Notes/implications
Support to social networks	Residents' social network is supported by an effective variety of tools (e.g., friends lists, sharing of objects, groups creation by users, access lists)
User-defined groups	Groups can be created and managed by users. No constraints are imposed by the Linden Labs, except that at least two residents must be subscribed to the group
Netiquette (customizable)	Every new resident is required to accept a general netiquette when subscribing to SL. Moreover, specific netiquettes created by residents can apply to specific areas or groups
Gestures	Avatars can partially support phatic communication by using gestures

beings (such as streets, kitchens, bathrooms, elevators, heating systems, etc.): on the contrary, they can represent an incongruent burden to avatars activities. In other words, practically no constraint limits residents possibility to mould—and re-mould in any moment—synthetic spaces into synthetic places, thus creating environments that intrinsically satisfy not only a quantity of their needs and desires, but also those typical of a community (e.g., the presence of both private and public places—Wenger et al. 2002).

Moulding of spaces into places can take place on different levels: public (any place publicly accessible, such as a square, a library, a town, a garden, etc.), private (a private house—as far as the usual concept of "house" can be applied to SL private spaces) and group. A special attention should be devoted to this last category, since SL customization tools offer new powerful opportunities to groups. The whole SL is a wonderful and extreme example of Participatory Design (see i.e. Nygaard, 1983; Schuler & Namioka, 1993; Blomberg & Kensing, 1998) and participatory development, that coalesces into projects such as Neualtenburg: an attempt to simulate the look and feel of a functioning Bavarian city. Collaboration and co-design are so stressed in SL, that strong groups tends to create spaces (also public) that deeply mirror the set of values they share. An evident example of such collective sense-making activity and mutual intelligibility is the vast group of islands owned by the Elf Circle, one among the more active and numerous community of SL. Residents belonging to the Elf Circle only occasionally are lovers of role-playing games, instead they tend to share similar ethical and cultural values (e.g., respect for nature and other living things, love for literature, poetry, and arts in general) and this is undeniably reflected by the aspect of their lands, that are dominated by beautiful landscapes and buildings, where no explicit representation of technology is allowed. Thus, only by visiting those areas, "foreign" residents are immediately immersed in a well-defined atmosphere.

Other phenomena well-known to architects are reproduced into SL synthetic spaces. As an example, people tend to redesign or reallocate pre-defined spaces to better fit with their needs. This is precisely what happens, e.g., in the "Help" and "Orientation" islands, the spaces where new-born residents arrive when entering SL for the very first time. A special category of long-date volunteer residents (the Mentors) hang around in those island for lending a hand (and their tacit knowledge—Nonaka & Takeuchi, 1995) to newcomers (or newbies); nonetheless these areas have also become a place where mentors meet and enforce their mutual network relations. In the

Table 3. Several SL synthetic world distinguishing characteristics—spaces and places

SL Characteristic	**Notes/implications**
Possibility to mould spaces into places	The transition from spaces to places is easy, thanks to the high customizability of the environment (e.g., creation of mountains and rivers, definition of weather conditions and flora, design of buildings)
Private and public places	The access of SL virtual land parcels can be open to public or restricted to specific lists of residents
World Map	Both spaces and places (e.g., events) can be retrieved through a map of SL virtual geography, coupled with search capabilities
Georeferencing	Search results can be highlighted on the map
Unconstrained building	SL residents can build whatever they like in SL. No constraints (e.g., about the architectural style) exist
Multimedia contents linked to lands	Multimedia contents (e.g., music or movies) can also be defined by the users as a characteristics of a specific area (e.g., when entering a region a certain music is diffused)
Import of off-world contents	As it happens in the Web 2.0 paradigm, specific tools can be created to import/export and distribute contents from/to external applications (e.g., RSS readers)
Collaborative building	Possibility to grant or deny modify permissions on own objects and buildings to other residents

same vein, the *recombination* of places (see e.g. Aurigi & Graham, 2002) is a very frequent event in SL: shopping area are seamlessly coupled with graceful hamlets, plants of a botanical garden are also for sale, etc.

Last but not least, people using SL often experience a sort of "double belonging" that mixes together the actual and the synthetic places: as an example, residents can interact through avatars present in a synthetic places while sitting in an actual place and discussing with other residents about actual life or work life issues, as it is often the case in our workgroup at It.net, and as it happened recently, when IBM employees went on strike both in the actual and in the synthetic worlds (IBM owns several islands in SL). This behaviour matches with recent evolution (see Soukup, 2006) in the concept of online third place (see Oldenburg, 1989a; Oldenburg, 1989b; Oldenburg & Brisset; 1982), according to which online third places (i.e. online communities) are sustained by Internet technology in multiple actual places. In this situations people can bring a synthetic third place with them during their everyday life and access it from a multiplicity of actual places (home, office, third places, etc.).

The main features of SL which act as enabler for effective places creation and management are summarized in Table 3.

Conclusions and Future Developments: Identities, Relationships, and Places in Second Life

The It.net project is aimed at building a community; hence it has to approach the interplay among the three fundamental dimensions—identity, relations, and places—in a comprehensive and holistic way.

In the project, personal identity is perhaps the less analysed dimension, since it is under the direct control of each single resident and, therefore, it is quite impossible (and useless) trying to affect it. More intriguing hints tickle our interest in the remaining two dimensions, their mutual interactions and their interplay with their actual counterparts. Hence, our efforts have a double focus: building a lively social network and effectively binding it to a place. These goals require to sustain social relations and to design spaces that can be easily moulded into places.

The first issue has been addressed in several ways: in order to favour communication and linkages among people (no community can be created if not based on an existing social network—see Wenger et al., 2002) a group has been created to collect all the residents interested in the project. Several events take place on the group land: live music concerts, literary meetings, charity markets, etc. Events are promoted through different media: the group in-world private messages channel, a group blog, message boards on the group land, etc. in order to reach not only members, but also any resident potentially interested, and to give a certain visibility to the group activities. The identity of the group has been enforced by creating a logo, a netiquette and a motto matching with its mission. Moreover, communities are built also on shared knowledge (both tacit and explicit); hence, they require shared repositories of memories. SL technical infrastructure is quite lacking form this point of view, since it provides no effective tools for keeping track of communities history and poor tools for retrieval of contents. The only available alternative has been the creation of a web-based group blog equipped with RSS feeds (that are also imported in-world).

The development of the social network has been intertwined with the design of the places supporting It.net community activities. The destination of the space has undergone a detailed analysis from different perspectives, since we had to couple technical constraints (many buildings mean too many prims, which in turn create delay in the environmental rendering, resulting in a poor user-experience) with the creation of the "sense of place". It.net land contains areas:

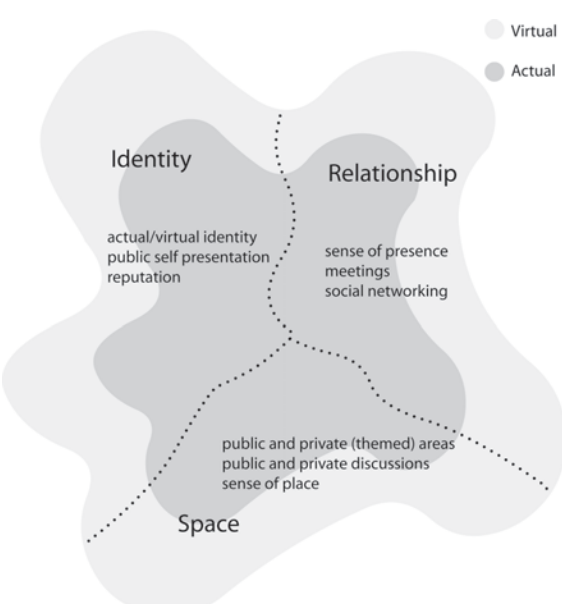
- *at a different level of privacy*: public places (connoted by the group identity), private places (teachers' houses) and semi-private places (meeting rooms accessible only to specific residents);

- *with different purposes*: some places are devoted to community activities (e.g., the amphitheatre), while other are more "institutional" (e.g., the area containing multimedia information about students' projects).

The intermediate results of the It.net project, jointly with the lessons learned from the other SL experiences we are developing, seem to support the intuition that the concept of augmentation encompasses the idea of enhancing actual world by seamlessly adding layers of digitally supported value. This form of augmentation is clearly perceivable in the synthetic world of *Second Life*, where, as outlined before, identity, relationship, and place become natural extensions of the actual world.

Thanks to augmentation, the value perceived by SL residents is increased not only along each dimension, but also by their mutual interplay. In Figure 2 we sketched the superimposed interactions that take place, on the one hand, among identity, relations and place, and on the other hand between their actual and synthetic expressions. Online identity, relation, and place extend their offline counterparts; similarly, rules that regulate their interactions behave in the same way for both the synthetic and the virtual worlds. This double circular interaction can support people actions in both worlds in an effective way, by creating a technology-enabled environment, appropriate for augmenting social interaction.

Figure 2. Relation between actual and virtual aspects in Second Life



Next steps in our research will focus on analyzing results of the It.net and the other projects under development, with a special attention to the impact of design choices on community development in synthetic world and to the differences existing among 2D (i.e. web-based) and 3D communities. Since technology-enabled communities are socio-technical systems, we will consider the impact of design choices on both aspects.

Acknowledgment

We wish to thank Andrea Spirolazzi, Francesca Piazza, and Paolo Mariotto. Without their efforts and work our investigations and knowledge of SL would have been by far less effective.

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keY ter Ms

3D chats: a real-time communication between multiple users over the Internet which occurs in 3d shaped "chat rooms" with 3d shaped "avatars".

Avatar: a representation of a real user in a virtual world. It can assume different forms (e.g., icons, 2 or 3 dimensional representations, text-descriptions) and may reproduce realistically the specific user or, on the contrary, portrait a totally-invented identity.

Cyberculture: a collection of cultures and cultural products that has emerged, or is emerging, from the use of Internet (and generally of computers) for communication, entertainment and business.

Massively Multiplayer Online Role-Playing Games (MMORPGs): an online version (played over a local network or the Internet by more than one player) of *role-playing games.* An online role-playing game can also be seen as a graphically illustrated MUD.

Massively Multiplayer Online Games (MMOGs): game type (not necessary an RPG) where several (typically several thousand) players act simultaneously in the same server based world. In order to play MMOGs users normally pay a monthly fee.

Multi-User Dungeons/Domains/Dimensions (MUDs): text-based environments in which many users are able to communicate and construct an environment in "real-time." MUDs can also be seen as a chat-room with a stabile geography and with focus on role-playing.

MUDs Object Oriented (MOOs): a particular kind of MUD operating with objects that the players/users can interact with (and sometimes alter/create).

MUVEs: online, multi-user virtual environments, sometimes called virtual worlds. This medium is born of the combination of two technologies: virtual reality and text-based chat environments such as Multi-User Domains (MUDs).

Online community: people who interact through an ICT-based communication environment, recognize a minimum common goal that holds them together, share one or more domain/s of knowledge and shared practice/s, and define implicit or explicit policies for regulating their interactions.

Virtual world: a computer-simulated environment, usually inhabited by avatars. The virtual world representation may assume very different forms (two or three-dimensional graphic landscape, text-based description, etc.). The majority of virtual worlds allow multiple users.

Chapter XXXIV
The Role of Affect in an Agent-Based Collaborative E-Learning System Used for Engineering Education

Mohamed Ben Ammar
Research Group on Intelligent Machines (REGIM), University of Sfax, ENIS, Tunisia

Mahmoud Neji
Faculté des Sciences Economiques et de Gestion, University of Sfax, Tunisia

Adel M. Alimi
Research Group on Intelligent Machines (REGIM), University of Sfax, ENIS, Tunisia

abstract

Affective computing is a new artificial intelligence area that deals with the possibility of making computers able to recognize human emotions in different ways. This chapter represents an implemented framework, which integrates this new area with an intelligent tutoring system. The authors argue that tutor agents providing socially appropriate affective behaviors would provide a new dimension for collaborative learning systems. The main goal is to analyse learner facial expressions and show how affective computing could contribute to learning interactions, both by recognizing learner emotions during learning sessions and by responding appropriately.

The question is not whether intelligent machines can have emotions, but whether machines can be intelligent without any emotions.

—Minsky

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research back Ground and Mot IVat Ion

On the one hand, with the focus on innovative and user centered interaction technologies, the interplay between emotions and computers, widely known as affective computing, "computing that relates to, arises from, or deliberately influences emotions" (Picard, 1995), plays an important role in human computer interaction (HCI). Research findings suggest that emotions play an essential role in decision-making, perception, learning and in general influence the mechanisms of rational thinking. According to Rosalind Picard: "*If we want computers to be genuinely intelligent and to interact naturally with us, we must give computers the ability to recognize, understand, and even to have and express emotions*" (Picard, 1997). On the other hand, it is often understood that the eventual objective of communication within virtual environments (VEs) is to model communication between humans in the physical world. In order to achieve this objective, communication capabilities within the virtual world must not be limited to the simple exchange of information. Everyday human communication involves a level of affective communication (communication involving emotional states) that is absent from many VEs. Many researchers now believe that *affective tutoring systems*[1] would be significantly enhanced if computers could adapt according to the emotions of learners (Alexander et al., 2004). If human emotions are essential for human thinking and learning processes, virtual learning environments must recognize this to be successful.

If VEs are to truly represent real world interactions they must both:

1. Facilitate the communication of affect, and
2. Make the agents situated in the environment react in a way that respects the affective context.

An agent that ignores these aspects of the environment will jar with the realism of the communication as much as a mechanical system that ignores the laws of physics.

Our objective in this chapter is to show that the use of affective systems is pat of an interaction problem that concerns the whole interaction cycle, where emotions arise from an active act of interpretation and participation on the end-user side. We introduce a model of interaction between users and animated agents as well as inter-agents interaction that supports the basic features of affective communication in VEs, given that detecting a learner's emotional reaction to a given situation is a fundamental element of any distant learning environment. This chapter presents an affective e-learning framework based on emotional agents that can partially replace and support human-teachers, by assisting and motivating learners in distributed learning environments (Ammar et al., 2005). We outline an approach to constructing an emotion-recognizing computer system, and present real-time results of the recognition of basic emotional expressions from the video. The system automatically detects frontal faces in the video stream and recognizes the emotion with respect to six basic facial expressions (anger, disgust, fear, joy, sadness, and surprise), as suggested by Ekman (Ekman et al., 1975).

This chapter is organized as follows: Section 2 introduces related work, Section 3 describes affective communication, Section 4 explains the proposed EMASPEL framework, Section 5 gives the application results, and finally Section 6 finishes with conclusions.

rela ted work

Psychologists have pointed out the way that emotions affect learning. According to (Piaget, 1989) affect has an accelerating or perturbing role in learning. Coles (Coles, 2004) suggests that negative emotions can impair learning; and positive emotions can contribute to learning achievement, e.g. learners can be weak in mathematics due to an affective blockage. Some educational systems have given attention to generation of emotion in pedagogical environments (emotional expression and emotional synthesis) and to the learner's emotional recognition (Conati et al., 2002), pointing out the richness presented in affective interaction between learner and tutor. We argue that socially appropriate affective behaviors provide a new dimension for collaborative learning systems, which provide an environment where learning takes place through interactions with a coaching computer agent and a co-learner (an autonomous agent that makes affective responses). One can consider affect in our framework from various angles:

- The emotional state of the learner will be modeled by an event appraisal system.
- The emotional state of the tutor is modeled as well, including values for emotions and parameters such as satisfaction, disappointment, and surprise.
- The dialogue acts come in different forms, with variation of affective values.
- Various affective parameters are used to determine which tutoring strategy to use and which instructional act to perform (sympathizing or non-sympathizing feedback, motivation, explanation, steering, etc…).

Over the last few years, researchers have worked to incorporate assessments of the learner's affect into intelligent-tutoring-system pedagogical strategies. Kort et al, for example, propose a comprehensive four-quadrant model that explicitly links learning and affective states (Kort et al., 2001). They used this model in their affective learning companion, a fully automated computer program that recognizes a learner's affect by monitoring facial features, posture patterns, and onscreen keyboard and mouse behaviors. Conati's probabilistic system in contrast reliably tracks a learner's emotions during interactions with an educational game (Conati, 2002). Her system relies on dynamic decision networks to assess the affective states of joy, distress, admiration, and reproach.

Our work is based on the following ideas:

1. Reintroducing the emotional and social context to distance communication in Collaborative Virtual Environments (CVEs) offers a stimulating and integrated framework for conversation and collaboration (Neji et al., 2007). Learners can become actively engaged in interaction with the virtual affective world.
2. The use of avatars with emotionally expressive faces is potentially highly beneficial to communication in collaborative virtual environments, especially when used in an e-learning context. Given this, an avatar head model, with limited but human-like expressive abilities, was designed to enrich CVE communication (Fabri et al., 2004). This is the objective of introducing an Emotional Embodied Conversational Agent (EECA), based on the PECS (Physical Conditions, Emotional state, Cognitive capabilities and Social status) model proposed by (Schmidt, 2000). We are the first researchers to integrate this model in an embodied agent.
3. Finally we combine peer-to-peer topology and e-learning together in a framework for an intelligent affective system, called EMASPEL (Emotional Multi-Agents System for Peer-to-peer E-learning) (Ben Ammar et al., 2007).

The following discusses the social logic that can render affective behaviors in software agents in a collaborative learning system. The work described considers the implementation of a facial expression recognition system based on intelligent agents that can analyze facial images and automatically classify them into particular types of expressions.

AFFECTIVE COMMUNICATION

DESCRIPTION

In our e-learning framework, the affective communication in the group of learners needs the real time assistance from a tutoring agent or others learners based on automatic Query By Emotion (QBE). In this section, one will explain the following two manners of intervention:

- **On behalf of the learner:** After detection and recognition of the facial expression (Emi) of learner (Li) in time (Ti) by emotional agents, the identified emotion will be sent to EECA which propagates it to the other EECA in the form of universal emotional message; which contains the encountered difficulty. If one learner can help him, he formulates his message of assistance and sends it with his EECA. (cf.Figure 1)
- **On behalf of the tutor:** The tutor intervenes, if the emotion in question corresponds to a difficulty encountered by the majority of learners. In this context - under the management of the curriculum agent, the tutor must reformulate the question and/or provide other explanations. (cf.Figure 2)

a ffective Modeling

Since 1970 much research has been carried out to specify the criteria of cognitive evaluation (appraisal) implied in the differentiation of the emotions (Frijda, 1972; Scherer, 1988; Ortony, 1988; Roseman, 1991; Elliot, 1992). The theory of appraisal aims at explaining what distinguishes an emotional experience from another type of experience and what differentiates an emotional experience, like fear and sadness. The majority of the recent theories regard emotions as a poly-factorial dynamic process made up of at least five components: cognitive activity, motor expression, physiological arousal, action tendencies, and subjective feeling states.

In order to produce an emotion for each level, many researchers have hypothesized that specific emotions are triggered through a series of stimulus evaluation checks (SECs) (Scherer, 1984; Scherer, 1999). We link the SECs system, that performs the emotion components' check in the internal state of the EECA to generate the appropriate emotion, with the emotional agents for recognizing the suitable expression giving by the learner. As a consequence, the SECs will be used in the input and output of our EECA (cf. Figure 4)

Figure 1. Communication of the emotion (Emi) and assistance from learners

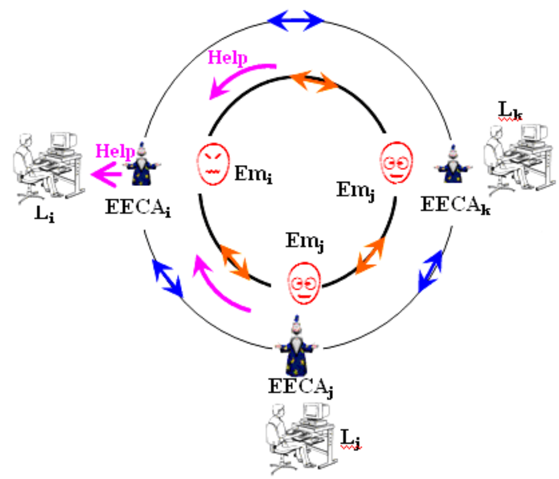
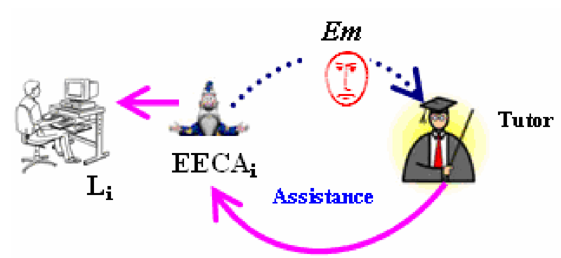


Figure 2. Communication of the emotion (Emi) and assistance from Tutor



e motional c oncept o ntology

A verbal dictionary can be described as a tool that aims at providing a partial solution for the problem when two persons do not speak the same language. In this case, one begins the conversation and keeps speaking; meanwhile the other concentrates just on looking for the meaning of the words of one's language. A nonverbal dictionary has the same concept of a verbal dictionary, but it differs in the type of information that is stored. Instead of words, a nonverbal dictionary contains information about all the ways that people communicate with each other nonverbally, such as facial expressions in our case, to construct the emotional ontology.

This is an extension of previous work named FED (an online Facial Expression Dictionary) (Jongh, 2002) concerning a nonverbal dictionary. We only focus on that part of FED which allows the learner to send his picture. FED requires that the learner himself locates manually his face and facial characteristic points (FCPs). After manually selecting and submitting the points, an emotional word (happiness, sad, etc.) will be output. Thus, FED lacks the ability of automatic extraction of facial characteristic points that are needed for the facial expression recognition process. In the current situation, interaction is needed to complete the whole procedure. In our system, the emotional ontology (Cowie et al., 2005) covers the major role that helps the emotional agents to distinguish emotions. These knots symbolize features of a current emotion: distances.

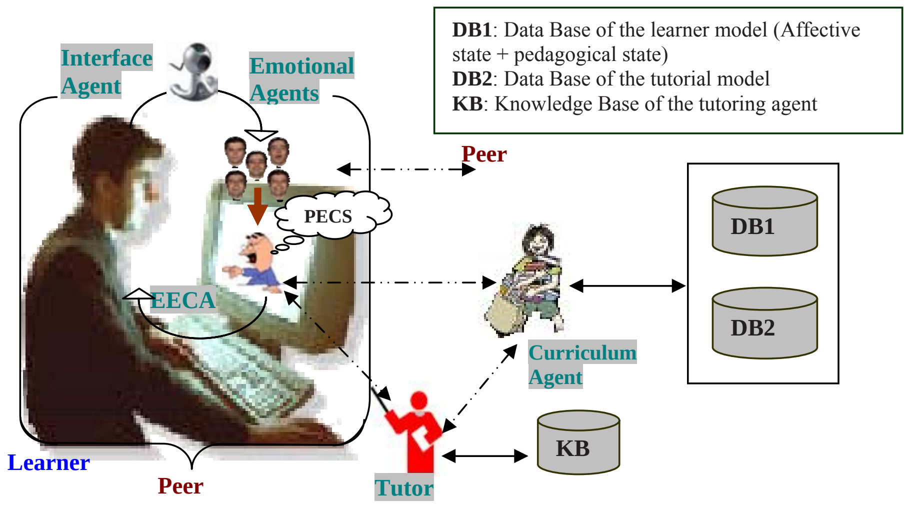
the Pro Posed Fra Mework

An Intelligent Tutoring System (ITS), like a human tutor, is a computer-based educational system that provides individualized instructions. A traditional Intelligent Tutoring System which is based on learner pedagogical state, decides how and what to teach. However, it has been demonstrated that an experienced human tutor manages the emotional state (as well as the pedagogical state) of the learner to motivate him and improve the learning process. Therefore, the learner model structure needs to be augmented to include knowledge about the affective state. The ITS needs the ability of reasoning about the affective state to provide learners with an adequate response from a pedagogical and more precisely affective point of view; that's why we require the affective e-learning system which it has two main functions: i) to infer the affective learner state; and ii) to establish the optimal tutorial action considering the learner affective state. In this way, our proposed framework (Figure 3) improves learning within our virtual learning environment by means of a more personalized environment through recognizing the learners' affective state with the aim of reacting appropriately from a pedagogical and affective point of view. The affective system considers the learner affective state and the tutorial situation to establish the affective action (via the EECA). The affective action helps the tutor to establish the next pedagogical action based on the knowledge base (KB), and it also helps the curriculum agent to establish the physical realization of the pedagogical action based on the DB1 and DB2. So the learner receives a tutorial action with an affective and a pedagogical component, which is our main contribution in this research. The other novelty of our research is the use of the multi-agent methodology, which can bring several advantages to the development of e-learning systems, since it deals with crucial application issues like distance, cooperation among different entities and integration of different components of software. As a result, multi-agent systems, combined with technologies of networking and telecommunications, bring powerful resources to develop the affective e-learning systems. So, in this research work, we propose affective framework for an intelligent affective system (Neji et al., 2007). This framework is called EMASPEL (Emotional Multi-Agents System for Peer-to-peer E-Learning) (Mahmoud et al., 2007), in which we have integrated five kinds of agents (Interface agent, emotional agents, EEC agents, curriculum agent, and tutoring agent) in order to promote a more dynamic and flexible affective communication between the learner and the affective system.

emotional embodied conversational agent

With recent advances many researchers have proposed the mechanisms of incorporating emotion into BDI (Belief, Desire, and architecture Intention) such as (Pereira, 2005), who presents an Emotional-BDI architecture including internal representations for agent's capabilities and resources. However, this chapter does not represent the difference between emotional agents and normal rational agents. The capabilities and resources themselves are independent of emotions, they cannot reflect the relationship

Figure 3. EMASPEL architecture



between emotions and beliefs or how emotions influence agent's decision making. Another effort to incorporate emotions into a BDI architecture is given in (Parunak, 2006). They enhance the standard BDI model using the OCC (Ortony, Clore, Collins) model of emotion (Ortony, 1988) in a framework that can support large numbers of combatants. However, it is not a generic model. The last effort is the architecture presented by (Jiang et al., 2007), which does not consider the dynamic change of the affective state according to human behavior, but takes into account both primary emotions and secondary emotions in decision making process and generates a conceptual emotional model based on the BDI agent architecture called the Emotional-BDI (EBDI) architecture. Although, some researchers have tried to expand traditional agents by adding emotion to them, but a universal accepted generic model or architecture for emotional agents has not yet appeared. This is the objective of our work but not based in the BDI architecture (Rao, 1995). Restriction to the factors of belief, desire, and intention is simply not appropriate for sophisticated models of real systems where human factors play an important role.

We developed the internal state of the EECA based on the PECS model because agents are virtual human beings. They are designed to imitate or model human behavior. Human behavior is complex with many-sides. Nevertheless, it is possible to argue that human behavior can within limits be modelled. Physical, emotional, cognitive, and social factors occur in all forms of human behaviour, so approaches, which regard human beings exclusively as rational decision makers are of limited value. The modelling of human behavior plays an important role in all areas in which action planning, decision making, social interacting and suchlike play a part. These are the four main building blocks of a particular PECS agent architecture adding a Sensor- Perception module and a behavior-actor module. (cf.Figure 4) PECS's agent model consists of three horizontal layers:

1. **Information Input Layer:** This layer processes the input taken from the agent environment and consists of two components: The Sensor and Perception components. The sensor component takes the external data by means of a set of sensors and the Perception component filters the irrelevant data and processes the information. The perceptions are used to update the mental state of the agent or for learning purposes.
2. **Internal Components Layer:** The personality of the agent is modeled at the second layer.

Thus, the parameters of this second layer are crucial to find out the response of the agent to the input taken by the information layer. They consist of four components: Physics, Cognitive, Emotional, and Social Status. The physical and material properties of the agents are modelled in the Physical component. The emotions that can affect the behavior of the agent are modelled as part of the Emotional component. The agent's experience and knowledge are part of the Cognitive component and finally the social features of the agent (e.g., whether the agents like to socialize or they prefer to be alone) are described in the social status component.

3. **Agent Output Layer:** This layer is in charge of modelling the set of possible actions and the selection process, and thus it produces the response of the agent and consists of two components: The behavior and actor components. The behavior Component selects the actions that are associated with the input information that reaches the agent and the agent's response is based on its internal parameters. The actor component takes the actions and executes them. The PECS architecture is not based on any social or psychological theory. The architecture is mainly an integrated model in which several fundamental aspects to human behavior and decision-making process are taken into account (Miranda et al., 2005). The purpose of the emotional agents consists of extracting the learner's facial expressions (acquisition and facial alignment) and subsequently categorizing them using the temporal evolution of distances Di as it is demonstrated in Table 1.

The analysis of Table 1 shows that it will be possible to differentiate between different emotions while being interested in priority in the Di distances which undertake significant modifications. Indeed, there is always at least one different evolution in each scenario.

EECA is made up of three layers (modules) (cf. Figure 4): the first one (perception layer) captures and extracts the facial expressions (image acquisition and face tracking) and proceeds to its categorization (classification) via the emotional agents, that will give him the facial expression detected on the current affective state of the learner. The second one (cognition layer) analyses and diagnoses the perceived learner's emotional state. The third one (action layer) takes decision on remedy pedagogical actions to carry out in response to the actual emotional state. Tutoring agent is then informed and may access information in the new affective state to adapt the current tutoring flow accordingly. The cognitive layer includes two main processes named analysis and diagnosis.

The EECA first carries out an analysis of the emotional state of the learner. The purpose of this analysis is to translate the meaning of the emotion in the training context. Its achievement is based on several factors such as the emotion sent by the emotional agents, the current emotional profile, the history of the actions carried out before the appearance of the emotion, the cognitive state, the evolution of the emotion and the social context (if it is about a social training or collaborative). The expressions in input are "joy", "fear", "dislike", "sadness", "anger", "surprise" and the analysis make it possible to conclude if the learner is in state of "satisfaction", "confidence", "surprise", "confusion" or "frustration". The interpretation of the analyzed emotional state is then established. It will consequently determine the causes having led to this situation (success/failure with an exercise, difficulty of work, missed knowledge, etc), and thus allow to the tutor to take, if necessary, suitable teaching actions. The role of the action layer is to define, if necessary, the tasks that can remedy the observed emotional state in order to bring the learner in a state more propitious to the knowledge's assimilation (cf.Figure 4). For this reason a collaborative reciprocal strategy in ITS can gain advantage from "mirroring" and then assessing emotions in peer-to-peer learning situations.

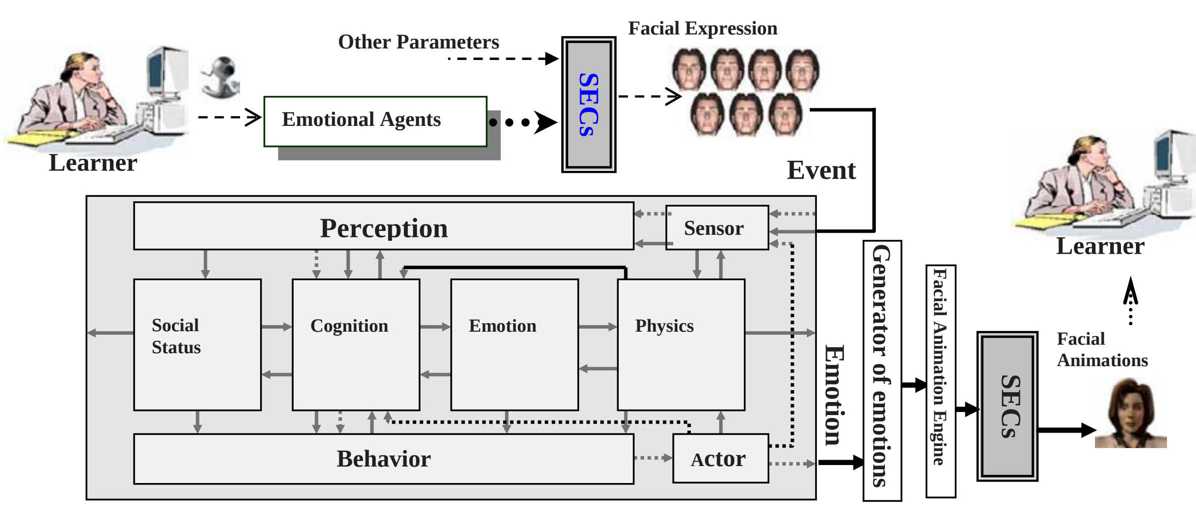
Figure 4 shows an agent-based virtual character whose purpose is to stimulate cooperative learning among learners by motivating their interaction and mutual assistance with the focus on the affective state dimension. The affective virtual character (EECA) was integrated to a learning environment and communicates with the learners in verbal and non verbal language such as facial expression, suggested readings according to the activities being performed (cf.Figure 4). When a learner needs assistance to learn a given topic, the EECA is capable of finding other learners that may play the role of a tutor after recognizing and processing affective state via the emotional agents. In the case that the EECA has not found the appropriate learner, this request can be addressed to the tutor for explanations and/or remarks. This involves roles **R7**, **R8** (see Figure 10).

t he e motional a gents

Facial expression is a fundamental carrier of emotional information and is used widely in all cultures and civilizations to express as well as perceive emotion. In addition, to make effective communication between an EECA and a learner, they need to be able to identify the other's emotion state through the other's expression and we call this task emotion identification established by the emotional agents. Extracting and validating emotional cues through analyzing the learner's facial expressions is of high importance for improving the level of interaction in man-machine communication systems. Extraction of appropriate facial features and consequent recognition of the learner's emotional state that can be robust to facial expression variations among different learners is the topic of these emotional agents.

The emotional agents have been successfully integrated in a learning environment and aim at capturing and managing the emotions expressed by the learner during a learning session, see **R5** Figure 10. They recognize the learner's emotional state by capturing emotions that he or she expresses during learning activities and send it to the EECA (Nkambou, 2006), see **R6** Figure 10. Developing a system that interprets facial expressions is difficult as two kinds of problems have to be solved: facial expression feature extraction and facial expression classification. Facial features' extraction uses a standard webcam and requires no specific illumination or background conditions. Emotional classification is based on the variation of certain distances from the neutral face and manages the six basic universal emotions of Ekman. An overview of the proposed methodology is illustrated in Figure 5

Figure 4. A full emotion engine architecture



Facial Expression Feature Extraction

First of all, the algorithm which is based on the YCbCr[2] space automatically detects the learner's face (cf.Figure 6.a). The (Figure 6.b) shows examples of the images for which the proposed algorithm could correctly detect the irises of both eyes. The components Cb and Cr offer the advantage of being a little sensitive to the variations of luminosity. Then, it is possible to define the initial learner's face region to start the search of the learner's facial features (cf. Figure 7) which are based on the pattern recognition algorithms described in details in (NEJI et al. 2004) to extract the contours of the eyes, the eyebrows, and the mouth. The goal was to find suitable accuracy to speed rate. Many methods were implemented in MATLAB and accuracy rate was tested on The MIT-CBCL face recognition[3] database and on the Faces96 database (C)Libor Spacek, 1996[4] and differ from the others algorithms, for instance, those of (Zakharov et al., 2007) with variation of background and scale, versus extreme variation of expressions and with multiple or single faces.

Facial Expression Classification

Facial expression classification is a classic example of a problem that is relatively easy for humans, but difficult for computers to solve. In this section, we describe a novelty approach to the problem of rapid facial expression classification. The classification is based on the analysis of the distances computed on face's skeletons. At this stage, it is assumed that an image of the learner at neutral expression is available. The distances considered make it possible to develop an expert system (for classification) which is compatible with the description MPEG-4 of the six universal emotions. The segmentation step leads to obtain what we call skeleton of expression. Six distances were defined: D1: opening of the eye. D2: outdistance between the interior corner of the eye and the eyebrow. D3: opening of the mouth in width. D4: opening of the mouth in height. D5: outdistance between the eye and eyebrow. D6: outdistance between the corner of the mouth and the external corner of the eye (cf.Figure 8).

- **Joy:** {D4 increases}, {D3 decreases and D6 decreases}, {the other distances remain constant}
- **Sadness:** {D2 increases and D5 decreases}, {D1 decreases}, {the other distances remain constant}
- **Anger:** {D2 decreases}, {D1 increases}, {D4 either decreases D4 increases}
- **Fear:** {D2 increases and D5 increases but more that D2}
- **Disgust:** {D3 increases and D4 increases}, {the other distances remain constant}
- **Surprised:** {D2 increases}, {D1 increases}, {D4 increases}, {the other distances remain constant}

Figure.5. Diagram of the proposed methodology

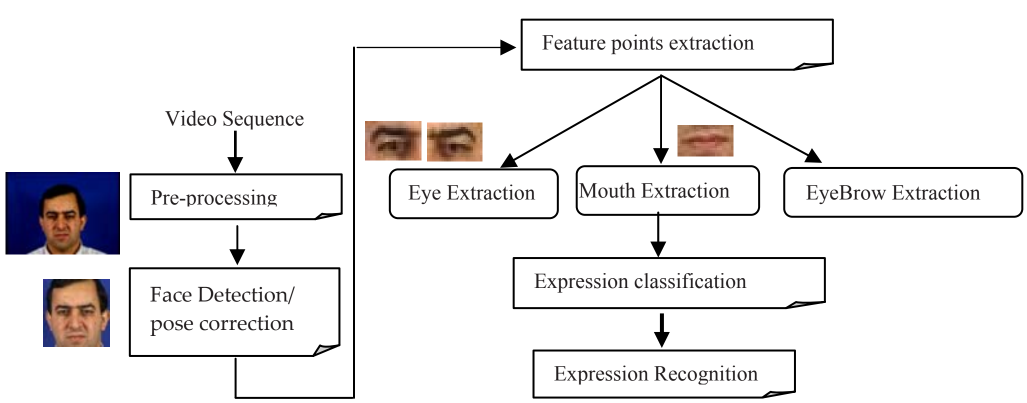


Table 1 gives a script of evolution of the distances Di for the six emotions (↑means increase,↓ means decrease and " = " translates the absence of evolution). Notice that for the fear, we do not make any hypothesis on the evolution of D1 because we do not know how to translate the condition {in state of eye contraction and alert}.

The classification of an emotion is based on the temporal evolution of the information contained in the "skeleton" resulting from this stage of segmentation (temporal evolution of six characteristic distances). For example, joy and disgust differ by the evolution of the distance D6. One notes that emotions (joy and surprise) differ by the evolution of distances D1, D2, D3 and D6. This allows a distinction between these two emotions.

Figure.6.a. Examples of robust face detection

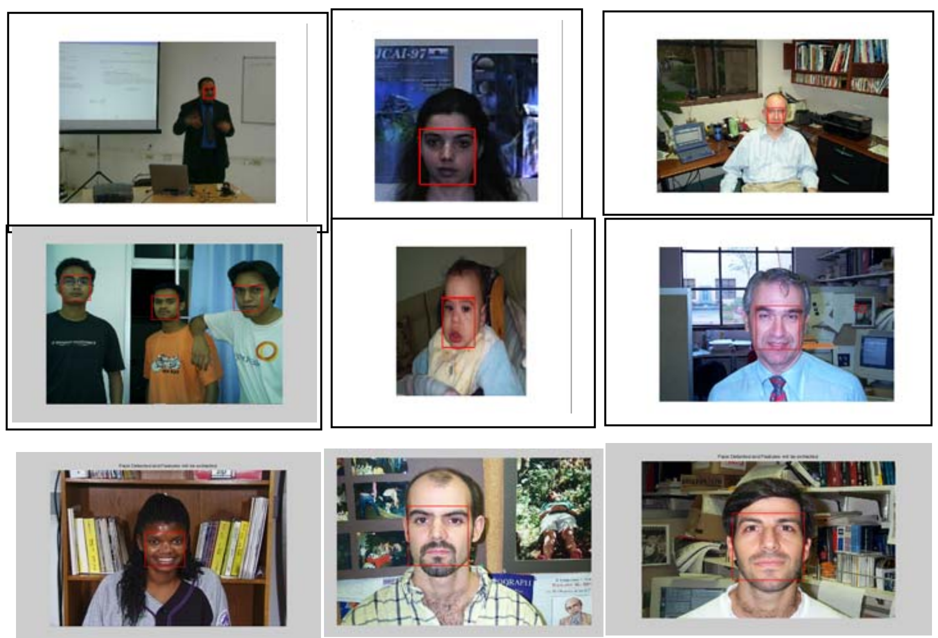
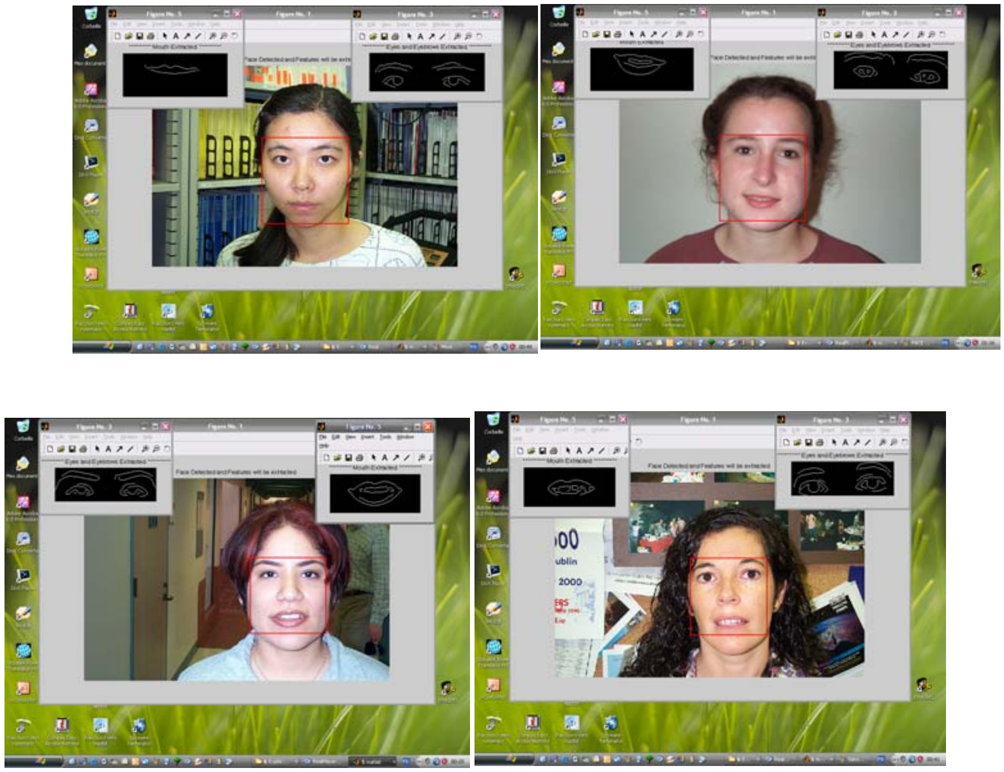


Figure 6.b. Examples of eyes detection

Figure 7. Examples of robust facial feature extraction (Eye, Eyebrows, and Mouth) after face detection



Curriculum Agent

The agent Curriculum saves the trace of the evolution of the system in interaction with the learner. The trace constitutes the history of progression of the learner in the exercise. While analyzing the profile of the learner, this agent proposes sessions of activities subsequently to apply. Our novelty is to add in the learner model the affective state of the learner during the learning session, see **R9** Figure 10. The learner model must contain knowledge about the affective state of the learner, in addition to knowledge about his pedagogical state, in order to give him an affectively adequate response and at the pedagogically appropriate time.

The agent curriculum carries out the following operations:

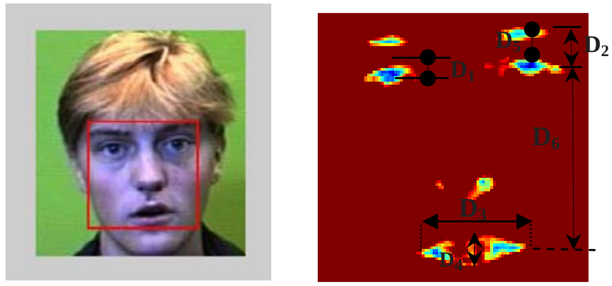
- To save the learner model and manage the tutorial model.
- To initialize the session of training by communicating the exercise to the learners according to their model and their competencies

Tutoring Agent

The tutor's role, see **R10** Figure 10, is:

- To ensure the follow-up of the training of each learner;
- To support learners in their activities;
- To support the human relations and the contacts between learners;
- To seek to reinforce the intrinsic motivation of learner through its own implication from the guide who shares the same objective. These interventions aim at the engagement and the persistence of learner in the achievement from its training;
- To explain the method of training and to help to exceed the encountered difficulties;
- To help learner how to evaluate his way, his

Figure 8. Definition of the distances Di



needs, his difficulties, his rhythm and his preferences;

The tutoring agent achieves pedagogical expertise on the learner because it has knowledge taught on the field (theoretical knowledge and practical skills). Its diagnoses are based not only on the session learning courses, but also on the learner historic actions. It may make requests to the model of the learner (through the Curriculum agent) to find out the history and proceed to the necessary strategy. In the diagnoses, the tutoring agent is based on the results of evaluations provided by the Curriculum Agent, as well as indications of EECA (which provides information on the emotional state of the learner). These data are analyzed to decide the need for its urgent intervention mainly due to a situation of panic or stress (or stop using the simulation) and save all diagnoses for later use. At the end of the e-learning session it updates assessment curves, calculates the final score, delivers its report and then takes the decision on the next exercise to achieve.

Table 1. D_i evolution for every emotion

	D1	D2	D3	D4	D5	D6
Joy	=	=	↑	↑	=	↓
Sadness	↓	↑	=	=	↓	=
Anger	↑	↓	=	↑or↓	=	=
Fear	?	↑	=	=	↑	=
Disgust	=	=	↑	↑	=	=
Surprise	↑	↑	=	↑	=	=

Interface a gent

The role of the interface agent is

- To mediate between the human and the computer cyberspace and to be capable of personalizing an interface by monitoring and sensing individual's capabilities, interests and preferences.
- To be a service agent with a particular role. It can communicate and negotiate with other agents in a multi-agent system to determine which and how services should be provided.
- To transmit the facial information coming from the learner to the other agents of the Multi-Agents System (MAS).
- To assign the achieved actions and information communicated by the learner **(R1)**, to curriculum agents **(R4)**, EECA **(R3)** and the emotional agents **(R2) (**see Figure 10).

resul ts

t he interaction a mong a gents

The interaction among human agents is not restricted to the proposed computational model. On the contrary, the computational interaction among the artificial agents aims at contribution even more for the communication and the exchange among the human agents. The interaction will be one of the main goals of this model because the proposal is about a model of collaborative learning. The several interaction forms involved in the model are interaction among artificial agents, interaction among artificial and human agents, and interaction among human agents. In respect to communication among the human agents, the system offers tools (synchronous or asynchronous) when physical presence is not possible (for example, in the case of virtual classes).

the organizational Model

Our organizational model (OM) (cf.Figure 9) is based on the Agent Group Role Meta model (AGR for short) (Ferber et al., 2003). This Meta Model is one of the frameworks proposed to define the organizational dimension of a multi-agent system, and it is quite appropriate to the e-learning context. According to

Figure 9. The UML meta-model of AGR (Ferber et al., 2003)

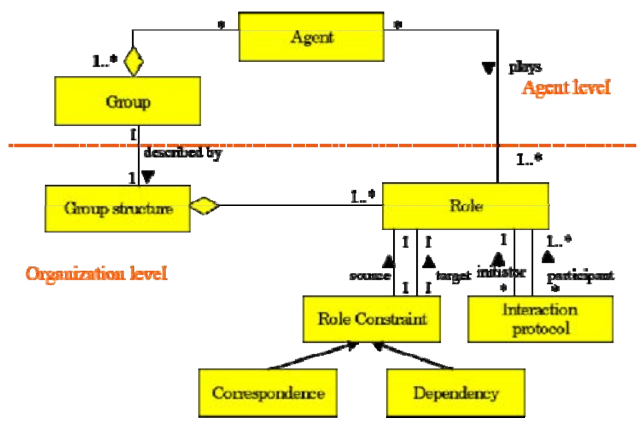
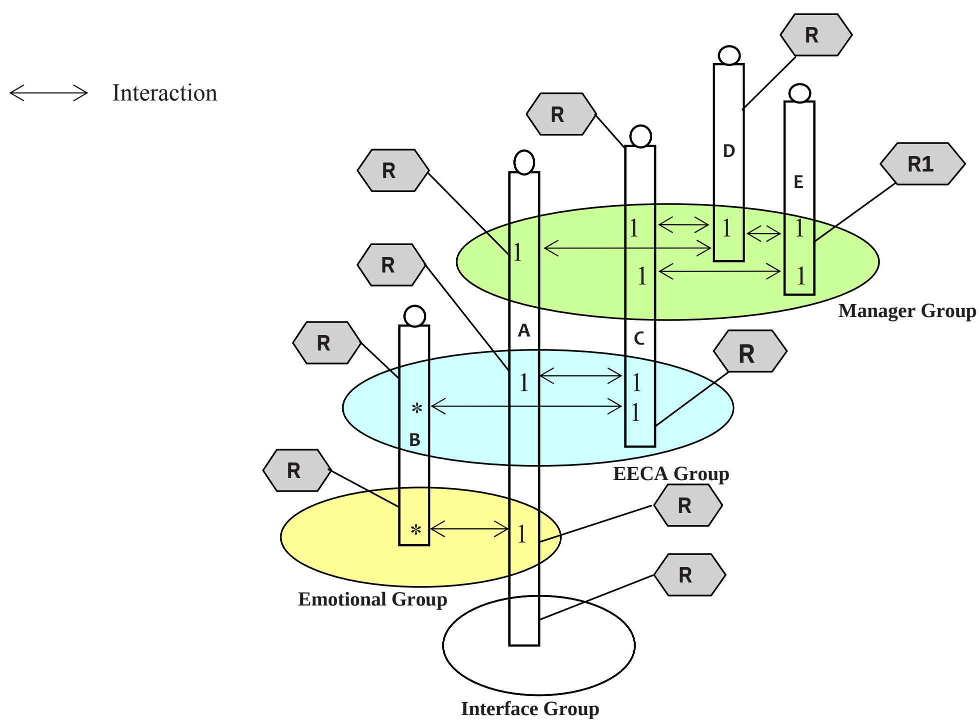


Figure 10. The EMASPEL organizational model



this model, the organization of a system is defined as a set of related groups, agents and roles:

- An agent is defined as an active-communicating entity.
- A group is defined as a set of agents.

A role is defined as "an abstract representation of an agent function, service or identification within a group": the role encapsulates the way an agent should act within a group. Roles are local to groups. An agent can simultaneously play different roles in different groups which can freely overlap. An agent can enter or leave groups by acquiring or resigning a role. The AGR Meta model is represented in Figure 9 with the language of modelling UML.

There are several reasons which justify the interests of this Meta Model. The main reasons are:

1. it is possible to construct secure systems using groups viewed as "black boxes" because what happens in a group cannot be seen from agents that do not belong to that group. (
2. it is possible to construct dynamic components of system when we view the system as an organization where agents are components. Adding a new group or playing a new role may be seen as a plug-in process where a component is integrated into a system.
3. Semantic interoperability may be guaranteed using roles because a role describes the constraints (obligations, requirements, and skills) that an agent will have to satisfy to obtain a role.

For platform EMASPEL, the Organizational Model comprises the following elements (cf.Figure 10):

- Five types of agents that are represented by candles: an agent interface (**A**), emotional agents (**B**), an EECA (**C**), the curriculum (**D**) and the tutoring agent (**E**).
- Four types of groups which are represented by ellipses: Interface, Emotional, EECA and Manager.
- Ten roles (R1-R10), as every agent plays a specific role in the group which is involved. Graphically, a role lies at the intersection of a candle and an ellipse. Multiplicity in a role is represented by a star.

Implementation

We developed agents, used in the EMASPEL framework (cf.Figure 11) with the MadKit Platform (Ferber et al., 2005). MadKit is a modular and scalable multi-agents platform written in Java and built upon the AGR (Agent/Group/Role) organizational model (Ferber et al., 2005): agents are situated in groups and play roles. We plan to extend the proposed framework to integrate the new AGRE (AGR + Environment) model, which includes physical (or simply geometrical) environments. MadKit allows high heterogeneity in agent architectures and communication languages, and various customizations. In fact, MadKit does not enforce any consideration about the internal structure of agents, thus allowing a developer to freely implement his own agent architecture. Communication among agents is implemented by a set of communication primitives, which is a subset of FIPA-ACL extended with specific primitives (FIPA, 2004). We used the JXTA[5] Framework to build an open source peer-to-peer network.

The proposed system to recognize facial expressions using an agent-based approach is presented in Figure 11.

It involves the following:

- The learner begins the learning session by login (Figure 11A). The Emotional Agents launch detecting of the learner's face and extracting the Mouth, Eyes and Eyebrows to recognize the emotion. (Figure 11E): The proposed system to recognize facial expressions using an agent-based approach utilizes interaction between Matlab-based image processing and a MadKit based agent implementation.
- Then the curriculum agent gives the course and the exercise according to the learner model (Figure 11B)

Figure 11. EMASPEL System

- The learner can communicate with other learners or with the EECA and the tutor can give suggestions or remarks. (Figure 11C)
- The learner can after that do exercises and answer questions. The emotional agents recognize affect state and accordingly; the tutor and the EECA express give explanations. (Figure 11C,D)
- Finally the tutoring agent shows the learner the final report and saves it in the learner model. (Figure 11F)

conclus Ions and Future work

Learning process implies socio-emotional aspects as well as cognitive aspects: a real world teacher observes the student's behavior to detect affective responses, which can express interest, excitement, confusion, etc. and hence change the actual interaction flow. This chapter presented an Intelligent Tutoring System (ITS) equipped with emotional management capabilities, which make the capture of learner's emotions possible during learning and affective response to learners' actions. We proposed a multi-agent system with agents that manage both cognitive and affective model of the learner and that are able to express emotions through embodied agent. Our interest to integrate emotional embodied conversational agents (EECAs) in ITS is motivated by the use of animated agents in computer based learning environments as a tutoring paradigm can be beneficial, increase the learner's motivation and with the main purpose of stimulating cooperative learning among learners. The goal of looking at facial expressions during tutoring sessions is to get information about the learner that may be useful to know for the system in order to adapt its teaching strategy. We have implemented our affective e-learning framework (EMASPEL) in order to validate the quality and exactitude of its prediction based on the recognition of emotional information with the completely automated real-time system for facial expression's recognition based on facial features' tracking and a simple emotional classification method. Facial features' tracking uses a standard webcam and requires no specific illumination or background conditions. Emotional classification is based on the variation of certain distances from the neutral face and manages the six basic universal emotions of Ekman.

As far as future work is concerned, we plan to consider the recognition of gestures jointly with face expressions corresponding to certain emotions. Several applications in the systems of communication between the learner and the systems of communication may be improved by incorporating the information from the gesture and face signs.

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KEY TERMS

Affective Computing: is the Science of automatic understanding of human emotions, and providing tools and machines that can respond to these emotions.

Emotion: in its most general definition, is a complex psychophysical process that arises spontaneously, rather than through conscious effort, and evokes either a positive or negative psychological response or physical expressions, often involuntary, related to feelings, perceptions or beliefs about elements, objects or relations between them, in reality or in the imagination.

Emotional Agents: Emotional agents are intelligent agents responsible for the recognition of the facial expression of the learner. Extracting and validating emotional cues through analysis of users' facial expressions is of high importance for improving the level of interaction in man machine communication systems. Extraction of appropriate facial features and consequent recognition of the user's emotional state that can be robust to facial expression variations among different users is the topic of these emotional agents.

ECA (Embodied Conversational Agent): Embodied agents are agents that are visible in the interface as animated cartoon characters or animated objects resembling human beings. Sometimes they just consist of an animated talking face, displaying facial expressions and when using speech synthesis, having lip synchronization.

EMASPEL: Emotional Multi-Agents System for Peer-to-peer E-learning. The first version was in 2006.

Facial Expression Recognition: Extracting and validating emotional cues through analysis of users' facial expressions is of high importance for improving the level of interaction in man machine communication systems. Extraction of appropriate facial features and consequent recognition of the user's emotional state that can be robust to facial expression variations among different users is the topic of this chapter.

Peer-to-Peer (P2P) Networks: Over the past few years, peer-to-peer (P2P) networks have revolutionized the way we effectively exploit and share distributed resources. In contrast to the traditional client-server architecture, P2P systems are application level, collaborative systems where agents work together to perform certain tasks.

Peer Learning: An alternative to the one-on-one strategy, co-operative strategies comprise an additional element, namely peer interaction. Co-operative learning systems, called also social learning systems, adopt a constructive approach using the computer more as a partner then as a tutor. Multiple agents that are either computer simulated or real human beings can work on the same computer or share a computer network. The e-learning community is increasingly recognising the importance of students learning from their study peers. When peers come together in a learning context they form an Online Learning Community.

endnotes

1 The term "Affective Tutoring System" was first used by (Alexander, 2003)

2 YCbCr color space : YCbCr color space is widely used for digital video. In this format, luminance information is stored as a single component (Y), and chrominance information is stored as two color-difference components (Cb and Cr)

3 B. Weyrauch, J. Huang, B. Heisele, and V. Blanz. Component-based Face Recognition with 3D Morphable Models, First IEEE Workshop on Face Processing in Video, Washington, D.C., 2004

4 http://cswww.essex.ac.uk/mv/allfaces/faces96.html

5 JXTA is a set of open protocol specifications that makes it possible for virtually any kind of electronic device (from cell phones to PCs) to communicate with other such devices in a Peer-to-peer way. (Gradecki, 2002): Mastering JXTA: Building Java Peer-to-peer Applications.)

Chapter XXXV

Gaze-Aided Human-Computer and Human-Human Dialogue

Pernilla Qvarfordt
FX Palo Alto Laboratory, USA

Shumin Zhai
IBM Almaden Research Center, USA

abstract

Eye-gaze plays an important role in face-to-face communication. This chapter presents research on exploiting the rich information contained in human eye-gaze for two types of applications. The first is to enhance computer mediated human-human communication by overlaying eye-gaze movement onto the shared visual spatial discussion material such as a map. The second is to manage multimodal human-computer dialogue by tracking the user's eye-gaze pattern as an indicator of user's interest. The authors briefly review related literature and summarize results from two research projects on human-human and human-computer communication.

The eyes of men converse as much as their tongues, with the advantage that the ocular dialect needs no dictionary, but is understood all the world over.

—Ralph Waldo Emerson, 1860

Introduct Ion

Increasingly, people are working and socializing in distributed groups that seldom, if ever meet face to face. When conversing face to face, we use a range of non-verbal behavior, such as eye-gaze, to complement and enhance our speech. When using communication technology of today, these non-verbal behaviors are either completely lost, or distorted, as in the case of gaze in video conferences, so that they become hard to interpret. This chapter describes two related novel paradigms for

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using one channel of non-verbal behavior, eye-gaze, to enhance effective communication.

In the first paradigm, designed for computer mediated human-human communication, the conversation partner's eye movement is directly superimposed onto the visual-spatial material being discussed, such as a map, so that one party can not only hear what the other party says, but also where the other party is looking. In the second paradigm, designed for improving multimodal human-computer dialogue, the computer utilizes the information of its user's eye-gaze pattern on the computer screen to initiate or manage the human-machine dialogue. The first paradigm can be useful in itself, but the knowledge gained in studying it can also inform the design of the second paradigm, as well as other collaborative systems. This chapter is organized accordingly. We first present the development and experimentation of a simulated tourist consulting service, RealTourist, which allows a tourist to talk to a remote tour consultant to plan a conference trip. The tourist and the consultant see the same map displayed on their monitors respectively. On the consultant's side the system also superimposes the tourist's eye-gaze onto the map, so the consultant could use it to determine the tourist's interest. Later we present the design, implementation, and a user study of an automatic tourist information system, iTourist, which automatically provides the user with city tour information in the form of a map, photos of different places, and synthesized speech. iTourist directs its information output based on the user's interests and needs analyzed from the user's eye-gaze pattern. Finally, we discuss the implications of the findings from these two paradigms for future collaborative system to enhance communication between groups of people and for future research directions.

Ga Ze and con Versa t Ion

In face-to-face conversation, much can be intuitively felt from the conversational partners' eye-gaze—whether they are interested or bored, attentive or preoccupied, engaged or unmindful, in doubt or in agreement, wanting to continue or trying to finish the conversation. Indeed, research has confirmed that eye-gaze plays an important role in face-to-face conversation. It enables us to assess a conversational partner's understanding, what he or she is looking at, and his or her feelings (Argyle & Cook, 1976).

Gaze plays a particularly important role in face-to-face communication when it comes to regulating the turn-taking behavior in a conversation. Gaze is used to signal if the speaker is about to hand over the turn, if he or she will continue after a pause, or if the speaker expects some feedback from the listener (Bavelas, Coates, & Johnson, 2002; Kendon, 1967). When two people attempt to take the turn simultaneously, gazes are used to resolve who should have the turn (Duncan & Niederehe, 1974). Beyond turn-taking, gaze is also used for emphasizing particular words or phrases, and aversion of gaze indicates lack of interest or disapproval (Argyle & Cook, 1976). The use of gaze is also related to the content of speech. Cassell, Torres, and Prevost (1999) has showed that when the speaker starts a new topic with a new utterance, he or she looks at the listener. When the speaker is pursuing an old topic, the speaker looks away at the beginning of the turn. When the utterance is a request, gaze is used to make sure that the addressee understands that he or she is supposed to listen (Goodwin, 1980, 1981). Similar pattern have been found when a person gives commands to an interactive object (Maglio, Matlock, Campbell, Zhai, & Smith, 2000).

The benefit of seeing a communication partner's eye-gaze has motivated many well known Computer Supported Collaborative Work (CSCW) design solutions. For example, Buxton (1990) used a half-silvered mirror to optically align a camera with a video screen to enable eye contact ("video tunnelling"). Vertegaal (1999) used virtual faces (avatars) that could rotate depending "who is talking to whom." Although research in face-to-face communication indicates that gaze serves an important function in communication, it has not been easy to empirically demonstrate the impact of preserving gaze in remote collaboration. For example, both Ochsman and Chapanis (1974) and Sellen (1995) could not find any large impact of preserving gaze in teleconferencing on task completion time. It is known that when conversational partners can not see each other, they compensate for the lack of visual feedback of the partner's face with more verbal feedback (Boyle, Anderson, & Newlands, 1994). However, this does not mean that the participants' experience of the communication situations were the same. For instance, Sellen (1995) noted that the participants experienced a higher degree of social presence when the partner's face was mediated through video, as compared to audio only. The experience of trust between the communication partners has also shown to be affected by the presence of gaze (Bos, Olson, Gergle, Olson, & Wright, 2002), and how well the gaze-direction is preserved in a video conference setting (Nguyen & Canny, 2007).

For tasks that involve visual spatial information, research suggests that a shared view of the workspace is more important than a view of the partner's face or gaze (Clark & Krych, 2004; Kraut, Gergle, & Fussell, 2002). People tend to look more at the shared workspace than at their communication partner (Argyle & Graham, 1977). With advances in technology it is possible to bring the view of the partner's face and the view of the shared workspace closer together. For example, by presenting graphical information on a "clear board" that superimposes the partner's image over common work surface in a video tunnel, Ishii and Kobayashi (1992) made both the collaborator and drawings visible in the same visual space. Monk and Gale (2002) have shown that the number of turns and numbers of words spoken decreased when the collaborators could see each other's gaze through this type of set-up, although no improvement on task completion time was found.

Instead of displaying the partner's whole face, only displaying the eye-gaze is an interesting alternative. In a video conference set-up, Vertegaal (1999) displayed all participants' tracked eye-gaze as light spots in a shared document view. As another example, Velichkovsky (1995) conducted a study in which one party's eye-gaze was superimposed onto a computer puzzle game. Velichkovsky was interested in how joint attention may facilitate the performance of a team in which the expert gave suggestions to a novice on how to move scattered parts around. Since such a puzzle game requires frequent deictic referencing, the team performance was improved over a voice-only condition. Velichovsky's work was focused on quantitative performance improvement and eye movement data. The multiple qualitative types of functions that augmenting a shared visual-space with eye-gaze may bring for remote collaboration needed further exploration.

Augmenting Human-Human Dialogue with Gaze Overlay

The important role of eye-gaze in face to face communication, the demonstration of "joint-attention" (Velichkovsky, 1995), and the observation that when communicating about visually complex material, people look more at the material than on their partner (Argyle & Graham, 1977) all point to an interesting communication paradigm in which the conversation partner's eye-gaze is overlaid on the visual-spatial material which the conversation is based on. In this section, we describe our findings of augmenting a collaborative tool, RealTourist, with eye-gaze overlay and the effects it had on the conversation between two collaborators.

The RealTourist Study

RealTourist, a simulated tourist information service, allows a tourist to get information from a remote tour consultant. When the tour consultant and the tourist talk about a place, such as a restaurant or a museum, the tour consultant can show a photo of it on the tourist's map. The photo has a line connecting to the discussed place on the map (Figure 1). RealTourist has two views, one for the tourist and one for the tour consultant. The tourist can talk to the tour consultant by voice and see a map of a city on a display integrated with a Tobii ET-17 eye tracker (Figure 1). The eye tracker's output is sent to the tour consultant's computer. The tour consultant's computer displays the interactive map of the city with the tourist's eye-gaze overlaid on the map. We used a processed (filtered) display of the eye-gaze in the study to make eye movements appear less jittery and easier to follow. Because eye movements are rapid, we found that the filtered display was helpful while still preserving the characteristics of the eye movements to be interpreted by the tour consultants.

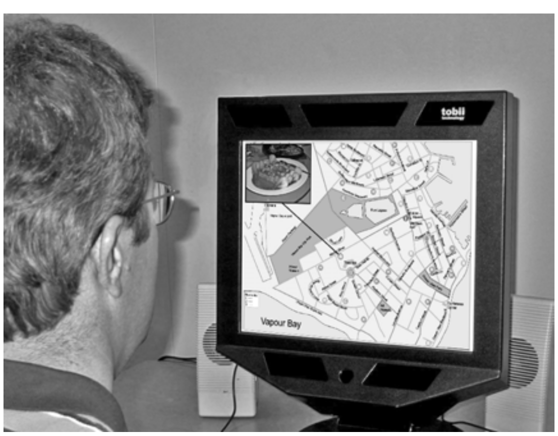
To observe how a user's verbal and gaze behavior were related, we conducted an empirical study in which "tourists" talked with "tour consultants" using the RealTourist system. With the tour consultant's help and advice, the tourist was asked to plan a conference trip to two cities, finding a suitable hotel within certain price range, and locating restaurants and attractions to visit. In our study, 12 people acted as tourists, and 2 as tour consultants. Working with one of the two tour consultants, each tourist made trip plans for two cities, one with eye-gaze overlaid on the tour consultant's screen and other without. The tourists did not know whether or how their eye-gaze was displayed before and during the experiment, but were informed after the test. The city and gaze conditions were balanced across participants.

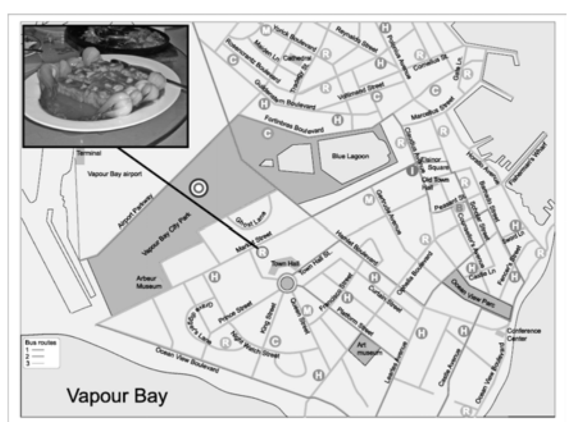
Collecting and Analyzing Speech and Gaze Data

In the RealTourist study, we collected the speech from both the tourist and the tour consultant, and the gaze data from the tourist. It is important to multimodal data collection that the data are synchronized between the different modalities. We used a specially developed tool for recording the gaze and the speech. This tool allowed us to later play back the conversation with the tourist's gaze overlaid on the shared map. Eye trackers generally come with a software tool for collecting and analyzing gaze data. However, the ability to add extra modalities, such as video or audio, may be limited. Another important factor for multimodal data collection is that all computers involved in generating data are synchronized. Even small time differences between the computers, especially when gaze data are involved, may put the data collection in jeopardy.

Our analysis of RealTourist was done in several steps. First the multimodal recordings were inspected, segmented and annotated with regards to different events, such as a change of focus in the conversation. The second step was that events or parts of events exemplifying reoccurring patterns were then further segmented, annotated and transcribed. For the detailed transcription corresponding

Figure 1. A tourist using the RealTourist system (left). The tourist's eye-gaze overlaid on the tour consultant's map (right)





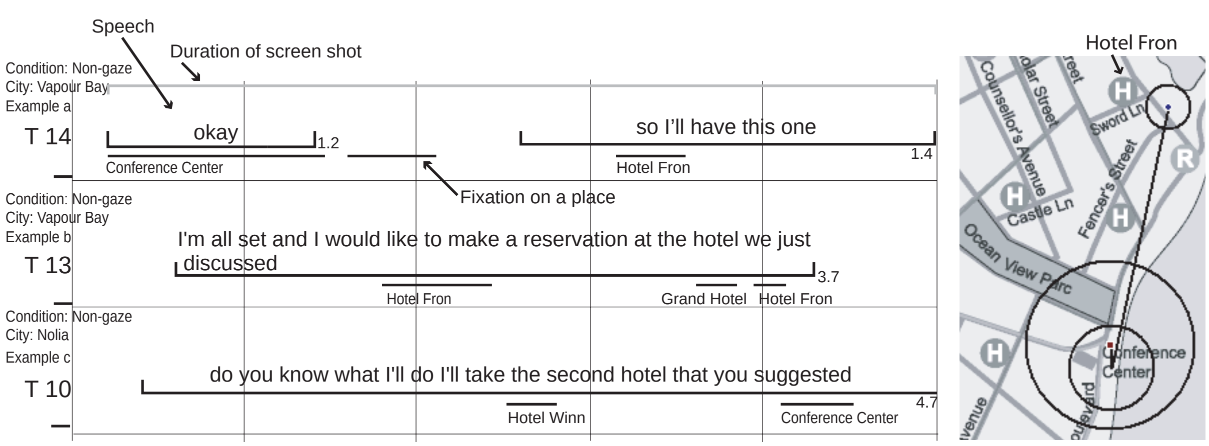
gaze data were plotted using one of three methods: raw gaze data as dots, gaze trajectories (i.e. the raw gaze data connected with lines representing the pass of time) and fixations with lines to represent the time. For fixation detection we used a specially designed tool based on a dispersion-based fixation algorithm (Salvucci & Goldberg, 2000). Many eye tracking analyzing software toolkits allow similar analysis. We found it useful to alternate between different representations of the gaze data, including animation, trajectory and fixations, since on occasion the trajectory or the motion of the gaze carried more information than the fixations. This was particularly true when the accuracy of the eye tracker was low. On those occasions, the general location of the eye and trajectory of movement would still inform the tour consultant, but when analyzing the gaze data no fixations could be detected. We also found it useful to control the speed of the animation, since eye movements are extremely rapid, and if attention is not paid during the analysis interesting eye-gaze patterns may be lost.

For the RealTourist study we also developed a special notation system composed of speech-gaze transcription graphs. In these graphs, verbal dialogue is transcribed and coded on a time line with the tourist's eye-gaze marked (Figure 2). The dialogues are segmented into 5-second "pages". On occasion, the speech-gaze transcription graphs are supplemented with a still image of the tourist's eye-gaze on the map. The time period shown in the still image is marked with a gray line in the speech-gaze transcription graph (Figure 2).

r esults of the r ealt ourist s tudy

The results from the RealTourist study showed that the eye is indeed a "window to the mind." Our data analysis along with reviews of the literature in the cognitive sciences such as psycholinguistics identified various functions that eye-gaze plays, including: (1) The overlaid eye-gaze can serve natural deictic and referencing functions that help one partner to keep track of what the other partner talks about, hence reducing the need and effort of frequent explicit verbal or gesture referencing. (2) The eye-gaze information reveals the partner's interest, which helps one to decide how much to talk about a particular topic. (3) Eye-gaze display can help synchronize the two partners' attention and form a common task focus. One may also use the eye-gaze information to switch topics and steer the conversation to the partner's need. (4) Information carried in eye-gaze can help to increase communication redundancy and resolve some of the ambiguities in verbal expressions. (5) Eye-gaze overlay gives one increased assurance or confidence that his or her conversational partner is engaged and indeed getting the information communicated. In what follows, we report data supporting these five functions in the

Figure 2. Examples of the correspondence of eye-gaze and verbal deictic expressions, with a screen shot for Example a.



RealTourist study; a more detailed description of these results can be found in Qvarfordt (2004), and Qvarfordt, Beymer, and Zhai (2005).

(1) Eye-gaze Carries Deictic and Spatial Reference Information; Hence, Displaying it May Reduce the Effort of Frequent Referencing

When communicating about spatial tasks one often needs to make reference to an object, a location or a path. This can be done either by giving complex verbal descriptions, such as "in the northeast part of the town, close to the Cathedral," or by deictic references in a combination of an utterance and a gesture, such as saying "here" and pointing at a place. Deictic information is also naturally carried in eye-gaze. Psycholinguistic research has shown that people look at the object they talk about even when they are not pointing at it (Griffin & Bock, 2000; Meyer, Sleiderink, & Levelt, 1998). Thus, the eye-gaze locus can serve as an implicit pointer when a person utters a spatial reference. Velichkovsky (1995) showed that when an expert's eye-gaze position was represented by a dot in the puzzle on a computer screen, the number of overall words used decreased.

The fact that eye-gaze can support deictic or referencing functions is quite evident in the RealTourist study. Figure 2 shows the speech-gaze transcription graph of three such examples. In Example (a) (top row, with screen image on the right), after considering the location of the hotel in relation to the Conference Center the tourist decided to book "Hotel Fron." During the utterance "so I'll have this one," his eye-gaze fixated on the hotel. Similarly in the next example in the same figure, Tourist 13 also referred to Hotel Fron by an utterance while looking at it twice and with longer fixation duration than on an alternative hotel. This example again shows that the eye-gaze could have served as an implicit deictic reference if the tour consultant could have seen the eye-gaze locus. These examples show that "pointing with the eye" is a quite natural and subconscious behavior.

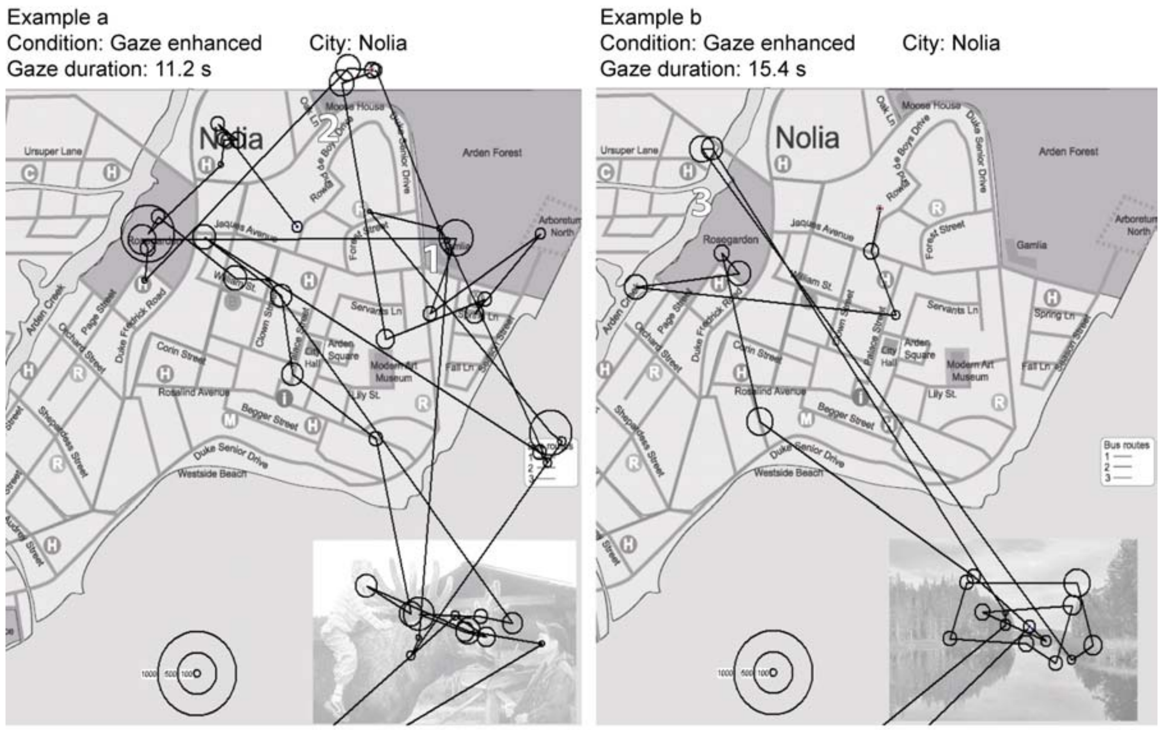
The subconscious role eye-gaze plays as a pointer to locations on the map was also demonstrated by the tour consultants' experiences. They often felt more lost in the non-gaze condition: "I was more lost in the non-gaze condition. The tourist was very inquisitive and asked information about specific places that I did not know their location of." (*Tour consultant B*). In sum, displaying eye-gaze onto the workspace can reduce the need to make explicit and effortful references (either verbal or gesture), since often the partner will know exactly what is being referred to based on the eye-gaze.

(2) Eye-gaze Reflects a Listener's Interest and can be Used to Judge Whether to Continue on the Current Conversation Topic

The partner's eye-gaze can also play a role when the partner is listening. Previous research has shown that eye-gaze tends to correlate with objects related to the verbal message heard. Cooper (1974) found that people look at objects that were relevant to what they listened to. For example, when they heard the word "lion", they looked at the lion in the picture. Not only does the eye-gaze follow the speaker's instruction, it may also anticipate what the speaker is going to talk about next. Kamide, Altman, and Haywood (2003) showed that when the speaker says "the boy will eat the cake" the listener is already looking at the cake when the speaker starts uttering "cake."

In the RealTourist study, we found that the tourist looked at what the tour consultants talked about at least for a while. In addition we found a tight coupling between eye-gaze patterns and interest level. How interested the tourist was in a topic (a club, a museum, etc.) was reflected by the duration and intensity of the tourist's eye-gaze on a particular place. The two examples in Figure 3 illustrate the eye-gaze relation to interest level. As we can see, Example (b) is very different from Example (a): Tourist 14 looked more intensely at the photo and the location of the attraction in Example (b) than in Example (a). Notwithstanding the longer dura-

Figure 3. Two examples from Tourist 14's conversation with Tour Consultant A that indicate different interest levels. The vertical lines in the transcriptions indicate the time periods of the gaze fixation trace. The numbers in the transcriptions refer to places in the map.



a1 TC A:	and another thing quite close to it [Gamlia 1] is the Moose House [2] where you can learn about the life of a moose
a2 T14:	mhum
a3 TC A:	they have also domesticated moose ah they so you can get close to them if that is interesting

b1 TC A:	yeah one can go canoeing in the Arden Creek [3] that is something quite nice they have eh one can either go up in the creek or down to the lake
b2 T14:	okay
b3 TC A:	and you will see a jungle-like scenery...

tion of the segment in Example (b) compared to Example (a), Tourist 14 hardly looked at anything else other than the photo of canoeing or the location of the canoeing. The long time period that Tourist 14 spent looking at the photo of the canoe is best explained by his interest in that activity. Indeed Tourist 14 eventually decided to sign up for a canoe trip. In addition, the tour consultants interpreted the tourist's interest as high when they saw a high intensity or long duration of the tourist's eye-gaze on places representing the current conversational focus. In Example (b) the consultant observed Tourist 14's high gaze intensity and continued to talk about canoeing for another 10.3 seconds after Tourist 14 uttered "okay."

(3) Eye-gaze Overlay can Support Topic Switching and the Development of a Common Focus Coordination

Closely related to interest detection is the coordination of the common focus and topic switching. Displaying a partner's eye-gaze may enable mutual awareness of each other's loci of focus, hence fostering a common focus when needed. Velichkovsky (1995) has argued that eye-gaze tracked and displayed to the partner can support joint attention because it constantly communicates where the conversational partner's attention is.

Eye-gaze may also help the dialogue partners to switch the topic of conversation. We have not found much in the previous literature in this regard, but it was evident in the RealTourist experiment. Clearly, the eye-gaze overlay can play an important role in the process of grounding (Clark & Schaeffer, 1989) in human-human communication. When the tourist was no longer interested in the particular place the tour consultant was talking about, the tourist started to look at new places. The drifting eye-gaze may give the consultant a clue on either moving on to other topics, or increasing the effort to get the collaborator's attention to the "right" place. In the gaze-enhanced condition of the experiment the consultant could take advantage of the displayed gaze trajectory and predict the change of focus or what the tourist was interested in hearing about next.

Figure 4 shows an example of this behavior. While Tour consultant B talked about a restaurant in the northern part of Vapour Bay, he noticed that Tourist 3 looked at the Conference Center. When Tourist 3 next roughly followed the yellow bus route, Tour consultant B told the tourist that it was possible to reach the restaurant by bus. This episode shows that the eye-gaze overlay enabled the tour consultant to adapt the dialogue to the Tourist's changing interest. Subjectively, the tour consultants noticed that they could use the eye-gaze to infer what the tourist was going to ask or talk about next: "I could be better prepared on what the person was interested in…the communication seems to flow better in the second task [with eye-gaze]" (*Tour consultant A*).

(4) Eye-gaze Overlay can Reduce Ambiguity and Increased Redundancy in Communication

While face-to-face communication in natural language is often ambiguous, telecommunication or human-computer communication can be more so. Since people often look at what they talk about, displaying eye-gaze may increase redundancy and reliability in communication.

In the RealTourist experiment, the tourist's eye-gaze was tightly connected to what was said about objects on the map. The utterance could be a proper name or a referring expression. Often these utterances were ambiguous. Instead of referring to a hotel by name, a tourist might say "the hotel we just discussed" or "this one" (Figure 2), which could be interpreted in more than one way if one attended to these words alone. Sometimes what was said verbally was not what the tourist really meant. For example in Figure 2 Example (c), Tourist 10 said "you know what? I'll take the *second* hotel you suggested" while he actually meant the *third* hotel. In all these cases, the tourist's eye-gaze could have provided information to either resolve the ambiguity, or to warn the consultant to disambiguate a disparity between the eye-gaze and the verbal utterance.

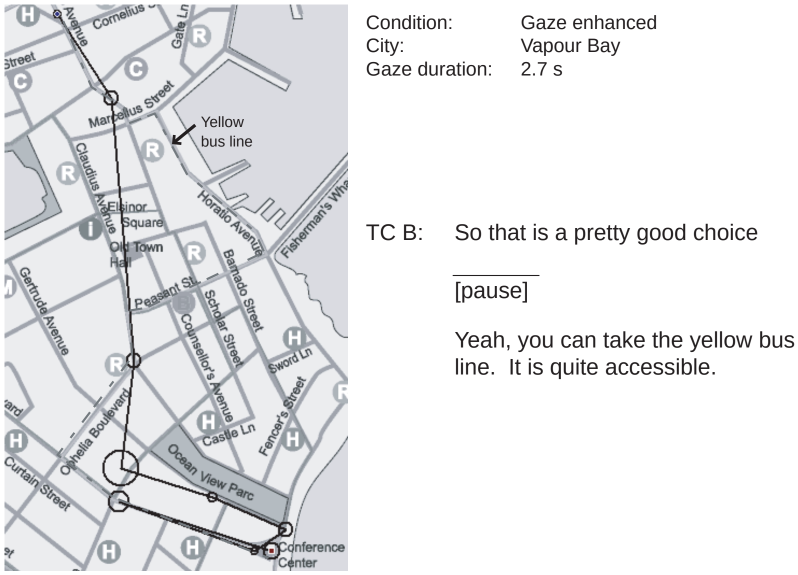
(5) Eye-gaze Overlay Enhances Assurance, Engagement, Confirmation, Understanding and Confidence in Communication

The subjective impact of an eye-gaze overlay includes confirmation, assurance, understanding and confidence of the tour consultants. Comparing the two conditions used in the experiment, the tour consultants felt that their communication with the tourists was qualitatively different; in particular it was more engaging: "With eye-gaze I was more engaged with the tourist" (*Tour consultant B*).

The experience of the eye-gaze overlay was that one could be more sure if his or her partner really "got the point" by looking at the partner's eye-gaze response. If the speaker's statement about a particular object was followed by the listener's eye-gaze on or around the same object, the speaker could be more confident that the statement was heard. We found that the tour consultants repeatedly used the eye-gaze overlay to confirm either their own understanding of what the tourist meant, or to confirm that the tourist was following their instructions.

Although eye-gaze overlay was a novel and synthetic phenomenon, the tour consultants were overall positive towards it and found it helpful. They

Figure 4. Tourist 3 looked up north and Tour Consultant B changed the focus accordingly.



did not find the overt display of eye-gaze confusing, disturbing, or unnatural.

In conclusion, overlaying the remote partner's eye-gaze information onto the visual-spatial discussion material can enhance certain types of computer mediated human-human communication such as those illustrated by the RealTourist system. The communicative functions the eye-gaze overlay supported are likely not limited to two person collaboration. These functions are equally important, if maybe not more so, for in supporting larger group collaboration.

It our Ist

The RealTourist study provided a rich source of empirical information on how eye-gaze can be used in future collaborative applications. It also offered implications on developing multimodal human-machine dialogue systems. In fact, we took some of the patterns observed and knowledge gained in the RealTourist study and embodied them in a prototype system, iTourist, which replaced the human tour consultant with eye-gaze pattern-based interaction algorithms and databases. We then tested whether human users could interact with such a system to accomplish the same type of tasks as in the RealTourist study. We found that iTourist users could indeed successfully accomplish the same trip planning task.

Like the RealTourist system, iTourist provides the user with city tourism information in the form of a map and photos of different places. Information about the different places is presented by pre-recorded, synthesized speech. iTourist manages its information presentation based on the user's interests and needs analyzed from the user's eye-gaze pattern. Although our ultimate goal is to make eye-gaze an integrated channel of multimodal systems including speech, gesture, and eye-gaze, iTourist was developed as a *stress* test to investigate how much information can be gained from a user's eye-gaze alone.

In the rest of this section we present an outline of the iTourist system and a user study, and refer the reader to Qvarfordt and Zhai (2005) for further details.

Modeling Interest

At the core of iTourist is user-interest detection. The interest model used in iTourist first detects which object (a place such as a hotel or a restaurant) the user's interest lies in and then activates that object by displaying its related visual information (such as photos) and playing synthesized speech telling the user about that place. After that, it determines the user's continuing interest in the active object and only continues if the user stays interested in that object. If it detects that the user's interest has shifted to a passive object, it "switches topic" by activating that passive object instead. All potential points of interest and regions of the city on the map are modeled as objects.

From the RealTourist study we learned that the duration and intensity of the user's eye-gaze on an object reflect the user's interest level in the object. However, the eye-gaze patterns identified in RealTourist were in a dialogue context that supported its interpretation. This dialogue context needs to be included in the interest model to accurately reflect the interest of the user. In our interest model, the dialogue context is represented by the dialogue history and the categorical relationship with the previous active object. A user is less likely to be interested in a previously active object than to an object never activated. The categorical relationship is useful, since users tend to divide their task into related subtasks.

Detecting if a user is still interested in an active object is also determined by the duration and intensity of the user's eye-gaze as well as the dialogue context. However, what is included in the context differs. For instance, when trying to find a restaurant for a dinner after the conference, the location of the hotel the user selected for his or her trip as well as the location of the conference center is of interest. Looking at these two locations would still signify interest in the activated restaurant, since the user may judge the location of the restaurant in relation to the hotel and the conference center. For this reason, the dialogue context for modeling the interest of an active object includes objects closely located to the active object, objects the user has committed to, and objects with a semantic relationship with the active object.

Eye-gaze patterns can be used not only to detect interest in an object, but also to detect interest in the relationship between two objects. We observed in the RealTourist study that when judging distance, the tourist switched back and forth between two places on the map. We used this eye-gaze pattern as the basis for iTourist to give information about the distance between two objects. However, looking back and forth between two objects is a relatively common eye-gaze pattern. It does not always indicate an interest in distance. One restriction imposed on iTourist in this regard is that distance information can only be triggered between the active object and another object. The specific distance-interest detection algorithm involves an object memory that sequentially stores objects being recently fixated on by the eye-gaze. The algorithm checks transitions between these objects in the memory store. If a pair of objects (one of them has to be the current active object) with two or more transitions between them is identified, iTourist will utter the distance between them to the user. Once the distance information is presented to the user, we have found that the user tends to gaze back and forth between the two objects, which may result in a loop of distance information. For this reason, our system keeps track of the history and suppresses the immediate second occurrence.

user study

We performed a user study of iTourist to test whether the goal of making eye-gaze a channel of human-computer dialogue and the iTourist approach based on observations from RealTourist study were feasible at all. Twelve people participated in the study, and the task was the same as in the RealTourist study, to plan a conference trip to a city.

The most remarkable evidence of the system's success was that all of the participants completed their tasks with iTourist. Considering it was the same trip planning task as in our previous Real-

Tourist study that involved a remote human "tour consultant" on the line busy looking up information and talking about places in natural language, this is quite encouraging for the role that eye-gaze may play in human-machine communication.

The results also showed that the relatively simple methods used in iTourist modeling the users' interest level based on eye-gaze information and the dialogue context were appropriate for the tourist information problem. iTourist quickly and accurately detected when a user was interested in an object. The users rated that iTourist rarely talked about places they were not interested in (average rating 2.2, SD=.72, on a scale where 1 corresponds to never and 5 to all the time). The experienced rate of false negative cases, where iTourist did not talk about places the users were interested in, was also low; on average 2.5, SD=1.09 on the same scale as above. In addition, iTourist users rarely reactivated an active object, which indicates that iTourist could accurately detect when the users lost interest in an object. The task completion time for iTourist (mean: 8:27 min, SD=2:34) and RealTourist (mean: 9:51 min, SD=2:27) did not significantly differ.

Envisioned Usage Scenarios, Applications and Future Research Directions

The research reported in this chapter has shown that eye-gaze information can be used to augment and enhance both human-human and human-computer conversation. In the RealTourist study, we found several eye-gaze functions, including deictic referencing, interest detection, topic switching, ambiguity reduction, and establishing common ground in a natural dialogue. Displaying eye-gaze information was found to enhance the experience of the collaboration between the tourist and the tour consultant. These results are promising for future applications using eye-gaze in collaborative settings where a group of two or more distributed persons collaborate.

The findings of eye-gaze patterns in the human-human dialogue study also inspired the exploration of using eye-gaze patterns in human-computer communication. iTourist demonstrated that eye-gaze can also play an important role in managing future multimodal human-computer dialogue. There are many further research topics on the use of gaze information. We outline a few here in human-human and human-computer communication and interaction.

Human-Human Communication and Collaboration

Although RealTourist was a research prototype, it demonstrated the possible benefits of eye-gaze overlay on a shared visual display. Yet there are still many aspects of using eye-gaze in collaborative settings that needs to be explored. RealTourist only shows the eye-gaze of one of the partners. Further research needs to test how eye-gaze overlays would scale, when two or more users' eye-gaze are tracked and overlaid in the user interface. It is possible that the collaborators would end up chasing each others eye-gaze indicator if not implemented properly. As the group size increases, the ability of being able to identify and make sense of multiple eye-gaze overlays may decrease. Different visualization techniques for the overlay and possibly intelligent filtering of the raw eye-gaze information may be needed. Also, for some applications and groups of users, tracking the eye-gaze raises privacy concerns.

In terms of application domains, we think that in situations where fluid and accurate communication is essential, such as in distributed command and control rooms, eye-gaze overlay can be particularly useful. In command and control rooms, the common focus of all involved partners is on accomplishing a critical task. But in order to accomplish the task, the participants need to create a shared understanding of it. Eye-gaze overlay can serve as a vehicle for creating a shared focus and understanding, while assisting the participants to resolved ambiguities quickly and efficiently.

As mentioned above, for some collaborative applications it may be beneficial to process the eye-gaze information before it gets transmitted to participants in a remote collaboration site. This would allow the system to show not the exact location of where a single participant is looking, but instead some kind of representation of the state of all participants' eye-gaze patterns. Previous research has shown that pointing using gaze is in many sense not the optimal solution (Zhai, Morimoto, & Ihde, 1999), and the results from the RealTourist study show that eye-gaze information has more information and functions than being a pointer in deictic references. An intelligent filtering mechanism may allow the participants in, for instance, a teleconference to get the gist of eye-gaze patterns, such as if the participants are focusing on the same objects, if some participants seem to have lost interest in the current topic, or if they seem to focus on some other aspect previously discussed, or not at all discussed so far. In addition, different representations of the eye-gaze of the group members depending on the role they have in the group could be envisioned. If the social setting is a distributed lecture, the speaker may have a visualization of the audience as a whole combined with alerts to specific members of the audience who need particular attention. The audience on the other hand may see the speakers gaze over the shared visual material to more easily follow the lecture.

The eye-gaze patterns we found in the RealTourist study may be domain-dependent. When applying the technique to other usage scenarios and applications in computer-mediated human-human communication, the characteristics of the eye-gaze patterns need to be studied. The manifestations of interest, for instance, may depend on the conversational context and the roles and the expertise of the people involved. The interpretation of interest may also differ for different applications. For some applications the interest in particular objects may signal that the listener is trying to make sense out of it rather than that he or she likes it. The interpretation of the eye-gaze should always be done within the context of the dialogue.

In sum, we believe that eye-gaze is an untapped source of information for enhancing computer mediated communication potentially applicable to a broad set of applications, but many more research questions need further exploration.

Human-Computer Communication and Interaction

iTourist successfully illustrated that eye-gaze patterns can provide important input for managing human-computer multimodal dialogue. For human-computer application involving visual-spatial information, eye-gaze information can prove particularly useful.

The role of eye-gaze patterns in conversation is particularly interesting when considering the challenge of building truly intelligent dialogue systems. Computer systems have a long way to go before they can become competent conversational partners based on syntax or semantics. The role of gaze in human-human conversation implies that as another modality it can be a useful complementary source of information to use for making human-computer dialogue more intelligent. Indeed, research building on top of the iTourist work, for instance Prendinger, Eichner, André, and Ishizuka (2007), has further pointed out that this may be a fruitful avenue for developing multimodal dialogue systems.

However, our approach in general and the iTourist implementation in particular are far from being mature or perfect. Eye-gaze pattern-based interaction systems, as any other recognition-based systems, can produce both false alarms and misses. Some of these limitations can be overcome by developing more advanced techniques, such as statistical learning, but more importantly ambiguity can be dramatically reduced when multiple modalities are combined, due to the mutual disambiguation effects (Oviatt, 1999). In fact, attempts have been made to improve speech recognition and multimodal interaction by using gaze as an additional information channel together with speech (Cooke & Russell, 2005).

Beyond human-computer communication, we think that it is possible to use eye-gaze patterns as an additional source of information about the user which can be used for instance, in recommender systems. One example application is online shopping. By tracking the eye-gaze and comparing it with stored eye-gaze patterns for that particular user as well as all users who have seen a particular page, it is possible to tell which items the user likes. Eye-gaze information would provide the recommender system with real-time data about a user's preference, which may have greater correlation with user preferences than, for instance, mouse events or past purchases. This form of social collaboration is implicit, since the users do not really know who the system is "pairing" them with, unlike the explicit collaboration described in the Section "Human-human communication and collaboration."

acknowled GMent

Parts of this chapter were adapted from Qvarfordt et al. (2005) and Qvarfordt and Zhai (2005). The research reported here was supported by the Swedish Graduate School for Human-Machine Interaction, the Swedish Agency for Innovation Systems (VINNOVA), the Centre for Industrial Information Technology (CENIIT), and the IBM Almaden Research Center. We thank David Beymer for his assistance in developing the RealTourist software, and Arne Jönsson and Tue Andersen for their academic and technical input.

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KEY TERMS

Deictic Reference: the use of gestures or other means of pointing to specify an ambiguous utterance, for instance pointing at a place in a map and saying "here."

Eye Tracker: equipment for tracking where a person is looking.

Eye-Gaze Overlay: a visualization of a person's eye-gaze overlaid on visual spatial information shared by two or more persons.

Eye-Gaze Pattern: a pattern of eye-gaze fixations and saccades that can be used to infer a person's intention or goal within a particular context.

Fixation and Saccade: Two basic elements of eye movement. A saccade is the rapid eye movement between fixations to move the eye-gaze from one point to another. A fixation is the point between two saccades, during which the eyes are relatively stationary and virtually all visual input occurs.

Multimodal Dialogue or Interaction: Combing information from different sources, for instance vision and speech, for human-computer interaction or dialogue.

Chapter XXXVI
How to Engage Users in Online Sociability

Licia Calvi
Lessius University College, Belgium

abstract

The chapter presents and combines the results of two case studies dealing with online communities[1] in order to understand under which conditions people are willing to engage in online sociability. Of the two studies considered, one case collected user needs data for an urban mobile application; the other focused on a virtual network connecting home and outside organizations. The chapter shows that people are interested in engaging in online networks mainly to connect to people they already know, but not to get in contact with the strangers and the anonymous others available to them online. The author argues that these results cast doubt on the viability of one single view on online sociability and hope that understanding the dynamics and motivations underlying online communities will help construct better online social places where people will feel more engaged.

Experimentation should never be goal-directed, otherwise data collection is limited, it is these last ones that, actually, have to be targeted even to some practical goal."

—Bruno Munari,
Italian artist and designer,
translated from exhibition catalogue,
Didattica 2. Perché e come, 1977

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Introduction

With the increasing popularity of Web 2.0, a lot of research has been devoted to the concept of online sociability, although research on online and virtual communities as such actually dates back from the late '90s, and some even originates from much older sociological studies (see, for instance in (Gusfield, 1975; Preece, 2000; Preece and Maloney-Krichmar, 2003; Rheingold, 1993). In this chapter, I look at online sociability from a different perspective. My research question is:

What are the conditions under which people will engage in online sociability?

This question implies the desirability of a novel type of online sociability, different from those just mentioned. I will formulate one such definition on the basis of the empirical results that were collected while performing a user and task analysis within two research projects, i.e., an urban mobile application[2] and a virtual network connecting home and outside organizations[3]. Both case studies foresee some form of community building and of online sociability as part of their objective. Although these projects present different starting points, assume different perspectives and aim at different finalities, they both impinge upon the notion of online sociability, since they both focus on the notion of personal networks as communities, i.e., on the concept of networking, and this mainly from the point of view of an individual who is engaged in social relations and on the way s/he networks. They analyse the possibility for them to become virtual communities and envisage the means by which such communities may profit from the strengthening of the ties among its members from being online. This is the reason why it is extremely useful to compare their results and to use them both in this attempt at defining online sociability differently, i.e., to come to a definition whereby the social context may change users' behavior, which in turn may have implications for design and evaluation.

The emphasis is therefore on the social issues involved in the creation and development of online communities, mostly of peers, i.e., at the crossroad between the social needs of individuals while networking and the activities that are pursued by it.

This topic has become more and more relevant and its consideration urgent since, in recent years, the new media have started to pervade everybody's life to the extent that they tend to shape and affect it: technologies are no longer used only by professionals but they are also used to manage personal activities thanks to applications like MySpace, Flickr, and Facebook, just to mention a few.

Understanding the effects of this use on users and on the activities they perform and, at the same time, understanding how the individual's social role within a personal network can affect the use of different media can help design and develop a better tool to support them.

To be able to answer the question of engaging people in online sociability, the paper has been structured as follows: first, the definition of online sociability I intend to address is presented; then, the projects that are used as case studies to this end are briefly and separately introduced; next, some of their results are compared; I ultimately draw some conclusions and explain on the basis of these results what I think are the conditions under which people are willing to engage in the type of online sociability that was discussed in this chapter.

A Definition of Online Sociability

There are different ways in which a social relation can originate and further evolve. Depending on this, different types of communities can be distinguished. I identified three of them (Calvi, 2006), depending on the intertwining of their online and offline character. Although I also believe, like others (Wellman, 2006; Granovetter, 1973) that there is no longer a marked separation between life online and offline, but that there is a constant shift between these two extremes, I believe as well that the amount of one character (e.g., online) into the other (e.g., offline) can determine different types of communities. The three typologies I identified can for this reason be represented taxonomically:

- **Just-virtual** communities originate online and mainly remain such.
- **Meta-virtual** communities originate in the real world but later further expand online.
- **Semi-virtual** communities originate online but, at a certain moment, also develop in the real world with a consistent number of their members (what is a major difference compared to virtual communities going offline), giving rise to a parallel real-world community. This is for instance the case of "Italians", an online community of Italian expatriates. It initially started as a virtual place where Italians abroad could meet and talk about their experiences as emigrants. It soon developed into a forum where also non-expatriate Italians and even non Italians (living both inside and outside of Italy) could meet. Additionally, a series of real events started to be organised where all community members could meet and get to know each other personally. Clearly, the side effect of these official gatherings is that people start to develop one-to-one or, also, more dedicated relationships with a restricted group of community members that they carry on both online and in the real world[3].

Both studies considered in this chapter deal with meta-virtual communities, on their establishing and maintenance, that is on communities whose members share a relation which is based on some sort of common interest. The geographical character of these communities is certainly an important factor to keep the community alive, but it is not the main reason why people stay connected (Wellman, 2006). The goal pursued in this chapter is precisely to identify under which conditions people are willing to engage in the online sociability entailed in such a concept of community life (i.e., meta-virtual). This happens when people start to use technology to amplify the possibility of sharing information and of cultivating the same interest, something that until that moment has mainly occurred offline.

Additionally, this can tell us whether communities which are based on the sharing of a common goal or interest by its members (e.g., living in the same city or sharing a sport activity) also imply a social bond among the members that goes beyond the declared objective of the community establishment and which may or may not be further strengthened by participating in a meta-virtual community life.

Methodology and Experimental Protocol

This section briefly introduces the finalities, the approaches and the methodologies followed by the two projects mentioned earlier in their attempt to better understand and realize online sociability among their target users. These projects share a sort of H0 hypothesis, or an assumption, namely that:

H0: Everybody is a member of a community of some kind.

This hypothesis was then refined and adapted to the specific case considered by each project.

Mobile Community Content Creation (A4MC[4])

The A4MC[4] project was dealing with the development of civic virtual communities for content creation and information exchange. Its objective consisted in the development of a mobile application, possibly in the form of a PDA[5], which could be used to exchange different kinds of content among the members of this virtual civic community and that could serve as well to the establishment and further development of a virtual community of users living in the same city.

A virtual community that is geographically localized like a civic community performs different functions: for instance, it helps improve the relationship between the citizens and their local political institutions, enhancing the communication between them; it also performs an economic function, as a business community or as a community of practice, and a cultural function, as a community of interest or a learning community. In this project, however, the civic virtual community that was aimed at had rather a cultural and economic role as a community of interest and of consumers more than being a sort of e-democracy, i.e., an instrument to enhance the citizens' participation in public life. What makes these community members distinctive is their need to exchange information about the city they live in, information of various kind, relative, for instance, to the services offered by the city (like the opening hours of the city hall and other municipal offices), to opinions and information on shops (for instance, product and service quality, as a community of consumers); to information exchange in the form of pictures taken in and of the city (of city-located events, as a community of interests). This information is normally exchanged with the other people such civic community members are already in contact with (and this justifies the meta-virtual character of the growing community).

For this reason, and on the basis of the three pillars of sociability foreseen by the PCCD framework[6] (Preece, 2000), city inhabitants were taken as the primary focus of this research analysis. Their most predominant activity is to communicate with their social contacts that range from very intimate (i.e., family) to less close (i.e., colleagues). Field literature shows that the impact of technology is likely to be different if it supplements communication with existing friends and family, or if, instead, it is a substitute for more traditional communication and social ties (Cummings et al., 2002). For instance, computer-mediated communication, and in particular email, is less valuable for building and sustaining close relationships than face-to-face contact and phone conversations (Cummings et al., 2002). The mobile system they will need to use to this end will therefore have to support at least two activities:

1. Communication
2. Content and knowledge sharing (Coenen, 2006) mainly in the form of information about places and events in the city itself. In this sense, this system will have many of the features of a mobile guide.

Based on this profile, the original H0 hypothesis was reformulated into:

H1: Users are willing to use a mobile guide-like application to exchange information with their social contacts while moving around in a city.

H2: Users are willing to share the same information with other, and even unknown, city inhabitants, who would be the members of a then established city community.

These hypotheses state that everyone can become provider of one's own content, i.e., by sharing ideas, stories and experiences with people with the same interests belonging to a virtual community through the use of mobile technologies.

In order to model the online social relations of this target user group, a formative study was set up (see also (Calvi, in press)). 13 inhabitants of the city of Hasselt, in Belgium, were selected, and heterogeneously chosen in terms of gender, age, familiarity with technology and professional background. This study was conducted using different design methods, both *in vitro* and *in-situ* ones. It consisted of two phases:

1. A structured interview, used to understand the users' social contacts.
2. Later, users were asked to observe themselves, by reporting on their own behaviors and thoughts by means of the Experience Sampling Method (Barrett and Feldman Barrett, 2000).

The structured interview aimed at discovering, for each end user:

1. The identity of his/her most frequent social contacts

2. The degree or quality of the social tie (i.e., strong or weak)
3. The kind of (social) activity that is carried on with these social relations
4. The way of performing the social activity that was indicated (e.g., by phoning, by sending a SMS, by visiting the person in question, by going somewhere). This is necessary to highlight the requirements the final system will need to have and to identify the sort of interactions and activities it will have to make possible
5. The kind of information each user is willing to disclose to each and everyone of his/her social contacts, like for instance information on his/her actual location as in a study on information disclosure by (Consolvo et al., 2005). This is a direct reflection of the nature of the social tie between the two.

In a second and last phase, users had to report of their own social activities during one week in the form of a diary. Here, experience sampling techniques were exploited (Barrett and Feldman Barrett, 2000). Users were asked not only to record the actual execution of social activities, but also the thoughts, the feelings, and any emotional elements they ascribed to them. This is important to assign a psychological value and relevance to take individual differences into account.

The outcome of this analysis has been the sketching of a first, rough conceptual model of the mobile city application.

This model has then been presented in the form of a paper prototype to 3 usability experts for further refinement. In this version, three actions seemed to be important: to communicate, to navigate and to post a comment (Figure 1). The most important outcome of this second analysis was the realization that the same task could be understood differently and, as a consequence, also performed differently by different users. The mobile application had therefore to be conceived in such a way as to take into account individual differences.

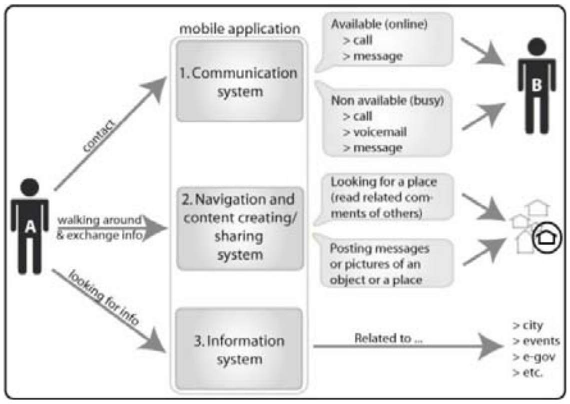
An improved conceptual model still in paper prototype form was ultimately presented to 10 additional city inhabitants, different from the ones consulted during the first analysis. They were also chosen heterogeneously from a sociological point of view. They were asked to evaluate the paper prototype by means of the connotation chain technique (Jans and Calvi, 2006), i.e., a methodology that combines the association technique with the laddering method (Figure 2) and that was developed to gain a holistic view on the user's expectations and preferences. The outcome of this final analysis was twofold: to identify the values these users were ascribing to this mobile application and to fine tune the end users' profile on the basis of their need to communicate and on the modalities for this.

Virtual Individual network (VIn)[7]

The second project that was considered focused on an individual's needs while networking, i.e., while building virtual, online contacts. It examined the way personal networks evolve into communities and identified the kind of technological and software support such networks need once they get online in order to keep the same level of interactivity among their members, to strengthen their social ties and to maintain social cohesion. The identification of the individual social needs while networking in a real-life setting was used to define the requirements of a possible technological counterpart.

In this project, the research setting was the domestic environment and the nature (and reason) for a person's contacts were mainly leisure-related. Consider, as an example of this application, the following scenario: a woman is forced home due to her child' illness but she can still follow her weekly tango lesson via an iTV appliance installed in her living-room. At the end of the lesson, she can download the special music and the movie trailer that the teacher hs used during the lesson, so she can watch it again, repeat it step by step and share it with her sister who is also fascinated by tango but does not follow these classes.

Figure 1. The three main functions of the mobile city application



Here, again, the H0 hypothesis mentioned above can be adapted to the specific research setting and it is translated into the following derived hypotheses:

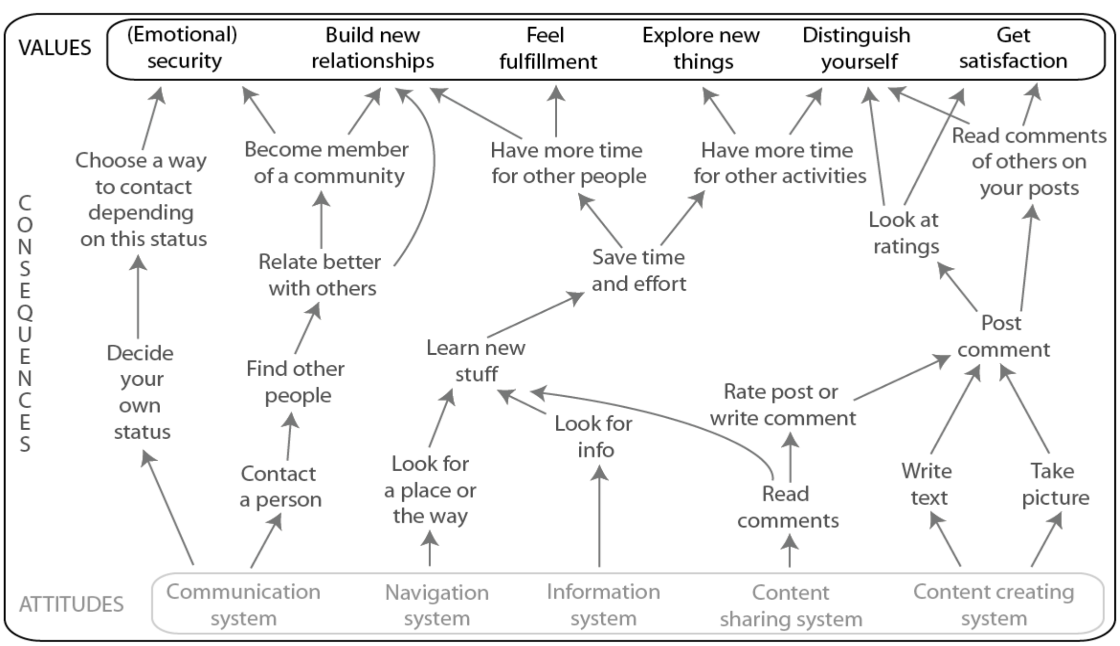
H3: The level of activity and the involvement within each community every person is a member of vary depending on the individual's role in it and motivation why being in that community and, consequently, on the particular nature of the ties with part or all of the other members.

H4: Individual networking can be fostered in and by a virtual environment.

There is therefore a main difference in the focus and objectives of this project if compared with the mobile one discussed earlier. Here, the emphasis lies indeed on:

- Individuals who are already in a well-established network of connections/contacts (in the example mentioned above, the tango students community) and who may profit from a digital/virtual device to enhance and foster such communication and the related tie.
- The setting, which is home based, and therefore static, not mobile.
- The nature of the communication, which is well circumscribed and somehow pre-defined, i.e., it originates within this well-established existing community sphere. It may of course extend and divert from it. Part of the user analysis that was performed was precisely intended to highlight this aspect as well.
- The unloose character of the ties among the community members.

Figure 2. The results obtained by applying the connotation chain technique



An empirical study was set up to analyse the importance of communities in everyday life and the way people normally keep up with their friends and acquaintances that are within their social network. In a way similar to Wellman (2006), an ego-centered approach was adopted that was focusing on both the individual's strong and weak ties but always on the basis of a shared interest among the nodes in this network as the means to keep the network alive and running.

The most important criterion that was followed in the selection of the subjects for this experiment was their being a member of a community of practice based on a common interest. To this end, the subjects that were recruited had all an active involvement in a community of this kind. By community of practice based on a shared interest, here, I specifically refer to any *extra muros*, leisure association. So, among all the possible other communities everybody is involved in (like family, friends and work-related communities), preference was given to those communities with a clear purpose, whose members are explicitly invited to contribute to the accomplishment of the community goal and which implement, to this end, a clear policy. Now, it is clear that any community is based on these three pillars, i.e., goal, members' motivation and involvement and internal policy (see PCCD framework in (Preece and Maloney-Krichmar, 2003) for details). But I claim that in a network with family and friends all these elements are less prescribed and are mainly left implicit and tacit, while in an association with *extra muros* finalities they are normally very well formalized. The associations I came across range from walking clubs to any form of sport clubs, from an Austrian fan club to the association of the engineers of the University of Leuven, from a dance group to a nature guide association, just to give a few examples.

I tried to span over other factors, like education and familiarity with new media, in order to collect a heterogeneous study group. Like all these elements, age is also a transversal factor.

Additionally, I decided to introduce a further element of distinction among the subjects and divided them into two categories: individuals and couples. This distinction was intended to highlight the possible *nuances* in intimacy relations. I was indeed interested in investigating in how far the fact that at least one of the two partners is a member of an association and therefore participates in the association life may affect the intimate/family relationship and may, at the same time, shape the associative tie. This can further help verify whether the bond among association members transcends the associative life to become something more intimate and if this intimacy is then extended to other people (in this case, the life partner) outside the association itself. This clearly refers to the H4 hypothesis.

I could ultimately recruit 10 individuals and 5 couples, but eventually received significant feedback only from 7 individuals and 2 couples. Of them, however, there was only one case where only one of the partners was a member of some associations, while the other was an example of a couple where both partners were members of the same associations. These data were therefore not enough to draw any significant conclusion.

Like in the previous study, the methodology that was adopted to analyse the community life of the experimental subjects consisted of the combination of two different design methods:

1. A structured interview in the form of a questionnaire that was used to highlight the present needs and habits in terms of communication modalities and practices of the subjects. This questionnaire aimed at discovering, for each of the selected subject:
    a. the type of most used communication technology
    b. their level of expertise and of confidence in it
    c. the reason for use, i.e., what, for which purpose, with whom, how frequently
    d. comments on the usability, cost/effectiveness, speed and simplicity of use of current technologies
    e. the importance of privacy issues
    f. a series of *desiderata* about current

technologies and possible technologies to use.

2. A structured diary the subjects were asked to keep during a full week. In this diary, they had to report per day how information within the association was exchanged. In particular, they were asked to indicate with whom, for how long, about what, how and why they were communicating.

   This diary study was meant as a form of cultural probes (Murphy, 2006). The respondents were given a probe pack and were specifically asked to compile their diaries by means of photographs of their association activities and of post-its or printouts of the messages or leaflets exchanged among association members. This was intended to give a wider and richer image of their association life and of the kind of relationship among its members. Part of the scope of this probing analysis was to verify the extent to which relationships within an association life were extending also outside the association itself and in which way they were evolving (for instance, if they were remaining rather formal and bound to the association topic or if they could also evolve into more intimate relationships).

Results were processed quantitatively, for what concerns the questionnaires, and qualitatively, as for the diaries. As Murphy (2006) rightly indicates, processing information from a probe analysis can be (and was) really difficult due to the amount of data users may provide and the lack of *ad hoc* techniques for that purpose (for instance, some sort of text mining tool to search within huge amounts of semi-structured or even unstructured collections of data). However, the somehow biased nature of the activities I intended to investigate (which are more related to the individual private sphere and are therefore generally not easily formalizable) made the adoption of this cultural probe technique appropriate to "understand users in their context" (Murphy, 2006).

COMPARISON OF THE RESULTS

Although some of the results have already been presented and discussed separately (Calvi, 2006), (Jans and Calvi, 2006), a one-to-one comparison between the two projects was never attempted before.

A strictly systematic comparison is however not appropriate because of the different context, premises and tools under analysis. However, since both projects share a common basic assumption, i.e., the possibility of using technology to share content within a community of peers, a comparison is desirable to highlight analogies and idiosyncrasies between the two cases that could help shed a new light on the notion of online sociability. This is not meant to be a statistically-based analysis, just a qualitative and sociological comparison between similar cases.

Such a comparison will limit itself to the following issues: what technology to use for which kind of social contact; how much to reveal about oneself; users' expectations about how to integrate technology in their actual personal sphere.

Choosing Technology to Make Contact

A first comparison focuses on the choice of technology to adopt depending on the kind of social contact and, as a consequence, on the kind of use that has to be done with it. A series of possible uses were identified for both case studies, e.g., for work or for leisure activities, to read the news, to take appointments, regardless of their nature, or to contact friends.

The results show that the respondents contact their friends most of the time with their mobile phone or PC (with Internet connection), while they make appointments with a mobile phone or computer. Technology seems to be considered useful only for less intimate relationships, like in making contact with colleagues or with less close acquaintances, where a less direct communication is preferred. The role of technology is however only supporting, it helps in maintaining, not establishing a relationship, for work-based relationships (e.g., relationships with clients, suppliers and colleagues). For simple information exchange, emails are mainly used, while for personal relationships with friends or family a telephone or personal contact is preferred.

Subjects reported little on face-to-face relationships because they found this was too personal and too much related to their privacy sphere. It can therefore only be assumed that they make more personal contact with their intimate relations than reported, and perhaps this occurs only to a relatively limited extent via mobile communication, telephone or email.

Figure 3 shows the responses given by the mobile (A4MC[4]) users. They mainly use three technologies: the computer, TV and the mobile phone. They seem to have their specific (and traditional) usage domain: TV is for the news, the computer is to work, the mobile phone to make contact (and mainly to contact friends).

These users do indeed consider the phone as the most straightforward way to contact mainly family and friends. To this end, email, for instance, is rarely used, and is even not considered at all when it comes to making contact with family members. Email is as a matter of fact used for work-related activities.

For the VIN users, instead, other correspondences seem to be valid (Figure 4). By considering the interrelation between the communication modality adopted and the kind of social ties, it is clear that these respondents mainly use the mobile phone to take appointments (and only as a second priority to contact friends), and computer-mediated communication (PC and Internet) for work-related activities. So, they do not seem to be particularly confident with the extensive use of new media.

Looking at the quantitative data, it appears that face-to-face communication (or communication in the form of a visit) is preferred for intimate relationships together with the telephone. Surprisingly, for these users a SMS is more common than a visit when it is directed to friends but not when it is for family members. They communicate by email, but mostly prefer fixed and mobile phones, which are both essentially used to make arrangements/appointments or to contact friends, although this kind of communication is not that frequent (a few times per month). The telephone is also preferred as a means to receive information.

Correlating this mainly quantitative information with the qualitative one reported in the diaries, suggests that when communicating with the other members of the association the telephone is normally used. Sending a SMS can be an alternative, but only in the case of brief messages, or as a confirmation/cancellation of a previously taken agreement (which was normally taken by telephone). Direct contact via voice (through fixed or mobile phone) is also reported as preferred for more intimate contacts (i.e., friends or family).

Emails are adopted when practical information needs to be exchanged (e.g., the programme of an activity), or when more people (e.g., all association members) need to be contacted at the same time.

From the diaries it can also be inferred that only in a few cases the ties among association members have evolved from weak to strong ties. In some cases, ties were strong and the relation was of an intimate nature to start with.

In this specific analysis, results are rather similar for both case studies although their context is quite different. Both types of context of use see a predominance of traditional media for more intimate relationships while colder media (from the commonsense understanding of media allowing a lower degree of intimacy and of direct contact, not as McLuhan's (1964) defined the difference between hot and cool media) like the email are mainly devoted to more formal contacts.

How Much to Reveal About Oneself

When asked to indicate how important privacy issues are for them, respondents from both cases gave similar answers, namely that they consider privacy issues both for themselves and for others essential. Others are not just the people they are making contact with, but also any other person who is present in their immediate environment at the time of contact.

Figure 3. The reason why the mobile respondents use different technologies

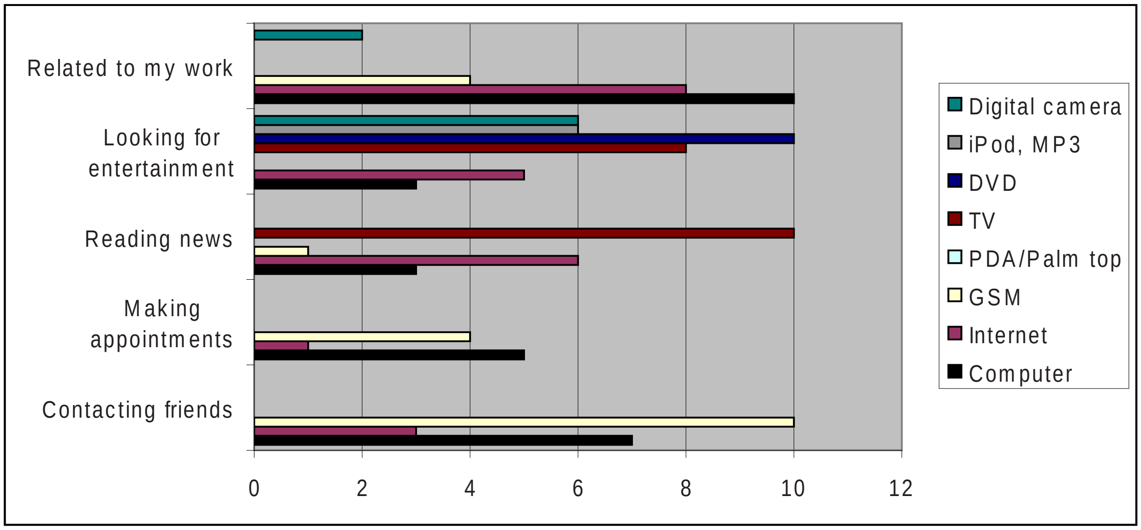
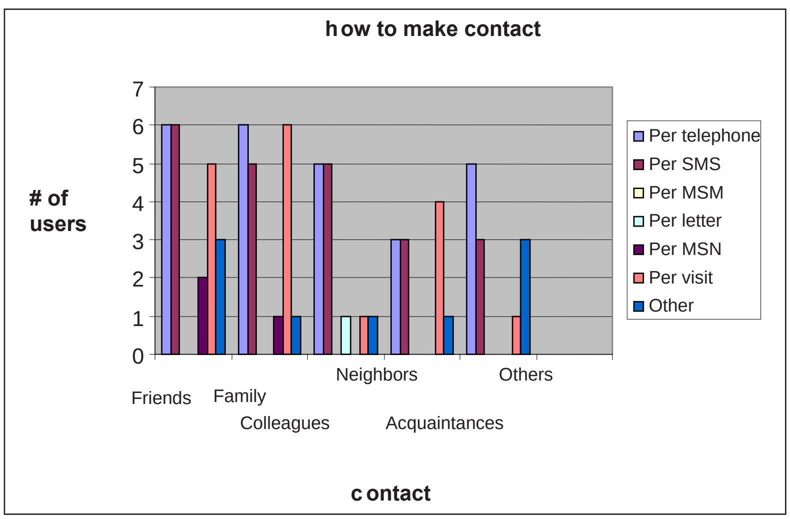


Figure 4. How the VIN respondents make contact using different technologies



When the mobile respondents were asked about this privacy and information disclosure issue ('Where do you contact others and how do you ensure the privacy of both?'), they all reported that they contact anybody, anywhere they have to, but that they pay particular attention to the privacy of the people they interact with, the privacy of the persons that are nearby and their own privacy. This can of course take several forms, i.e., by talking less loudly or even by leaving the room (if in a closed environment) when other people are too near, or by being careful with mentioning personal data like full names, addresses, or phone numbers. More than 25% of the respondents even reported they talk to somebody on a mobile phone only in closed places.

Similar comments were expressed by the VIN respondents. They added that when they make contact by mobile phone they make sure to ask always if they are disturbing the person they are making contact with as s/he picks up the telephone or to make sure that nobody who may be listening is around while they are talking. In order to achieve a similar form of discreetness, they prefer to send a

SMS rather than to phone directly. Discreetness is also guaranteed by giving any other form of notice before visiting or contacting somebody.

Both groups of respondents seem to be worried by a sort of "Big brother" effect, i.e., the possibility that unknown other people may misuse their personal data, or the information they may be extorted from them by overhearing their conversations. This clearly reveals a general and also genuine mistrust in new technology, the feeling that new media can certainly help them achieve much more but that they are not as secure and comfortable as they pretend to be (see next).

Users' Expectations About Technology in Their Personal Sphere

When the experimental subjects were asked to express what they expect technology will bring about in their private and personal sphere of social contacts, both groups of respondents seemed to see speed and entertainment-like functions as the only way technology enhances their user experience.

The diary studies suggested that all respondents have the feeling that technological improvement is handy, that it makes life and task execution mostly easier and that it opens up new possibilities for interaction and communication when applications are affordable, although some of the older respondents (over 45 years) found it very difficult to stay up-to-date and to find out how such applications work.

As a general remark, however, it seemed to be difficult for the subjects that were selected to image how technology might help, enhance and improve their social life, or to be able to give a concrete definition of or a possible development for online sociability.

Despite the fact that there is a willingness to use new technologies, people like to share information by the more traditional communication means as the phone or by direct personal contact (see above). Text messages like SMS will mostly be used to confirm an appointment, or to ask when somebody can be contacted without interrupting something or disturbing (see before). For less intimate contacts (weak ties, or people they have a formal relationship with) email is preferred.

General Discussion of the Results

While a systematic analysis of the experimental results was not possible (due to the different variables implied by the two projects), a more qualitative comparison was attempted in the previous section to verify how users (in different settings, with different finalities) react and what they think about the possibility of online sociability. What is remarkable is that despite the differences in scope and target use, both case studies reached similar conclusions.

The initial H0 hypothesis, i.e., that everybody is a member of a community of some kind, is confirmed by both project respondents, even the mobile respondents, who were not selected on the basis of such a clear bond. They are interested in sharing content and information with the persons they know, provided certain conditions are met (namely, the privacy of everybody involved is respected). As a matter of fact they do not seem to understand the benefit of being in contact with people they do not know, not just to share personal information, but even to exchange content of some practical use for all the parties involved in the communication (like, e.g., information about city-located activities). The people that were selected for this pilot study were indeed not particularly familiar with Web 2.0 concepts and technologies, and had problems trying to transfer their actual real-life experiences online imagining how life "on the screen" might possibly look like and feel.

A similar mind set was experienced by the VIN respondents. The derived H4 hypothesis, i.e., that individual networking can be fostered in and by a virtual environment, does not seem to be verified on the basis of the data collected, since the experimental subjects did not seem interested in experimenting with new media in performing the activities of the associations they belong to. As for the H3 hypothesis, i.e., that the level of activity and the involvement within each community every person is a member of vary depending on the individual's role and motivation and consequently on the particular nature of the ties with part or all of the other members, there was a general stability in the ties within the associations these respondents were members of: the roles did not evolve, people did not seem to be looking for more occasions to meet, to deepen their relationships, or to communicate more than what the association life requires. And these were all members of leisure associations, like dance clubs or gardening groups, where one expects to find a much richer social life. The data suggests that the relationships in this study were static: intimate social contacts remain such throughout the life of the association and not intimate ones remain formal. People do not long to get better in touch with one another, as if they do not want to overrule the essence of the association/community they belong to.

c onditions for e ngagement

From the results presented above and the discussion that followed, a number of conditions that seem to be necessary to engage people in online sociability within meta-virtual communities have emerged. They can be grouped into the following items (see also in (Anderson and Rainie, 2006)):

- **Transparency:** Whatever can be achieved with the technology has to be transparent for the user. Transparency is in this sense another way of saying that the user has to remain in control of what s/he does and what happens with technology. Transparency also implies a circular phenomenon, i.e., that the user has to be confident in him/herself using the technology and at the same time that s/he should trust the technology and feel secure while using it. In both cases, the respondents who took part in these studies did not feel that the technology they were using was transparent for them.
- **Privacy:** This is a central issue. And in some sense it is in opposition with the previous one: how can communication be transparent if it has to guarantee privacy as well? Where is the balance between opening up one's data, information and keeping it private? How much do people want to disclose about themselves and to whom? While different scenarios of information disclosure had been identified depending on the profile of the receiver, it is not always clear how customizable and flexible this practice is both from a technological point of view but mainly from the user's expectations, trust and sense of security in technological innovation.
- **Collaboration:** This also seems to be a critical issue as well, but for other reasons. The notion itself of online sociability relies on and presupposes collaboration among people, also among people who never met (online or offline) before. It seems however that this is precisely what scares potential users due to the mixture of the transparency and privacy concerns discussed earlier.
- **Involvement:** Users express some preference for certain media over others (see above). This distinction can be based on habits but also on expectations: certain media involve subjects more than others, certain media allow them to get more directly and intimately in contact with their social ties than others and all this can result in a higher engagement in the relationship, in the form of collaboration, of communication, or of community participation. Because of the critical issues discussed above (i.e., the necessity to find a balance between transparency and privacy, for instance), it seems that a technology that would appeal to these respondents should be a technology that supports all this. A "warm" technology, to say it in one of the respondents' words. If the Web 2.0 is one such technology, is still to be discovered.

conclus lon

This paper compared two case studies dealing with the notion of online sociability in an attempt to model users' expectations about the conditions for engagement in online sociability within a meta-virtual community. The two cases considered were rather different in target users and objectives but were both dealing with such a notion and with its implications for users. Their common denominator was a basic assumption, namely that everybody is member of a community of some kind (e.g., friends, family, colleagues, neighbours). One project was dealing with community building through information and content sharing in a city setting; the other project focused on the notion of individual virtual networks in a home environment for mainly leisure activities. Both contexts verified the possibility of building a virtual network of more or less intimate social contacts to exchange information or content within the expectations of the needs and the desirable technological developments of the subjects that were selected. A restricted set of results from a preliminary analysis was compared in a mainly qualitative way, i.e., what technology respondents use to communicate, how much they are willing to reveal about themselves when communicating and how they see technology improve their present social life in the specific form analysed in each of the two projects. This comparison indicated that a number of conditions are necessary to make people willing to engage in this specific type of online sociability. They presuppose a balance between transparency in use and privacy preservation. In an instance of collaboration the implication of involvement also raises the importance of being a "warm" medium. This suggests that one single view of online sociability is rather restricted: online sociability seems to have a rather contextual nature, as the results presented in this study indicate.

acknowled GMent

I wish to thank all partners involved in both project consortiums. I particularly wish to thank my colleague Greet Jans who worked on previous papers related to one of these projects.

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KEY TERMS

Community of Practice Based on a Common Interest: Communities whose members have some interest in common that they develop together. Coming together to pursue it is a way of supporting each other by exchanging experiences and giving feedback to one another. This enhances the learning of all the members of this community.

Online Sociability: A way of keeping social contacts that develops in virtual environments. Different kinds of online sociability are possible (e.g., negative, superficial, convivial, see in (Clemmensen, 2006, http://ir.lib.cbs.dk/download/ISBN/x656516967.pdf) for details). Online sociability has to be enhanced by a specific technology and supported by an adequate design (see in (Preece, 2000)).

Online and Virtual Communities: Networks of both strong and weak ties that take place virtually, in an online environment. Virtual communities express online sociability (see above).

ENDNOTES

1. Other related results can be found in (Calvi, in press).
2. This is the A4MC[4] project, i.e., Architectures for Mobile Community Content Creation (https://a4mc3.ibbt.be).
3. This is the project VIN, i.e., Virtual Individual Network (https://projects.ibbt.be/vin).
4. The difference between meta-virtual and semi-virtual communities is that for the former, the online existence is seen as an extension of its real world counterpart, and has therefore an ancillary role, whereas for the latter both existences, i.e., online and offline, are equally important, although they might not involve all community members.
5. Personal Digital Assistant.
6. The *Participatory Community-Centered Development* (PCCD) framework offers the widest perspective on the community building process. It foresees four stages in community development (i.e., (i) understanding community's social needs; (ii) developing a conceptual model of it; (iii) refining sociability and usability; (iv) supporting the community's growth and expansion. These four user-centered stages presuppose a technological process which consists in the selection of a system that can support all this) and identifies three elements to support online sociability, namely "the community's purpose, its people and the policies that help to guide online behaviour" (Preece, 2000).
7. The description of the experimental protocol, of the methodology adopted and of the results as such has been partly presented in (Calvi, 2006). See also (Calvi, in press).

Chapter XXXVII
Socio-Technical Systems and Knowledge Representation

Ivan Launders
Sheffield Hallam University, UK

abstract

The UK National Health Service (NHS) provides the opportunity to undertake local socio-technical system design to help staff maximize the opportunities of using mobile technology whilst minimizing the impact of change to existing patient systems. A real-world example from a local NHS socio-technical system is considered, that contains a collection of mobile clinicians and technology which provides home care to patients. The success of the Mobile NHS service has a high dependency upon the social aspects of the solution and draws upon a combination of people, resources, technology and economic events. This chapter considers multi-agent system architectures, to model social complexity, and capture system knowledge, and then outlines a prototyping technique as a means of implementing and testing the design model. It concludes that the practice of implementing a prototype ontology provides a valuable step in clarifying meaning and understanding of concepts at the outset.

There is no distinction of meaning so fine as to consist in anything but a possible difference of practice

—Charles Sanders Peirce, How to make our ideas clearer, 1878.

Introduction

Socio-technical systems have arisen in response to the challenge of understanding complex technical systems that are embedded in a human world (Trist, 1981). Multi-agent System (MAS) architectures are used to build complex technical systems using social concepts such as agents and intelligent agents, which often comprise of many autonomous entities that communicate across multiple organisational tiers. Gathering requirements for such systems and accurately implementing and testing them is a challenge.

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As computing moves from single node systems into vast multimode networked systems capable of operating autonomously we need software solutions that are capable of operating with some degree of autonomy acting socially in our best interest. Woodridge et al. (2000) describe this as a software environment which is capable of autonomous action to meet design objectives. Such a system is described as an *agent*. Taking this definition one step further Woodridge, (2001) describes an *intelligent agent* as being reactive, proactive and exhibiting social behaviours. If an agent can embody reactive, proactive and social characteristics, then it also possesses the necessary characteristics to be able to transact with other similar agents. Agents can then transact to exchange knowledge. Methodologies for MAS development are still evolving and with the rapid expansion of Web Services and the Semantic Web (Berners-Lee, 1999), tools and architectures are now more in demand.

Hill et al. (2006) identify that whilst many approaches and tools assist various tasks required to develop a Multi-Agent System there still exists a gap between the generation of MAS models and implementation. Hill's work provides "A Requirements Elicitation Framework for Agent-Oriented Software Engineering". Hill provides a preliminary design framework using conceptual graphs to show how the Transaction Agent Modelling (TrAM) approach assisted the design of complex community healthcare payment models. Insight gained during the design process is used to enrich and refine the framework in order that detailed ontological specifications can be constructed. Conceptual Graphs (Sowa, 1984) are a system of logic based on Charles Sanders Peirce's existential graphs. Conceptual graphs are a flexible and extensible method for knowledge representation, they are particularly useful forms of semantic networks, as they also include generalisation hierarchies of types, relations, and complete graphs (de Moor, 2004). A proposed use of conceptual graphs would extend established methods of designing socio-technical systems such as using the Unified Modelling Language (UML). UML can be extended using conceptual graphs to support ontology engineering, conceptual graphs and semantic networks are examples of knowledge representation languages. They have the full power of first order logic and can represent model and higher-order logic, they have a direct translation into natural language. Conceptual Graphs consists of a "formal language" to access knowledge and meaning in both computer and people systems. Transactional Agent Modelling (TrAM) provides a framework employing conceptual graphs for enriching the requirements gathering process for multi-agent systems. For these reasons conceptual graphs are our formalism of choice to model social complexity.

Taking a real-world example such as Mobile NHS it is possible to analyse the complete system knowledge of a socio-technical system and then refine that analysis and test it through a prototype implementation. Having mobile access to data entry at the point of care electronically could ensure that the right data is captured first time and in real time, the correct treatment coding is used, assessments are completed in full, tighter security of data and governance of access is provided, and that decisions are fully auditable reducing the risks of miss-transcription. A mobile transaction offers the opportunity to remodel the old process and remove needless system boundaries to bring transactions closer to their intended goals (Launders et. al, 2007). Having mobile access to patient records could enable medical decisions to be supported at the point of treatment, they could allow for electronic patient records to be examined at a patient's home, improving the level of care at the same time as saving time, money and resources. This would lead to more patients receiving home treatment. A mobile clinical application that considers the socio-technical aspects of design such as the context of the treatment being provided at the same time as using knowledge of previous treatments provided and then applying inference to deduce more facts about the treatments, could prove a smarter system application. A smarter system application may be able to make the projection and alert that a treatment could be potentially dangerous or inappropriate for a given set of circumstances. An example of this could be a general practitioner (GP) who specializes in family medicine providing primary care, using mobile access to patient records to gain a greater knowledge and vigilance of drug-drug and drug-condition interactions at the point of treatment in a patient's home.

CONCEPTUAL ANALYSIS

Conceptual Graphs (Sowa 1984) are a system of logic based on Peirce's Existential Graphs (Roberts, 1973). They have the full power of first order-order logic and can represent model and higher-order logic, they have a direct translation into natural language. Conceptual Graphs consists of a "formal language" to access knowledge and meaning. Knowledge bases are the means to represent knowledge and meaning. A conceptual graphs is a graph or network of two kinds of nodes:

1. Concepts;
2. Relations.

The nodes have arcs between them. The arcs are always directed, i.e., they have a direction. This is indicated by an arrow head. An example of a conceptual graph may be written in the following 'linear' text based form:

[Concept_1]→ (relation)→ [Concept_2].

Consider the Mobile NHS example:

[Home Care]→ (requester)→ [Patient]

Reads as "The requester of the Home Care is the patient"

[Home Care]→ (manager)→ [Mobile NHS]

"The manager of Home Care is the Mobile NHS"

[Platform]→ (provider)→ [Mobile NHS]

"The provider of the platform is the Mobile NHS"

[Home care]→ (producer)→ [Mobile NHS Services]

"The producer of home care is the Mobile NHS Service"

Modelling a socio-technical system using conceptual graphs could reveal where systems could maximise their effectiveness. Disciplines that use conceptual analysis give it a different name. In the computer field the most common names are system analysis, enterprise analysis and knowledge engineering. The goal of the analysis being to formalise a catalogue of concepts, relations, facts and principles about Mobile NHS. The result of the analysis is an "ontology" for a possible Mobile NHS world or socio-technical system, this is a catalogue of everything that makes up the world in a given Mobile NHS domain and how it is put together and how it works. Sowa (1984) describes the word "ontology" as the study of the categories of things that exist or may exist in some domain. The product of such a study, called an ontology, is a catalogue of the types of things that are assumed to exist in a domain of interest D from a perspective of a person who uses a language L for the purpose of talking about D. So the initial output for the analysis of Mobile NHS as a socio-technical system would be an ontology, which would increase in complexity as more knowledge was represented and could be expressed in the linear form or in a visual display form illustrated in Figure 1

The linear form of this graph reads:

[Home Care] –
    (requester)→ [Home_Patient]
    (deliverer)→ [Care_Professional]
    (manager)→ [Mobile_NHS].

In Conceptual Graphs, type labels belong to a type hierarchy. Thereby:

General_Practitioner < Care_Professional

This means General_Practitioner is a more sepecialised type of the type Care_Professional i.e. General_Practitioner is a subtype of Care_Professional. Subtypes and supertypes are analogous to subclasses and superclasses in object-orientation, thus a subtype inherits the characteristics of its supertypes.

Polovina (2007) provides an introduction to conceptual graphs explaining how a powerful knowledge representation and inference environment exhibits familiar object-oriented features of contemporary enterprise and web applications. Conceptual graphs are core to the ISO Common Logic standard ISO/IEC FDIS 24707 (Delugach, 2008). Common logic is a framework intended for information exchange and transmission. This framework allows for a variety of different syntactic forms, called dialects, all expressible with a common XML-based syntax and all sharing single semantics. Common logic fixes meaning of a few conventions such as numerals to denote integers and quotation marks to denote character strings, and has provision for the use of data types and for naming, importing and transmitting content on the World Wide Web using XML. The common logic syntax and semantics provides a full range of first-order syntactic forms, with their usual meanings.

socIal worlD anD desIGn

Stamper's "Semiotic Ladder" provides a framework with the "social world" at the top of the ladder with beliefs, expectations, commitments, contracts, law, culture to provide a basic check list for analysis and design (Stamper, 1996). Stamper proposes that solutions should handle "meaning, context, cultural knowledge, and the structure of conversation" (Stamper, 2007). With these goals in mind we have to produce designs that handle these issues.

Figure 2 illustrates Stamper's "Semiotic Ladder" as a framework to identify where the human information functions sit in relation to the IT platform.

The semiotic ladder identifies that information systems function adequately when signs are handled correctly on every level and that ineffective systems tend to ignore problems on one or more levels, often the upper three level of the Semantic ladder (social world, pragmatics and Semantics). Technical levels are often well catered for whereas formalising the analysis and designing the semantics, pragmatics and social aspects of an information system at human levels could be formalised. Stamper outlines that designing smart applications incorporating conceptual structures mostly employs methods from the syntactic level, especially logic and computing theory.

An experienced designer would consider the problem from a human and social level but they would tend to deal with it intuitively and informally using experience and domain knowledge from previous work. Conceptual graphs (CG's) allow the designer to represent knowledge and to use interactive tools such as Amine (Kibaj, 2004-2007) for translating natural language into a knowledge representation language.

Conceptual analysis enables the systems analyst to define the socio-technical schemata for a knowledge based system. Applying conceptual analysis through a framework approach such as Transaction Agent Modelling (TrAM) (Hill et al. 2006) provides the focus that builds upon the rigour of CG's by providing model checking to assist in the early requirements capture. Early analysis stages in design are about analysing

Figure 1. Ontology expressed in visual display

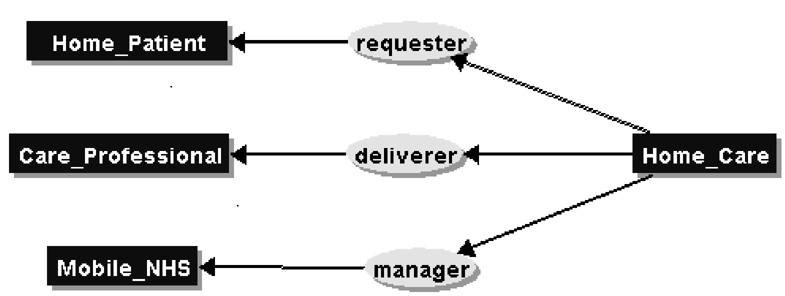
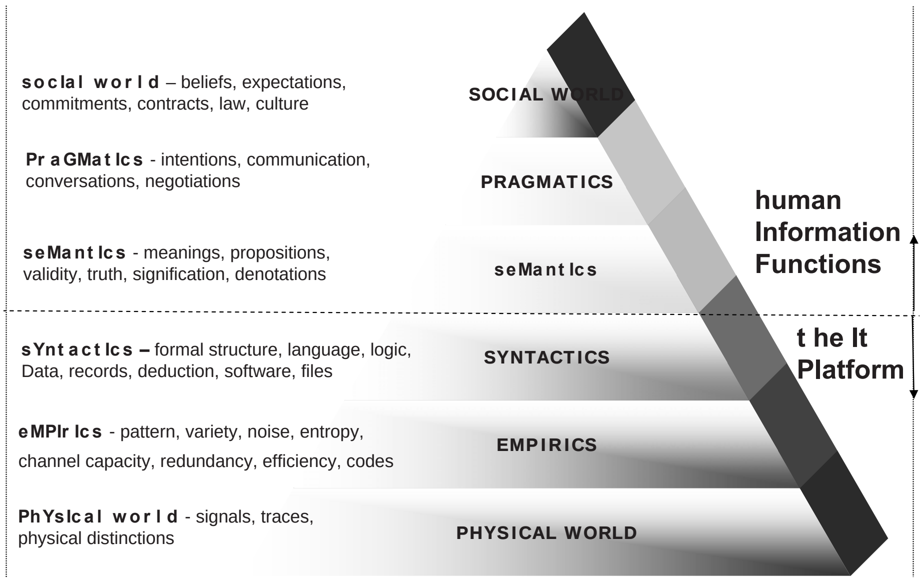


Figure 2. Stamper's semiotic ladder



the problem in a given domain. Understanding the concepts, relations, facts, principles and important features such as:

- **Inference.** Deducing or concluding missing or more information from Mobile NHS system fact and reasoning. Projection plays an important role in inference.
- **Context.** Clarifying meaning from parts that immediately follow or proceed. The Mobile NHS system could remember the current topic of treatment and uses the context to resolve meaning.
- **Knowledge Base.** Interactions based on systems knowledge of the subject. Adding new knowledge where possible as opposed to using detailed procedure for every possible transaction.

The results of the analysis and the description of the concepts within a particular domain are known as an *ontology*. The ontology contains the understanding of knowledge in a given domain, creating that ontology requires input from domain experts and design models. Creating that ontology could benefit from methodology and tools and its process is likely to be iterative.

A significant step in creating an ontology is not only being able to accurately capture and represent knowledge but to be able to realise it in an implementation. Capturing data, understanding the concepts behind that data and knowing what it is possible to do with those concepts. Then being selective about what data to use and why we are using that data is a key design step. The problem of meaning and the clarity behind this becomes a key design goal, and being able to translate that meaning into implementation as closely as possible. Therefore the translation from requirements capture through to an efficient implementation is a crucial component of socio-technical design in a socio technical system.

Framework and Prototype Technique

Conceptual analysis enables the designer to define the schemata for a knowledge based system. TrAM addresses the early stages of the analysis for Transaction Modelling. The TrAM framework suggests that to design and implement an enterprise system we follow the steps:

1. Capture concepts;
   a. Model the system with CGs.
   b. Capture all concepts, relations, stakeholders, goals, governing bodies, norms, 'custom and practice'.
   c. Examine graphs for joins and common specialisations.
   d. Identify goals.
2. Transform models with TM;
   a. Identify qualitative and quantitative goals.
   b. Produce type hierarchy and identify missing nodes. Verify models against initial requirements and high-level goals.
   c. Parse TM models and check statements with domain expert
   d. Specialise TM models with new knowledge.
   e. Update type hierarchies and examine for concept type generalisation.
3. Refine the requirements analysis with use cases;
4. Inference against models and verify;

The next steps in the technique developing upon the TrAM framework are to prototype and verify the model:

5. Create a first iteration of a prototype ontology using the Amine LexiconOntology layer;
6. Refine the conceptual catalogue relations through the prototype ontology;
7. Iterate the prototype Ontology through CG Operations testing TrAM;
8. Create and test the ontology rules.

Figure 3 illustrates a prototype and model verification stage in more detail.

MobIl e nhs use case exaMPl e

Lack of IT support at the point of treatment can restrict the quality of medical care provided by a mobile clinical workforce (Coiera, 2007, and Health Insider, 2008). Observation during a mobile clinical workforce pilot (Mobile NHS, 2007) providing mobile access to patient records and treatment data revealed a complex working socio-technical system in need of design and while medical care was successful the use of technology was only partially successful.

Mobile NHS provided access to patient records at their homes in an attempt to improve IT support for clinicians at the point of treatment. By analysing the results of mobile NHS trial and modelling the system at a conceptual level it is hoped that it will reveal patterns of behaviour showing how to maximise the efficiency. Mobile NHS as a process is a complex mixture of mobile technology, process, people and their surroundings. It is true to say that mobile technology can be used in multiple, and sometimes unexpected ways, the design challenge is how best to model that social complexity. Figure 4 illustrates Mobile NHS.

Mobile NHS consists of three specific groups of users, identified as key stakeholders:

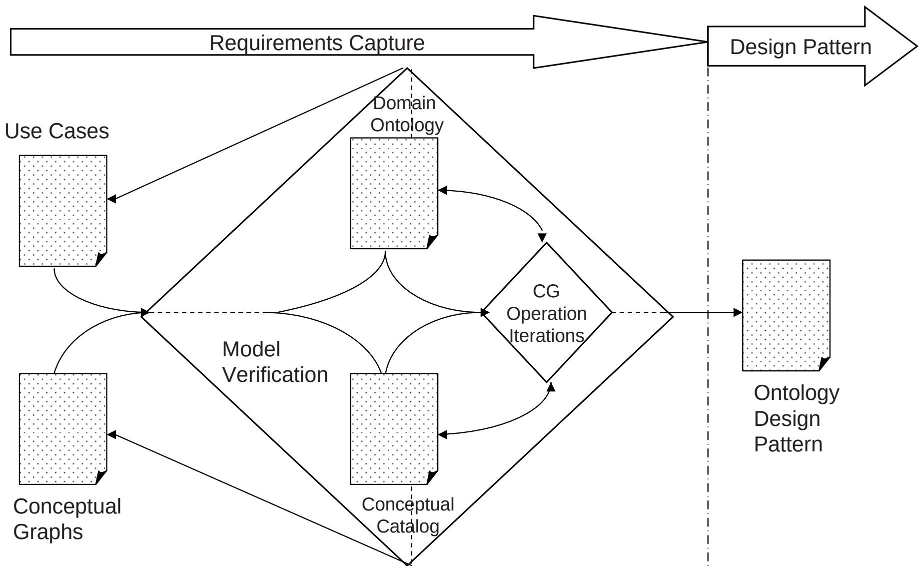
1. **Patients:** Patients receiving treatment and diagnosis in their home;
2. **General Practitioners:** GP's visiting patients at their home or away from GP clinics or NHS buildings.
3. **Clinicians:** Nurses visiting patients at patient's homes or away from clinics or NHS buildings.

The three month NHS trial using a mobile device to access patient records revealed an abundance of benefits and requirements. Examples of which are described by the stakeholders in Table 1. An initial view of these requirements showed a number of design goals to be scrutinised.

Specific design objective and challenges are:

1. To explore and model the main mobile transactions
2. To identify and model the key links between economic events, resources and clinicians in the mobile transactions, then to optimise the model.

Figure 3. Model and prototype technique



It is likely that analysis focused around design goals will link together several requirements. For example, designing transactions to be 'paper light' will involve the analysis of 'trust' in transactions as well as that of the economic and ecological benefits of not printing out paper at every step of a transaction. Whereas analysis around design goals such as 'maximising the use of appointment resources' will explore more direct relationships between economic resources and economic events.

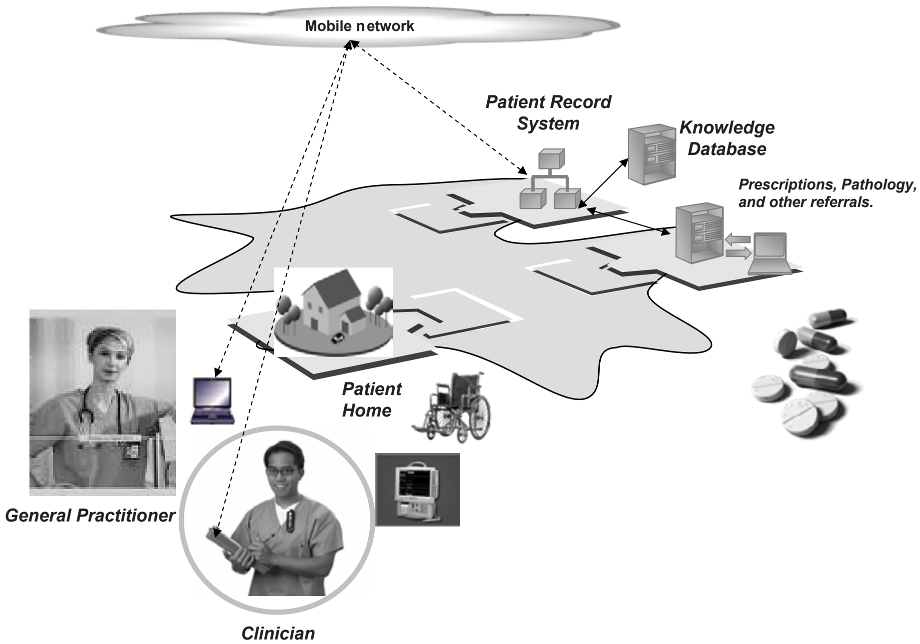
Transaction Agent Modelling

Designing Mobile NHS requires the designer to consider the system concepts and components in detail. Concepts such as accessing patient records and completing patient assessments within a mobile context. A designer needs to explore how system components can function in a mobile domain and how the concepts for that domain can change. This process takes advantage of the opportunity to maximise a requirements capture stage.

The requirements capture stage should tease out concept and system component details identifying those requirements that can make a real difference to the system, polarising those requirements which have the largest effect on the systems design. In order to maximise the requirements capture stage using conceptual graphs, a modelling approach is needed which allows for interactive adjustment and re-design. Design refers to the process of originating and developing a plan for a product, structure, system, or component. A design in the Mobile NHS domain can be used as an outline architecture, description or model.

TrAM can be used to capture the early requirements for a design pattern in transactional designs where the design goals model the links between resources and economic events. A design pattern is a general repeatable solution to a commonly occurring problem in software design which could be stored and re-used (de Moor, 2005). A design pattern is not a finished design that can be transformed directly into code. It is a description or a template of how to solve a problem that can be used in many different situations. Using conceptual graphs as a starting point without a framework such as TrAM to focus on the design goals would result in the requirements capture and analysis being very abstract. TrAM provides guidance and focus to Mobile NHS transactions. Making design goal choices based around resources and economical events, a key part is exploring and setting design goals and then refining those goals.

Figure. 4. Mobile NHS socio-technical system



Our process starts with the goals identified by Mobile NHS stakeholders. Stakeholders revealed and described a number of key benefits, TrAM focused the modelling of these benefits through the requirements gathering stage.

A mobile NHS system for clinicians and GP's to be able to access patient records during visits to patients is likely to be complex in terms of transactions, involving a mixture of repetitive and bespoke transactions. Hill, et al. (2006) identify that whilst the Multi-Agent System (MAS) paradigm has the potential to enable complex heterogeneous information systems to be integrated, there is a need to represent and specify the nature of qualitative conceptual transactions in order that they are adequately understood. Polovina et al. (2005) show how Conceptual Graphs enhance the initial requirements capture of multi-agent system. Conceptual analysis enables a system's analyst to define new concepts schemata for a knowledge based system. TrAM provides a framework that builds upon the rigour of CGs by providing model checking to assist in the early requirements capture.

The early analysis stage in TrAM is about understanding the problem in a given dimension and then defining the requirements and their goals. Identifying a model relevant to the mobile NHS domain and context, and then constructing a model to test the design. The TrAM framework is used to produce a set of artefacts including:

1. High level conceptual models demonstrating qualitative influences upon the Mobile NHS case study;
2. Specialised Transaction Models (TM) illustrating the relationships between events and resources;
3. A hierarchy of concept types and an audit trail of key modelling decisions;
4. An Ontology development from the requirements models.

TrAM first captures some concepts for the mobile NHS solution, the principle being that you don't need to be a subject expert to capture the initial concepts, according to the principle that it is an unconstrained view of the subject domain. Expert knowledge is then introduced whilst providing knowledge feedback. Hill (2006) shows that expert knowledge develops in light of the checks and balances that the model provides.

Table 1. Example stake holder benefits, requirements and design goals

Design Goal	Stake Holder Benefits and Requirements
Paper light transactions (Transactions without the exchange of paper).	a) Mobile access to patient records real time allowed clinicians to work in a "paper light" way, a paper light system does however demand high reliability.
Increase transaction trust.	b) Paper systems and the transfer between paper based systems are significantly slower, plus inherently less secure and robust.
Reduce transaction time.	c) The entry of a new patient record or assessment was typically reduced from 1 ½ hours to between 20 and 30 minutes when accessing the patients records electronically. The overhead is greatly reduced for what could be a 5 minute treatment such as an injection.
Improve transaction workflow and scheduling.	d) Mobile access to patient records in shared mode allows for support notifications of treatments to be passed in real time between clinicians within the care teams. Support notifications being passed between members removes the need for relying on voice, missing each other and then chasing through information. Providing more robust and safer care.
Increased speed for transaction fulfillment process.	e) Mobile access allows for immediate requests to be made for prescriptions, pathology requests and other referrals.
Improve transaction security.	f) Mobile access to patient records improves the security of patient records and notes. Paper based copies often means one copy of a patient's record or treatment plan. Paper for mobile clinicians is very insecure, often carried in a clinician's car.
Improve transaction security.	g) A GP using mobile access to patient records allows for greater knowledge and alerts of drug-drug and drug-condition interactions at the point of treatment.
Maximise use of appointment resources.	h) GP's can book appointments real time using mobile access.
Real time access to medical test results.	i) Pathology results can be made available real time.
Reduced transcription errors.	j) Provision of the information once at the point of care ensures zero manual memory or transcription errors (reduced errors on notes taken which are later recorded).

Applying TraM to Use Case

Using unified modelling language (UML) "use case" diagrams capture system behaviour. The purpose of the initial "use case" diagrams is to illustrate an overview of functionality provided by the system in terms of its actors, their goals represented as use cases and any dependencies between those use cases.

To capture an initial use case it can be helpful to create a very high level use case model of the benefits described by the Mobile NHS stake holders during the trial. This step can provide analysis to show process logic to further develop the understanding of the Mobile NHS ontology. Map the initial use case diagrams to conceptual graphs to represent the main concepts.

Figure 5 provides the generic event accounting transaction model used in TrAM modelling the concept between the transaction economic event and economic resources based on the work by Geerts and McCarthy (1991) and further developed by Polovina (1993). The purpose of this step is to enrich the requirements capture stage prior to modelling a Mobile NHS design.

The Transaction Model denotes that home care is a transaction that arises due to the occurrence of two economic events, a 'complete medical assessment' and a home appointment (Figure 5). These are considered economic events because they place a demand upon limited resources. The 'Complete Medical Assessment' requires significant medical resources by the NHS at the cost of other resources. Similarly the 'Make Appointment' takes clinician or GP time and resources traveling to a patient at home. Hence Mobile NHS needs to provide a balance between patient home visits and the medical conditions receiving that level of treatment. The corresponding benefit for 'costs' is the economic resource of the patient treatment at home, this concept of patient treatment being an economic resource provides a focus for the Mobile NHS transactions relating economic resources to economic events.

Mobile NHS is shown as the destination of patient treatment. This would be better informed by an effective measure. Figure 5 shows a measure in the form of a performance indicator (PI). A measure can offer quantifiable information upon which a clinician can make an informed decision therefore some economic resources need to have a characteristic of being measurable.

A conceptual relation describes constraints on the use of the relations in Conceptual Graphs. The collective set of conceptual relations form a Conceptual Catalogue published by Sowa (1984) (pp405-424).

KNOWLEDGE BASED DEVELOPMENT ENVIRONMENTS

Following an initial analysis and modelling stage using TrAM, the next step is to implement a model using a development environment that allows operations to be performed on the Conceptual Graphs. It is hoped that by performing operations such as the joining of graphs it will be possible to facilitate the inference of more knowledge in a given domain because more projections can be made in bigger graphs. Maximal join is an extension of join in SQL (Sowa 1984), it defines that the optimal method graphs can be joined. It is hoped that by carrying out CG operations on Mobile NHS domain model it will be possible to learn more about the domain and how to make improvements to this socio-technical system, leading to an improvement in the quality of medical care provided by Mobile NHS.

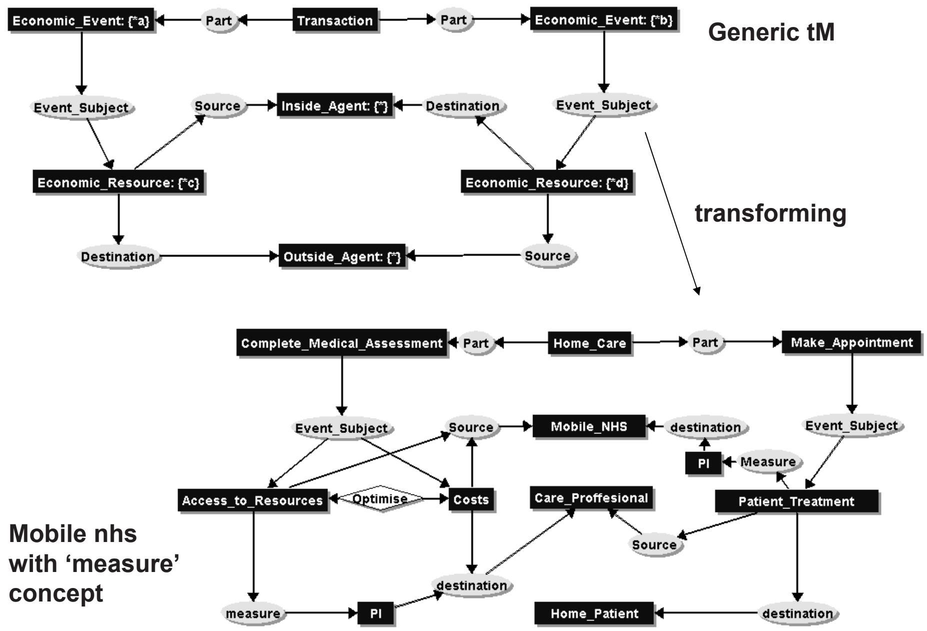
There are a very few conceptual tools which can be used for modelling conceptual graphs. Charger (Delugach, 2007) is a conceptual graph creator and editor and SeSAM is (Shell for Simulated Agent Systems) (SeSAM, 2006 and Maybery and Polovina, 2007) capable of providing a generic environment for modelling and experimenting with agent based simulation. SeSAm is a Multi Agent Simulation tool which uses graphical user interfaces with UML style mapping in the creation of simulated environments. Alternatively it is possible to build and model Conceptual Graphs using Prolog with extensions. Prolog+CG is an implementation in Java of standard Prolog, but with extensions for handling the Conceptual Graph theory of Sowa (1984). Object-Oriented extensions are also provided. However Prolog+CG has been developed by Kabbaj (2004), the original author of Prolog+CG. The new version is included in the Amine-platform. Amine (Kabbak, 2005-2007, Kabbaj, 2007, Kabbaj ,2006, & Kabbaj et al 2006) is a multilayered platform and integrated development environment, based on CG theory, this platform is the most current environment for implementing symbolic programming, intelligent system programming and intelligent agents programming.

There have been other development tools such as those developed by Heaton & Kocura (2000) who identified an Open World Theorem Prover for Conceptual Graphs however these tools are not in the public domain. Heaton & Kocura's work outlined and illustrated the functionality of a theorem prover for Conceptual Graphs. Their system was based on Peirce Logic and implemented CG theory including open-world semantics with three truth values: true, false and unknown. It used type and relation inheritance for projection, nested negated context, inference by modus ponens and modus tollens.

Given all of the above considerations Amine should be the development platform of choice for Mobile NHS. Amine is a modular integrated development environment based on CG theory and suited for intelligent system programming and intelligent agents programming (Kabbaj 2006 & Kabbaj et al. 2006). The Amine Platform is a suite of software tools used for building "intelligent" applications within amongst others the fields of Artificial Intelligence, Knowledge-Based Systems, Natural Language Processing, Agent-Based Systems, and others requiring conceptual structures. Amine is composed of five hierarchical layers:

1. **Ontology Layer:** This layer contains a multilingual ontology editor to build an ontology. Starting with "Universal" as the root or top node and "Relation" as the Relation Hierarchy Root. This is the first place to start in terms of building the Mobile NHS ontology.

Figure 5. Generic transaction model (TM) transforming mobile NHS model with 'measure' concept



2. **Algebraic layer**: This layer provides type of structures and operations including CG structure and CG operations. These structures and operations are "inherited" by higher layers in Amine. The layer provides basic and common operations along with matching-based operations common to all structures such as match, equal, unify subsume, maximalJoin and generalise.
3. **Programming Layer:** This layer provides three programming environments, including PROLOG+CG based on CG extensions to PROLOG, activation and propagation-based programming embedded in the SYNERGY language based on executable CG and ontology or memory-based programming concerned with incremental knowledge in an ontolog.
4. **Agents and Multi-Agent System layer:** This layer allows Amine to be used with a Java Agent development environment to develop multi-agent systems. This level is already offered by other open source projects such as JADE.
5. **Application Layer**: This layer allows for the development of various types of applications including ontology based applications.

Although these five layers are built on top of each other they can be used independently to model or implement solutions such as Mobile NHS. Lower layers can be used without higher layers and can be used directly with other domain specific Java applications. The overriding design goal of Amine has been to implement with modularity and independence between component layers.

Pr ot ot YPe ont ol oGY

Starting with the ontology layer (LexiconOntology) create a first iteration of an ontology based on the TrAM analysis for the Mobile NHS domain. This step will drive out the detail behind the conceptual relations for the Mobile NHS domain. Defining the conceptual catalogue and the conceptual relations to be used in the Mobile NHS model will be an iterative process in that as the ontology develops, it is likely that conceptual relations and their definitions will become clearer.

Amine's Ontology layer gives the designer the opportunity to perform Type Hierarchy Operations on the Mobile NHS ontology created, testing and examining the logic in the ontology. Ontology layer operations include:

1. IsSubType
2. IsSuperType
3. DirectSubTypes
4. DirectSuperTypes
5. AllSubTypes
6. AllSuperTypes
7. MaximalCommonSubType
8. MinimalCommonSuperType

Implementing conceptual relations

The reference point for defining conceptual relations is Sowa's published 'Conceptual Catalogue' (Sowa 1984, pp405-424). Combining these conceptual relations together with more specific event accounting transactions from Polovina's work (1993) will give a domain specific conceptual catalogue to model Mobile NHS in Amine. Starting with two relations (SRCE) and (DEST) from Sowa [a8] p419:

Amine uses a slightly modified notation for expressing CG's in Linear Form.

Sowa would describe a relation as:

relation PART(x,y) is [Universal:*x]-Relation->[Universal:*y]

The equivalent in Amine is:

relation PART(x,y) is [Universal:x_source]-Relation->[Universal :y_target]

Therefore the relations above can be expressed as below:

relation SRCE(x,y) is [Act:x_source]-Relation->[Entity:y_target]

relation DEST(x,y) is [Act:x_source]-Relation->[Entity:y_target]

Referring back to the generic TM of Figure 4, we see that:

[Economic Resource:x_source]-Source->[Agent:y_target]

[Economic Resource:x_source]-Destination->[Agent:y_target]

Therefore we can derive that:

relation Source(x,y) is

[Economic Resource:x_source]<-SRCE-[ACT]-AGNT->[Agent:y_target]

and:

relation Destination(x,y) is:

[Economic Resource:x_source]<-DEST-[ACT]-AGNT->[Agent:y_target]

Figure 6 illustrates in linear form the relations for Source and Destination and their use in graphical form in Amine for the Mobile NHS use case model:

The linear form for the graphical illustration in Figure 5. can be expressed as below:

SIT#01
[Agent :y_target] -
-dest->[Economic_Resource :x_source],
<-Agnt-[Act]

SIT#02
[Economic_Resource :x_source] -
-source->[Inside_Agent:y_target]<-source-[Economic_Resource :y_target]-destination->[Outside_Agent:y_target]<-destination-[Economic_Resource :x_source]

The right hand side of Figure 4. illustrates a resulting MaximalJoin operation using a CGOperation in Amine's Algebraic layer. A MaximalJoin operation is carried out on the following two simple CG's which form a small part of the Mobile NHS ontology:

```
CG1
[Agent: Gordon]

CG2
[Agent :y_target] -
        -dest->[Economic_Resource :x_source],
          <-Agnt-[Act]
```

CG Operations in Amine provide the next step in the modelling process in that they allow the designer the opportunity to activate CG operations without dealing with CG and CG Operation application programming interfaces. The designer can observe through a CG model how system components can function in a domain. This process takes advantage of the opportunity to maximise the requirements capture stage testing requirements against system design goals.

Ontology related processes using Amine include classification, information retrieval, dynamic knowledge integration, elicitation and elaboration (Kabbaj 2006). These operations are as follows:

1. Equal;
2. Maximal Join: The joining of graphs facilitates inference because more projections can be made into bigger graphs. Maximal join occurs when graphs are joined on the most common, or *maximally extended*, projection;
3. Generalise;
4. Subsume: The *Classification process* uses subsume operation to classify a description in an ontology;
5. Subsume with Result;
6. Expand;
7. IsCanonic.

In Amine an *Information retrieval* process uses the classification process and searches to know if the specified description is contained or not in the ontology. The aim of information retrieval is not to answer by “yes” or “no”, but to situate the specified description in the ontology; to determine its neighbourhood: which nodes are “fathers” (minimal generalisations of the specified description), which nodes are “children” (minimal specialisation of the specified description) and which node is equal to the specified description.

The *Elicitation process* is an interactive process that helps a designer to make his description more precise and more explicit. The process will continue iteratively: it considers all the types used in the current description including the new types. Beside this *type-directed elicitation process*, Amine provides a *situation-directed elicitation process:* while type-directed elicitation operates at the concept level, situation-directed elicitation operates at the structural level.

Conclusion

Capturing and modelling the complete system knowledge in a socio-technical system is problematic in that it is difficult to gain a full understanding of complex technical systems that are embedded in a human world and then translate that understanding into an accurate implementation. An experienced designer would consider the problem from a human and social level but they would tend to deal with it intuitively and informally using experience and domain knowledge from previous work. The practice of modelling and implementing a prototype ontology provides a valuable step in terms clarifying meaning and understanding of concepts.

The production of conceptual graph models in the initial requirements capture for multi-agent systems enables higher-order issues to be captured by a designer, scrutinised and considered in an abstract way (Polovina & Hill, 2005). This compliments use case analysis, and promotes early discussion. The use of a particular graph, the Transaction Model, means that concepts can be evaluated in a way akin to transactional analysis. This analysis results in the generation of the most suitable term to represent concepts in the socio-technical system. The process steers the system designer so that the most pertinent questions can be asked of the expert, rather that requiring the system designers to be domain experts and rely on their intuitive knowledge informally from previous work. Also, the ability to query the representation for a socio-technical system allows models to be tested and validated much earlier in the system design process. The use of TrAM on a complex socio technical such as Mobile NHS illustrates how transactions can be scrutinised in terms of design goals. The TrAM approach allows an agent-based system to be designed that exploits different aspects of agent technology (Hill, 2006). In particular defining a semantic economic model to represent the relationships that exist between home patient home visits and the medical conditions receiving that level of treatment. This approach demonstrates that multi-agent technologies could be adopted to design socially complex systems such as Mobile NHS.

Building up a collective set of conceptual relations for a conceptual catalogue will enable an ontology to be tested and modified at run-time. Amine's ontology layer presents a specific ontology model and various related processes including edition, elaboration, elicitation, classification, information retrieval and dynamic integration (Kabbaj, et al. 2006). These processes are considered as "basic" ontology processes; they can be used or extended in many ways according to the need of the application's domain.

The Amine platform, with its Ontology Layer, used in conjunction with a TrAM design framework constitutes a starting point for "integrative development" of ontology-based intelligent systems and intelligent agents. Further work will refine the process for how TrAM can be implemented in Amine and how the implementation extended can be used as a design pattern in the Mobile NHS domain.

acknowledGMent

This work has been assisted by the generous efforts of Simon Polovina, Richard Hill and Paul Crowther.

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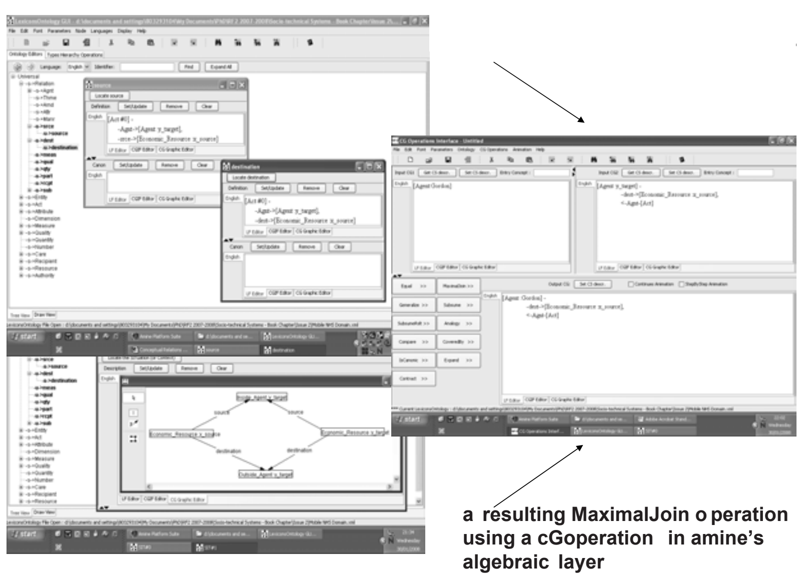
Figure 6. Source and destination relations and their use in graphical form



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KEY TERMS

Local Socio-Technical: Computer technologies that enable or support local social interaction used in the context of combining local health services with the use of computer and mobile technology. Computer and mobile technology used in a social network to provide local access to patient records at their homes in an attempt to improve the quality of home care to patients.

Intelligent Agents: Intelligent agents refer to software agents capable of being reactive, proactive and exhibiting social behaviour. Linking software and social behaviour intelligent agents are used in the chapter to describe multi-agent system architectures.

Conceptual Graphs: Conceptual graphs consist of a formal language to access knowledge and meaning. A conceptual graph is a graph or network of two kinds of nodes, concepts and relations. They have the full power of first-order logic and can represent model and higher-order logic. Conceptual graphs have a direct translation into natural language.

Transaction Agent Modelling: Transaction Agent Modelling refers to a framework employing conceptual graphs for enriching the requirements gathering process for multi-agent systems. The chapter uses transaction agent modeling as a formalism of choice to model social complexity.

Conceptual Analysis: In the context of this chapter conceptual analysis is the work of a system or enterprise analyst engaged in knowledge engineering. Conceptual analysis gives content to a graph or network of two kinds of nodes, concepts and relations.

Ontology: In the context of knowledge sharing, the chapter uses the term ontology to mean a specification of conceptual relations. An ontology is the concepts and relationships that can exist for an agent or a community of agents. The chapter refers to designing ontologies for the purpose of enabling knowledge sharing and re-use.

Conceptual Catalog: The theory of conceptual graphs is primarily formal; conceptual analysis determines the content. A Conceptual Catalog shows how the form can be applied to some of the words and concepts use in a domain. This chapter refers to a catalogue of conceptual relations to be used in the Mobile NHS domain.

Chapter XXXVIII
Social Support for Online Learning

Claire de la Varre
University of North Carolina at Chapel Hill, USA

Julie Keane
University of North Carolina at Chapel Hill, USA

Matthew J. Irvin
University of North Carolina at Chapel Hill, USA

Wallace Hannum
University of North Carolina at Chapel Hill, USA

abstract

This chapter describes the design of a sociotechnical system to support rural high school students in an online distance education (ODE) course. The design is based on the American Psychological Association's Learner-Centered Psychological Principles (LCPs). The system includes a Web-based module to train school-based facilitators to create a socially-supportive local environment for students and encourage community building among facilitators. The system also includes an online instrument for collecting data on learner-centered practices in the classroom and student perceptions of these. ODE typically has high attrition rates, in part because participants' social needs are often neglected, leading to perceptions of isolation. Additionally, success in online courses depends on students' abilities to engage in self-regulated learning, effective time-management and self-reflection, skills that many students in high school are still learning and may need help with as they engage in ODE. This system is an attempt to address these issues.

Nine tenths of education is encouragement.

—Anatole France

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Introduction

Rural schools make up 30% of all schools in the United States and educate approximately one out of every five children, amounting to more than 10 million children nationwide (National Center for Education Statistics, 2007; Rural School and Community Trust, 2005). Frequently, rural secondary schools are small, with more than half enrolling fewer than 400 students (Hobbs, 2004). Many of these schools face challenges resulting from their size and geographic isolation. These include a lack of highly-qualified teachers, limited curriculum offerings, reduced funding and threats of consolidation, where small local schools and districts are combined into larger, regional schools.

Rural high schools typically play a vital part in their communities and consolidation negatively impacts the social and economic health of these communities. Many students face bus journeys of several hours per day to consolidated schools, and both families and students participate less in school-based activities when the school is not local (Rural School and Community Trust, 2005). Thus rural communities are reluctant to embrace school consolidation and are increasingly turning to the Internet and other emerging technologies to address these challenges.

Online distance education (ODE)[1] can provide students with access to specialized courses, interaction with master teachers, and comprehensive and flexible learning opportunities that may not be readily available otherwise (Simonson, Schlosser & Hanson 1999; Simonson, Smaldino, Albright, & Zvacek, 2006).

In 2005, the National Research Center on Rural Education Support (NRCRES) conducted the first national ODE survey to focus exclusively on rural school districts (Hannum, 2006). The survey found that the majority of the participating districts (85%) had used ODE at some point, and 69% of districts were using ODE at the time of the survey. Many states have implemented online learning programs, with 50% of states now having a "virtual school"—more than double the numbers two years ago (Hannum & McCombs, 2008). However, incidents of student isolation and higher dropout rates in distance learning courses are frequent findings in ODE research. Given the large numbers of students who are educated in rural communities and the increasing use of ODE to extend and improve their educational opportunities, more attention needs to be focused on ways to enhance the effectiveness of ODE in rural schools and improve academic outcomes.

The purpose of this chapter is to describe the design, development and implementation of a Web-based intervention currently underway in rural high schools as part of a national research study funded by the U.S. Department of Education. We sought to enhance an ODE system, and thereby to improve academic outcomes for rural high school students, by offering social support for students at the local classroom level. This includes encouraging the development of a range of cognitive and metacognitive practices and strategies that will be beneficial in both virtual and face-to-face learning experiences. The participants in the system play one of three roles. The *online instructor* teaches the content of the course, the *student* takes the online course during an assigned class period each day in a small rural school, and the *on-site facilitator*, a staff member within each school, supervises and is available to help students with technological and other issues. All participants communicate via technology, but some also communicate directly, face-to-face, in the local environment.

Review of the Literature

There has been less ODE research conducted on the K-12 age group (primary and secondary schools) than in tertiary education and typically it has not examined the impact of different student populations or geographic regions such as urban, suburban or rural. Consequently, less is known about the effectiveness of ODE in high schools and the variables that influence it. Most distance learning studies compare the traditional face-to-face courses with distance learning and hundreds of these have reported remarkably similar findings: differences between face-to-face courses and distance learning courses are small, if they exist at all (Bernard et al., 2004). Some of these studies also sought to identify factors operating within ODE to influence academic outcomes. Active involvement of the online instructor and frequent, informative feedback have been shown to positively influence student outcomes but much research also reports high dropout rates, higher than 50% in some instances. (Carr, 2000; Fulton, 2002; Roblyer, 2006; Simpson, 2004; Zweig, 2003, cited in Rice, 2006; Parker 1999).

Success in ODE courses depends on the student's ability for self-regulation, independent work, and use of effective time management strategies (Parker, 1999). These factors are all less critical in traditional face-to-face courses where students and teachers interact continually. Research shows that participants who succeed in postsecondary online courses are better than average at time-management and balancing school and personal commitments, have higher rates of intrinsic motivation, and are experienced in writing and information searching (Land, Nwadei, Stufflebeam, & Olaka, 2003; Parker, 1999). In high school, however, many students are still learning, or are struggling with, such skills. Additionally, the lack of visual cues between student and teacher, and the often asynchronous nature of classes, can lead to student perceptions of isolation and lack of support.

Liu, Lavelle, and Andris (2002) found that as students progressed through an online course there was an increase in their internal locus of control, defined as the extent to which an individual attributes outcomes to internal versus external factors (Parker, 2003; Roblyer & Marshall, 2002). Kramarski and Mizrachi (2006) studied the effects of metacognitive support on self-regulated learning. The students who were learning online with metacognitive support outperformed all other groups. If intrinsic factors such as self-regulation and motivation are integral to success in ODE courses, it is important to create effective means to support students in developing and enhancing these traits and becoming self-reflective learners.

The disparate settings of rural schools mean that the learning environment is unique for each school and each set of students. K-12 research does not often examine the local social context in which the learning happens (Dingle, Napp, Gooch, & Kelly, 2000). Both learning and social interactions also occur outside the online environment and these are integral to students' experiences of the course. Having a social context that supports online learners may be more important for younger adolescent students, who are most vulnerable to isolation and lack of social interaction. To ensure that students persist and succeed in ODE courses, socio-technical systems employed in rural schools should therefore be informed by the local factors that affect student learning and the unique contexts within which the students interact with technology and each other.

Many virtual high schools use the teacher-facilitator model, assigning an on-site facilitator to operate equipment, distribute instructional materials, and answer students' questions. The role of the on-site facilitator in high schools is to help students develop competence in the domains that will be important for future success in college and beyond, and acquire the habits of reflection needed to develop self-awareness and to monitor their own learning progress. Kirby and Driscoll (1997) found that the facilitator was the person the students went to for help or guidance, and to keep them focused and on task, regardless of whether the facilitator had expertise in the content. Other studies found that the amount and quality of student participation was increased by the involvement of the on-site facilitator, and peer-to-peer interaction influenced student persistence in the course: in the absence of facilitators, students participated less and had higher rates of attrition (Frid, 2001, cited in Rice, 2006).

a theoret Ical Fra Mework

In 1997, the American Psychological Association (APA) developed a set of 14 learner-centered principles (LCPs) intended to guide educational reform at all levels and informed by a number of different research perspectives (APA Work Group of the Board of Education Affairs, 1997). The evidence on the effectiveness of these LCPs in classrooms has been widely documented (McCombs & Miller, 2007). This theoretical framework has recently been applied to distance education approaches to learning (McCombs & Vakili, 2005). LCPs indicate that learning is social in nature and that social interactions are a key element in learning. LCPs also outline other factors critical for learning, focusing on four research-validated domains, which can be summarized as follows:

1. The *cognitive and metacognitive domain* refers to thought processes involved in learning, including self-reflection.
2. The *motivational and affective domain* refers to effort and engagement while learning, affective and emotional factors, and the beliefs and interests that directly influence learning.
3. The *developmental and social domain* refers to the previous experiences of students and their learning readiness (i.e., developmental factors) as well as interpersonal relations between and among students and teachers (i.e., social factors) that affect current learning.
4. The *individual differences domain* refers to the differences between and within students that influence learning. Students have different strategies and skills for learning based on their backgrounds and prior learning experiences.

While much research focuses on motivation or individual characteristics as the factors that are most important for student success, researchers have determined that it is the interpersonal connections and group dynamics that will foster success in both face-to-face environment and online environments (McCombs & Vakili, 2005). Creating an environment that supports the learner in both online and offline interaction is seen as a vital contributor to success: "Focusing on building collaboration and group interaction may be more important than focusing on individual participation" (Simonson, 2006: cited in Rice, 2006). Thus we believe that an approach that incorporates LCPs to support students as they interact with technology is likely to improve student outcomes in ODE courses.

The consideration of the local, social context in which the students are embedded when they interact with the virtual environment became the central focus for our intervention and research. The aims of our current work are therefore to determine the ways in which facilitator practices affect student success in the ODE environment. We examine the multiple layers of interactions within the whole system, including consideration of both on and offline behaviors. These include interactions between students in the physical classroom and online, interactions between facilitators and their students, interactions between facilitators in their online community, and interactions between facilitators and the online instructors.

research des IGn

Pilot s tudy

Prompted by NRCRES survey data (Hannum, Farmer, Veal, Barber, Banks, & Sylva, 2006), we decided to examine local contextual factors including the role of the on-site facilitator in ODE. Seven rural schools were selected to participate in a year-long pilot study with a total of 40 students participating in three advanced placement (AP) courses: English Language and Composition, U.S. History, and Psychology. We chose to provide AP courses because they are nationally standardized and are designed and accredited by the College Board. We offered this array of courses, delivered via a widely-used content management system. Schools were responsible for selecting students for these courses and for identifying a facilitator, staff members who ranged from teachers to librarians and football coaches. They were provided, via the content management system, with articles and brief scenarios based on LCPs, and access to an online discussion forum. One goal of the pilot was to collect the facilitators' strategies for supporting students for future incorporation into our full intervention. The small rural schools were typically located in tight-knit communities where the facilitators not only knew the students very well but also their families. As a result, the strategies that these facilitators used with their students were very instructive for our expanded intervention design.

The pilot qualitatively confirmed the importance of the facilitator role, being critical in supporting students, particularly when online instructors were unavailable to students, or in some cases insensitive to their needs. Facilitators were crucial in preventing drop-out, student frustration and failure and successful online learning experiences were often due to the facilitators' good relationships with their students. Additionally, the pilot highlighted the unique contextual factors in rural schools that have to be addressed such as school closings for reasons ranging from the potato harvest to extreme weather, and technological issues Through the recruitment process for pilot, we became aware that large rural schools (>600 students), did not need AP courses because they had the resources to provide access to such courses while very small schools (<50 students) did not have the demand for such courses.

study design

A more extensive study funded by the U.S. Department of Education, is currently being implemented over a two-year period, with 112 schools and over 400 students participating. Our intervention is designed to train on-site facilitators to become learner-centered in their perspectives and the practices they use to support their students. This is a randomized, controlled, cluster design with two cohorts, 2007/2008 and 2008/2009. The unit of analysis is the individual school.

In each cohort, students in small rural schools geographically dispersed across the United States take a year-long online class in AP English Composition and Literature. The AP course is offered through *LearnNC*, a North Carolina-based organization that developed the teacher-facilitator model that we employ in this study. LearnNC uses an off-the-shelf content management system to deliver course content, host discussion forums and support administrative functions. Schools are required to have a minimum of four students in order to be eligible for the study. Our suggestions to principals were that suitable students should be college-bound, and the most academically-capable in the school. A pre-test modeled on an AP English examination was administered to students before they started the online course. The results from the pre-test showed no differences in the scores or abilities of the students across groups.

Participating schools are randomly assigned to either the intervention or control group, with the intervention group being exposed to an enhanced learner-centered approach. Once schools are assigned, sections of the online course, with 20-25 students per section, are created to include up to four geographically-dispersed schools. Each course section forms a discrete, virtual classroom and each of the two online instructors teaches a number of sections. Each school is required to appoint an on-site facilitator to be present when the students take the class each day. The facilitator supports the students in their online interactions with other remote students and the online instructor as well as in their interactions with peers in the physical environment. This socio-technical network is complex and includes multiple layers of interaction.

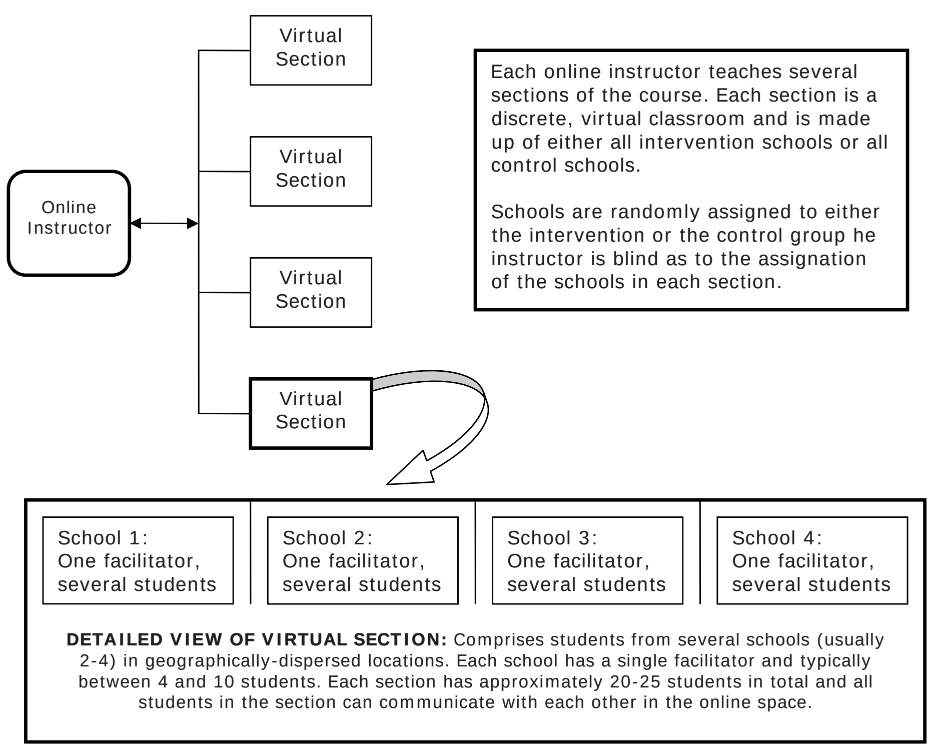
Schools within each treatment group are randomly distributed across instructors, with instructors blind to the assignment of schools. To prevent contamination, each section is either all-control students or all-intervention students and peer to peer interactions are limited to those peers in the same section. While students are assigned a specific class period each day where they collectively complete that day's assignment, the class is asynchronous because schools within any given section are on different schedules and may be in different time zones, and the online instructor responds to students anytime within a 24-hour period.

Figure 1 shows the organization of the online course, with a detailed view of a virtual section.

The social and technical parts of the system in this study are inextricably linked. All participants in the model, whether students, instructors or facilitators, navigate the system through a seamless combination of online and face-to-face environments and interactions, some of which may be experienced simultaneously. Figure 2 shows a detailed view of the teacher-facilitator model for a single, physical classroom in a rural school, with a description of the facilitator training in the intervention and control groups. Both intervention and control students are required to engage in interactions with other students in their section and the online instructor through instructors' assignments and the design of the online course. They also have the opportunity to engage in social exchanges online via discussion boards and email. Complementing these online interactions are the interactions in the physical classroom. Students spend a class period each day with their facilitator and peers in the school. Intervention facilitators have been trained in learner-centered principles to create a positive, interpersonal climate. They have access to materials with numerous strategies to support student learning, including collaborative exercises, and encourage students to engage in discussion offline as well as in the virtual classroom.

The facilitators in our study play a role that is complementary to that of the online course instructor although for both the aim is to help students become increasingly independent learners (Land et al., 2003). The facilitators do not deliver or teach the content, nor do they attend to online interactions that are part of the course. Instead, the facilitator's role is to support learners by addressing the immediate needs of the students in the physical environment and to encourage interaction, face-to-face discussion, and self-reflection within the group. If the key to the role of on-site facilitator is to support students' learning then a knowledge-base for doing so is needed. LCPs provided the theoretical and practical underpinnings of our intervention, which is described in detail later in the chapter.

Figure 1. Schematic showing organization of course sections and detailed view of section

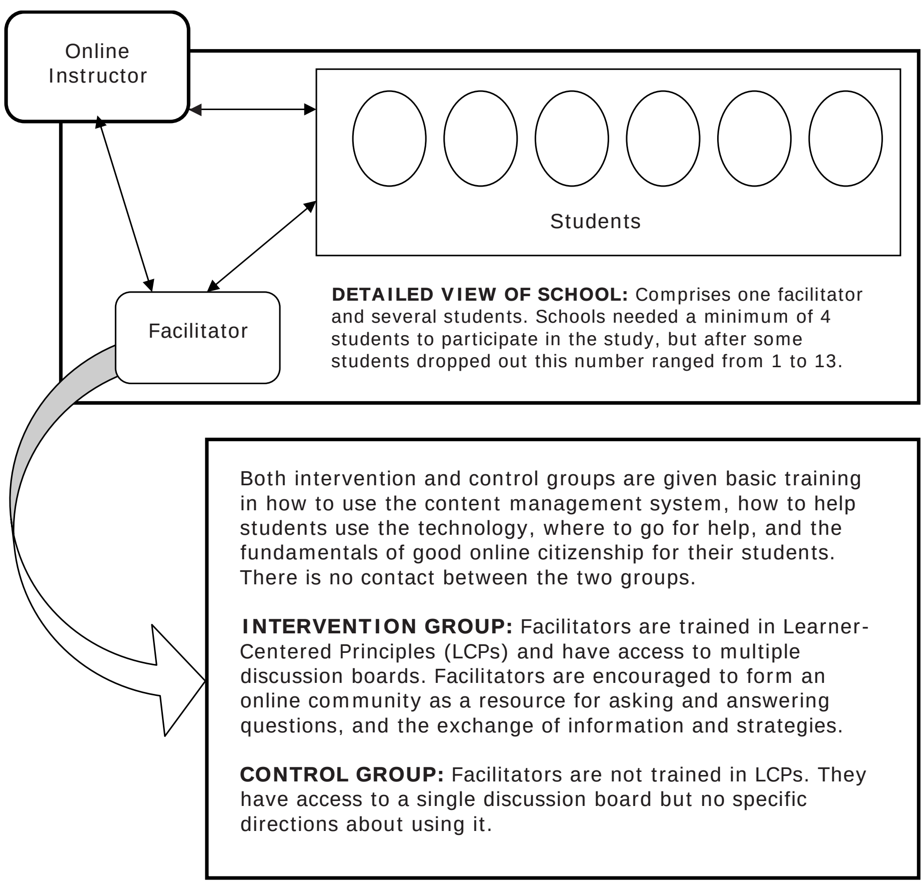


Inter Vent Ion des IGn

The facilitator role was new to the majority of study participants, so drawing from LCPs we treated the intervention group facilitators as another group of new online learners. We designed an online training module that emphasized community building. This element was intended to allow facilitators to become familiar with the online environment and the technology that their students would be using, and to enable them to interact with, and hence get to know, other facilitators in rural schools around the country. This ideally would counteract any feelings of isolation on the part of the facilitators, as well as giving them a resource for the exchange of advice, strategies and information. The intent of this online training in LCPs was to raise the facilitators' awareness of the social supports that are necessary for student success in ODE.

The facilitators in the intervention group were first given some online ice-breaking activities to encourage them to post personal information and get to know their fellow facilitators. Once these activities were complete, online scenarios illustrating issues that their students might face were provided to them over a period of several weeks. Most of these scenarios were based on actual incidents from the pilot study and were delivered in a multiple media format that included text, audio clips, images and suggestions for in-class activities. Each scenario featured one or more students who raised problems or concerns to which the model facilitator responded

Figure 2. Detailed view of the teacher-facilitator model for a single school, showing interactions between facilitator, students and online instructor



with appropriate and exemplary responses that incorporated LCPs. The on-site facilitators were then encouraged to discuss each scenario, offer examples from their own classroom experiences and make suggestions as to what they might have done differently. A summary of each scenario is given below:

1. **First Day of School:** Strategies for introductions and ice-breakers.
2. **Discussing Assignments:** Recommends setting aside a class period in the first week of the year to go over the course logistics.
3. **Student Fears:** Linda, a reluctant student, has a conversation with Pat concerning her fears about the course.
4. **Time Management:** This scenario features Curtis, a procrastinator, in conversation with Pat over time management.
5. **Helping Students Help Themselves:** Designed to encourage students to interact with their online peers.
6. **Too Much Work:** Daniel, an arrogant student who moved to a rural area from Chicago, complains of being overwhelmed by the workload and is far less confident than he initially appeared.
7. **Disengaged:** Beth, the top student in the first semester, is experiencing low grades and she seems disengaged in class.
8. **Worried About Grades:** Beth is considering dropping the course because she does not want her Grade Point Average (GPA) to reflect the lower online course grade.

discussion boards

Our control group of facilitators was provided with a single, unmoderated online discussion forum, but was not provided with any scenarios or information about learner-centered principles. The discussion in the control group was initially promising, with facilitators introducing themselves and discussing technical issues. However, facilitators were somewhat unclear about what their responsibilities were or how to support struggling students:

Their failing scores depress them, since they are students competing for Valedictorian honors. Fears include what will show up on their transcripts, the absence of the instructor's body in front of them, questions left unanswered before due dates, and the time required to keep up with the syllabus requirements. I need to know...Are we the only group encountering this scenario? I would feel no sympathy if the students were not applying themselves, but this is not the case. Any suggestions? I've got 3 students wanting to drop this class before they lose themselves in the strife. (Control group facilitator.)

Without LCP training or the online training module used in the intervention group, facilitators did not have access to effective strategies to help their students manage their workload and cope with the rigors of the course, even commenting on the lack of social interaction:

We are experiencing much of the same frustration. Many of my students did drop; the few that have hung in there are continually discouraged. We faced all kinds of computer problems, most of which are sort of ironed out now. The work load is discouraging, too. But overall, the issue you raised about low GPA is definitely worrying my students also. Beyond the technical issues, there is also a social aspect about being in the classroom that the the kids miss. (Control group facilitator.)

After some talk about student frustration with the course, the discussion dropped to nothing before the end of the first semester. The experiences of the intervention facilitators were different. While similar frustrations were expressed on the discussion board, the LCP materials provided both strategies and language for developing a classroom climate that supported the online course.

We contracted with one of the facilitators from the pilot study to act as the "facilitators' facilitator" to monitor and moderate intervention facilitator discussion, and also post her own insights and potential solutions to problems based on her prior experiences:

… those that hung in there are really glad that they did. It showed that some have tenacity and certainly this should stand out in a college review. It is hard to convince your students that it will be worth it in the long run. It is important that you as facilitators try to keep a positive outlook for your students. Contact the parents and talk things through with them as well, bring the counselor on board with an explanation as to how the individual school with look at the grade and just how it will affect their GPA. Constant communication is vital for the students to keep going. (Moderator, Intervention Discussion Boards.)

In a response to this post, the facilitator reports that she has used these communication strategies and is aware that this is within her scope of responsibility in this role. The total response to these challenges is broader than just the context of the online course or the physical classroom. The facilitator in this example gets the wider community involved:

Yes, we've had quite a time with students wanting to bail out! Grades have definitely been a hot topic of conversation. We had a meeting with the parents of my students, the principal, and the counselor. The principal even discussed the issues with the superintendent afterwards. (Intervention group facilitator.)

In another discussion board, the facilitator describes his interaction with students in a way that clearly indicates both his learner-centered strategies and his understanding that his role is to foster their intrinsic motivation:

All four of our students expressed the desire to take this class to see what a challenging college level class is like before they get to college - good for them. I have harped on them about the class being about learning something and about developing habits that will help them be successful in college, and not about the grade. I've even gone so far as to downplay the AP exam stressing that I think there is more to be gotten from this experience … (Intervention group facilitator.)

These discussion boards illustrate that the facilitators in the intervention group had an expanded view of themselves in the facilitator role as an active participant in their students' learning community.

CHARYSMA: an online data system For Measuring Learner-centered Practices

Based on findings from over a decade of research on LCPs in schools, an online assessment tool to measure learner-centered practices was developed, called CHARYSMA (The Challenge to Raise Your Student's Motivation and Achievement). The CHARYSMA Project was originally conceived by Tim Small, a UK teaching consultant, in partnership with Dr. Barbara McCombs, and was designed and developed by Andrew Hulme, currently the manager and administrator. Through the CHARYSMA instrument, facilitators report on their own learner-centered practices twice during the academic year. Students are also asked to give their perceptions of their facilitator's classroom practices. The results are aggregated so that no individual student is identified, and compared to a rubric developed and validated by Dr. McCombs. The facilitator self-assessments are then compared to the assessments from their students. These findings are shared with facilitators through telephone interviews with project staff. This feedback is intended to help facilitators identify the areas where their students might be struggling and become more self-reflective practitioners. Facilitators are encouraged to revisit their materials on LCPs and learning strategies in order to address any issues that have arisen.

CHARYSMA provides easy access to graphic representation of survey data for teachers and facilitators that allows them to clearly visualize the areas where they could improve their learner-centered classroom practices. As part of the CHARYSMA process, facilitators completed a 125-item survey designed to measure facilitator beliefs about learning, facilitator characteristics and attitudes including their own self-efficacy in the facilita-

Figure 3. Mean differences between students' and facilitator's perceptions of the facilitator's learned-centered practices in the classroom

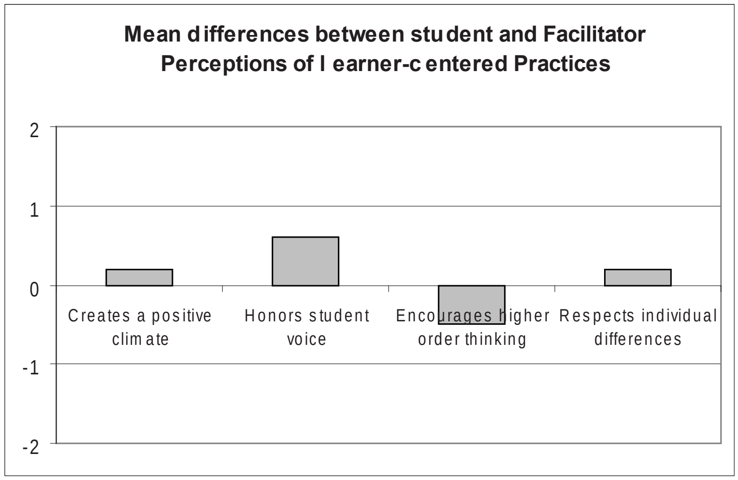
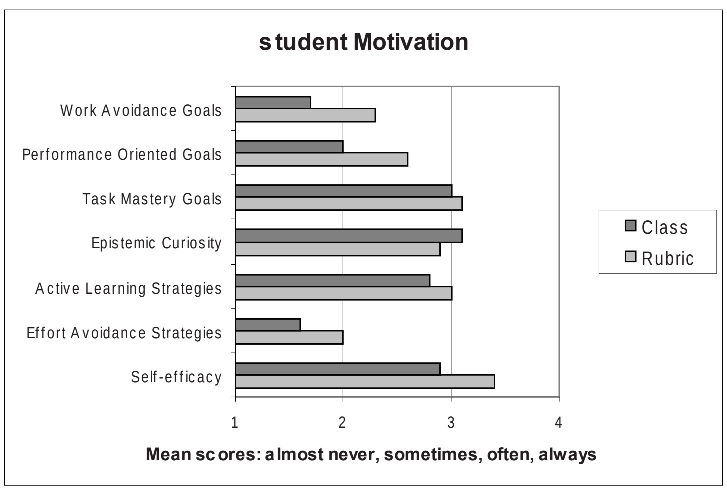
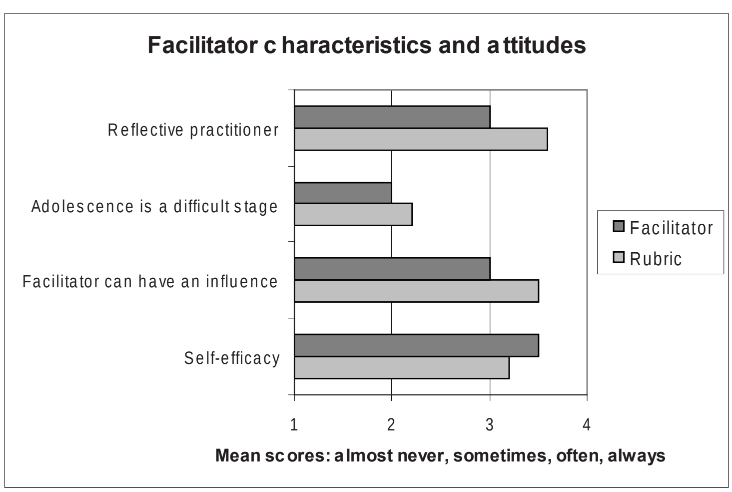


Figure 4. examples of CHARYSMA data





tor role, and how they support student autonomy. Students completed 75-item survey, that measured their perceptions of how learner-centered their facilitator was. The student survey also measured latent concepts such as student self-efficacy, effort avoidance strategies, active learning strategies, epistemic curiosity (curiosity about the process of learning), task mastery goals, performance oriented goals and work avoidance goals.

Figure 3 compares student-rated and facilitator self-rated perceptions of learner-centered practices in the classroom, for one school. Where the chart is positive, student perceptions are higher than facilitator self-ratings. This example indicates that although student and facilitator perceptions are very close, the students perceive that the facilitator uses LCPs in the classroom slightly more than the facilitator perceives her own use of LCPs. The exception to this is in the domain of encouraging higher order thinking, where the students have rated the facilitator's practices lower than the facilitator has rated herself.

Additional data from CHARYSMA are shown in Figure 4. The upper slide shows aggregated results for a single class. The lower slide shows self-rated characteristics and attitudes for a single facilitator. The upper slide in *Figure 4* shows that these students have a lower than ideal self-efficacy score; their effort and work avoidance strategies are very low, which is good; their active learning strategies score is slightly lower than optimal, and their epistemic curiosity is slightly better than the rubric. The lower slide indicates that this facilitator has higher self-efficacy than the rubric, believes that the teacher can often influence students, believes that adolescence is sometimes a difficult stage and is a highly self-reflective practitioner.

conclus Ion

Our intervention incorporates three parts: online scenarios for training in LCPs, online discussion and community building among facilitators, and the CHARYSMA system for feedback on learner-centered practices and student perceptions. We believe that this multi-faceted approach contributes to a more supportive learning environment for students, many of whom are unfamiliar with online learning and have not been exposed to advanced coursework before.

Preliminary findings suggest that there is a higher rate of student retention in the treatment group. As we near the end of the first year of the study, the control group schools have dropped out at a much greater rate (44%) than the intervention group schools (11%). The dropout rate for individual students in the control group (57%) is also considerably greater than for the intervention group (33%). This suggests that when control-group students drop out it is more frequently in the context of the whole school dropping out of the course, whereas when intervention-group students drop out it is more likely that at least some of their peers will continue with the course.

The main issues that have arisen for students so far relate to the rigorous content and high standards associated with AP courses. Facilitators are trying to support students who are accustomed to receiving high grades and to being the best students in school. They need to use strategies that help students develop practices that will allow them to be successful in ODE e.g. enhancing their students' self-regulated learning abilities and fostering an intrinsic orientation in their students. Such skills are essential in preparing students for post-secondary education, and are particularly relevant for our sample of rural students who live in small communities and are educated in intimate settings. Often, the important findings from research looking at social support for learning fail to be applied in the real world; it is even more difficult to integrate such findings into ODE practices because of the lack of consideration of the social context in which students are embedded. Our training scenarios attempted to provide an effective method for facilitators to incorporate and apply LCPs in this complex, learning environment that blends both the social and technological aspects of learning. The CHARYSMA system allows facilitators to incorporate their students' perceptions of their support practices with their own, encouraging self reflection and discussion with other facilitators about effective strategies. By expanding and enhancing the teacher-facilitator model we are attending to the interpersonal relationships and providing the learning strategies that can be most effective in promoting student success. The content of the online discussion boards illustrates the broad view of the facilitator role that the intervention group facilitators hold. The student and school dropout pattern indicates that attending to social factors in the physical classroom, supporting online interaction and participation, and sharing strategies that foster internality may contribute to students' persistence in ODE.

The strength of this system is the incorporation of the robust theoretical framework of learner-centered principles. This is pertinent to the historically underserved population of rural high school students, in schools that are struggling to attract qualified teachers and for whom ODE may be the only option for delivery of advanced courses. The system utilizes local resources to support students in their work and online interactions with instructors and classmates dispersed over wide geographic areas and multiple time zones. In this study the facilitators know their students very well, are cognizant of different learning styles, can see when students are struggling with tasks and can suggest and model appropriate strategies for coping. All of these factors contribute to a successful online learning experience for the student and encourage persistence in the course.

There are wider implications about teaching and learning here and designers and developers would be well-advised to consider the four domains of learner-centered principles when designing a sociotechnical system. It is vital to support any user of technology in ways that take into account individual differences, the developmental stage of the user, prior experiences, the emotions that may be aroused by the interaction, and the user's need for comfort and security. It is also important that users in underserved populations feel they have a voice. We hope to encourage designers to apply learner-centered principles to systems of human-computer interaction. By doing so, the users of such sociotechnological systems will feel they are in a supportive, positive and respectful climate.

ACKNOWLEDGMENT

This work was supported by a Research and Development Center grant (R305A04056) from the Institute of Education Sciences to the National Research Center on Rural Education Support.

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Key Terms

Advanced Placement: Advanced placement courses are accredited by the College Board in the United States. High school students take an exam at the end of this course that qualifies them for college credit. AP course are offered in multiple subjects in the major academic disciplines of English, History, Science and Math.

Asynchronous Classes: In this format, participants in online distance education courses do not communicate in real time but interact at different times. These courses can be self-paced but are often conducted on a specific course calendar with students and instructors following regular feedback schedules.

Intrinsic Motivation: The undertaking of an activity without external incentive; personal satisfaction that is derived through self-initiated achievement.

Learner-Centered Principles: In 1997, the American Psychological Association (APA) developed a set of 14 learner-centered principles (LCPs) intended to guide educational reform at all levels and informed by a number of different research perspectives. They include four research-validated domains:

a. **The cognitive and metacognitive domain:** Thought processes involved in learning that includes self-reflection.
b. **The motivational and affective domain:** Effort and engagement while learning, including affective and emotional factors, and the understanding that personal interests directly influence learning.
c. **The developmental and social domain:** Previous experiences of students and their learning readiness (i.e., developmental factors) as well as interpersonal relations between and among students and teachers (i.e., social factors) affect current learning.
d. **The individual differences domain:** Differences between and within students that influence learning. Students have different strategies and skills for learning based on their backgrounds and prior learning experiences.

Locus of control: The extent to which an individual attributes outcomes to internal versus external factors.

Online Distance Education: Formal courses, often institution based, that are conducted with instructors and students separated by a distance. Interactive communication technologies (can include web-based communication, video-conferencing, audio-conferencing, etc.) facilitate the connection between learners and instructors.

On-Site Facilitator: A supervisory adult that assists students in the physical classroom; common in distance education courses offered to students in high school. The facilitator operates equipment; distributes instructional materials, answers students' questions, and communicates with online instructor.

Endnote

[1] Not all online learning is at a distance, and not all distance education occurs online but the associated terminology has often been used interchangeably in research literature (Rice, 2006). Throughout this chapter, we refer specifically to online distance education (ODE), meaning online learning for students who are geographically dispersed and in different locations than the teacher.

Chapter XXXIX
Enabling Remote Participation in Research[1]

Jeremy Birnholtz
Cornell University,USA

Emilee J. Rader
University of Michigan, USA

Daniel B. Horn
Booz Allen Hamilton, USA

Thomas Finholt
University of Michigan, USA

Abstract

This chapter uses the theoretical notion of common ground to explore remote participation in experimental research. On one hand, there is a desire to give remote participants the same views and capabilities that they would have as local participants. On the other, there are settings where experimental specimens and apparatus are large and difficult to effectively manipulate or view from a remote vantage point, and where multiple and diverse perspectives may be useful in decision making. In exploring these issues, the authors draw on two studies of researchers in the earthquake engineering community. The first, an interview study about attitudes toward teleparticipation, suggests that engineers are wary of remote participation because they fear the inability to adequately detect signs of potential failure. The second study, an observational study of researchers conducting an experiment in a centrifuge facility, illustrates that researchers adapt to the available information, and that diverse perspectives and information may be valuable in troubleshooting.

The way a team plays as a whole determines its success. You may have the greatest bunch of individual stars in the world, but if they don't play together, the club won't be worth a dime.

—Babe Ruth

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Introduction

Ubiquitous information and communication technologies are having transformative effects on the ways in which people socialize and work together. In particular, “virtual organizations”—aggregations of individuals, facilities and resources that span geographic and institutional boundaries—are an increasingly common work structure in a range of settings (DeSanctis and Monge, 1998). Virtual organizations enable interaction between individuals with diverse and varied perspectives who might not otherwise work together (Birnholtz and Horn, 2007), the sharing of expensive and scarce resources (Finholt, 2003, Kouzes and Wulf, 1996), and allow for novel ways of accomplishing tasks and solving problems (Atkins et al., 2003, Nentwich, 2003).

Among the many potential benefits of these technologies, the facilitation of increased access to scarce research apparatus and resources was among the first to be explored (NRC, 1993, Finholt, 2003). Consequently, a range of collaboratory projects have sought to increase access to and aggregate data from remote shared instruments (Olson et al., 1998), and to provide remote manipulation capabilities for laboratory apparatus, such as microscopes (Kouzes and Wulf, 1996). While these examples are specific to the research domain, the lessons learned can also be applied in areas such as telemedicine or remote consultation on repair of complex devices.

A key issue when providing access to remote instruments is providing all participants in the activity, both local and remote, with enough information to have an adequate shared understanding of what is taking place—that is, what Clark and Brennan (1991) refer to as *common ground*. As Birnholtz et al. (2005) point out, however, the amount of information and interaction needed to achieve common ground depends significantly on the *grounding constraints* (Clark and Brennan, 1991) present in the specific situation at hand. Some situations require more detailed discussion and may require more information, while others have simpler requirements. How to predict in advance the grounding needs for a particular situation, however, remains an open question.

This is a particularly important question for the realm of providing shared access to research apparatus and instruments. There are a number of modes of collaboration, ranging from traditionally structured projects involving a small number of investigators working closely together, all the way to distributed “mass collaborations” like NASA Clickworkers (Kanefsky et al., 2001) or the ESP game (von Ahn and Dabbish, 2004) where distributed collaborators contribute effort, but make no intellectual contribution to the project. There’s also a vast space in between these two extremes; Wikipedia, for example, probably sits more toward the latter category, but it does allow for some more cerebral contributions. Given the various grounding needs and constraints due to the wide range of participatory modes for distributed collaborators, an important design question is therefore how we should think about providing information to remote participants.

In this chapter we report on our involvement in the development of the George E. Brown, Jr. Network for Earthquake Engineering and Simulation (NEES), a cyberinfrastructure project aiming to interconnect large-scale earthquake engineering (EE) laboratories. One goal of NEES was to enable remote participation in EE research. This research area and others like it present an interesting puzzle for e-science. On the one hand, the scarcity of laboratory facilities strongly suggests the value of using network technologies to increase access by scientists at “peripheral” universities to laboratories at a small number of “core” universities. On the other hand, though, the scale and potential danger in the research seem anecdotally to lead many researchers to reject outright the idea of serious scientists participating remotely in laboratory research.

Background: Perspectives on Participation

One goal of e-science and cyberinfrastructure programs is to enable new forms of geographically distributed collaboration and participation in science (Nentwich, 2003, Atkins et al., 2003). Such distributed collaborations can take many forms, ranging from asynchronous collaboration via shared computational and database resources to synchronous remote participation. The degree of remote involvement can vary from passive observation to active manipulation (e.g., Kouzes, Myers and Wulf, 1996).

This wide range of participation modes has important implications for our understanding of communication in collaboration, and in particular for theories of common ground in conversation. On the one hand, some studies have shown that it can be more difficult for distributed groups to reach common ground—a state of shared understanding in conversation (Fussell et al., 2000, Clark and Brennan, 1991, Olson and Olson, 2001). This would suggest that more detailed information and a more realistic experience for remote participants will be useful in ensuring that common ground is reached as quickly as possible. At the same time, however, different modes of participation have different "grounding needs" (Birnholtz et al., 2005). In other words, there are cases where participants do not need a high degree of common ground to accomplish their task, in which case large amounts of shared visual information may not be beneficial, and may actually be harmful.

The first and most common design approach to remote participation seeks to approximate for remote participants the experience of actually "being there." In the simplest case, a single networked video camera can provide views to passive observers (Postek et al., 1999), and some basic camera manipulation can be provided.

Combining video or other data views with lightweight chat (Birnholtz et al., 2005, Olson et al., 1998) can allow remote participants to move beyond passive observation, and ask clarification questions or provide suggestions in a relatively unobtrusive way. Others have experimented with the provision of physical robotic avatars that can be controlled by a remote participant and include cameras and other communication functionality (Paulos and Canny, 1998, Jouppi, 2002).

One common trait shared by many of these systems is their focus on small objects that can be seen within a single screen, or specimens that are so small that they would need to be viewed on a screen even locally (like the nanoscale objects in the Nanomanipulator). When the research apparatus entails more than can be viewed on a single screen, enabling remote participation may be trickier (Ranjan, et al., 2006).

Adopting an alternative approach, Hollan and Stornetta (1992) argued that seeking to approximate "being there" is a potentially debilitating constraint on the design process for remote participation technologies. Even the best video and audio links offer constrained views and are limited to what can be effectively captured by cameras and microphones. Designers, in other words, need to think beyond replication, and toward innovations that exploit the unique attributes of the technologies being used.

There have been some examples of asynchronous remote participation attempting to bring the "beyond being there" approach to bear on technologies for e-science. NASA's ClickWorkers program, for example, made use of thousands of amateur space-enthusiast volunteers to effectively identify craters in a massive set of Mars photographs (Kanefsky et al., 2001). This example suggests that there is potential value in enabling novel forms of distributed participation in e-science, but leaves open our initial question of how to accomplish this for synchronous participants in large-scale laboratory experiments. There have been few examples of effective remote participation in such work.

"Beyond being there" approaches to remote participation are different from those that attempt to *approximate* "being there" in that they present different challenges when it comes to providing information for grounding. In the two studies we below, we present our findings with respect to the grounding needs and requirements, and discuss ways in which "beyond being there" approaches might be beneficial. We will show that:

1. Experimental earthquake engineering researchers were pessimistic about the potential

for remote participation, in part because they doubted that would be able to accomplish their goals for the research without being physically present

2. In one particular experiment we observed that had many characteristics of remote participation scenarios, the researchers were able to adapt and successfully complete the experiment because they were able to communicate effectively and bring diverse perspectives to the conversation.

research context and Methods

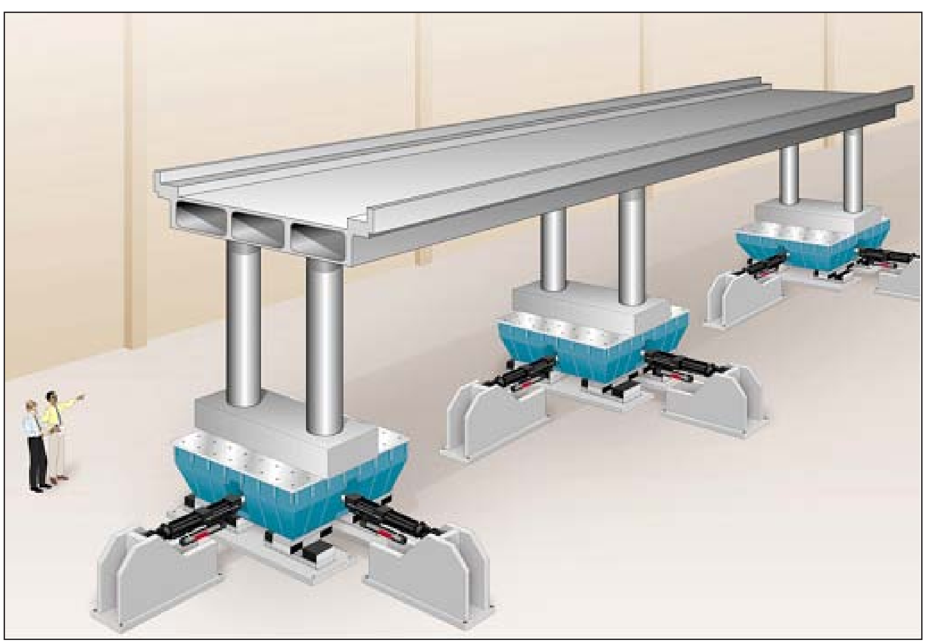
We present results from two studies in this chapter, both of which take place within the overarching context of the experimental earthquake engineering research community.

experimental earthquake engineering

Earthquake engineering (EE) research is concerned with understanding the responses of materials, structures and soils to seismic forces. Work consists of field evaluation of structures, numerical simulation, and laboratory tests of physical models. Our work here is primarily concerned with the conduct of laboratory tests.

In a typical lab test, a full-size or scale model of a real-world structure is constructed, instrumented with sensors, and placed on a large testing apparatus such as a concrete *strong wall*, large shaking platform (Sims, 1999), or a centrifuge (Zimmie, 1995). Graduate students take several weeks or months to build the model, or *specimen*, under the supervision of faculty and technicians. The specimen is then subjected to a series of pre-orchestrated, increasing stresses, which reproduce ground motion from actual earthquakes at various scales, until the specimen experiences structural failure. Given the scale of these experiments and the use of materials like concrete and steel, unexpected failure of the testing equipment or the specimen itself can be dangerous or harmful, and waste large amounts of money and effort.

Figure 1. Artist's rendition of a full-size bridge deck that spans the three shaking tables in the structures lab at the University of Nevada, Reno



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We studied this community in part because our research team was involved in specifying the user requirements for The George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) (NEES, 2006), a National Science Foundation project aimed at improving research, education, and practice in EE. The initial NEES project included funding for constructing or upgrading EE testing equipment at 15 universities across the United States as well as developing a computing infrastructure to enable collaboration among researchers, educators, and practitioners.

Methods

Between October 2000 and October 2003, members of our team visited fifteen universities that received NEES-funded equipment and one that did not. At these sites we conducted a combination of interviews and observations. We also were participant observers in the first trial experiment conducted with the NEES system.

Interview Study

We interviewed 94 participants at fourteen sites, including faculty, students and technicians. All interviews lasted 20-60 minutes, were semi-structured, tape-recorded and typically conducted by two of us: one person asked questions, while the other took notes. The note-taker typed full interview notes for each interview afterwards, consulting the audiotape when details were unclear. The same basic interview protocol was used for the interviews, but this was iteratively refined as the project progressed.

The protocol typically included 10-15 high-level questions, and probes were used to get more detail when necessary. Emphasis on specific issues was shifted based on the participants' experience and expertise, but questions generally focused on the process of conducting research investigations, from idea to published paper. As part of this, we asked participants if and how this might change if they had remote collaborators. We asked, for example, what their concerns might be, what they would want their collaborators to see during the investigation, and if they had ideas for involving remote collaborators in their work. In carrying out preliminary coding, we realized that our participants had significant concerns about remote participation in their research, and that these were largely centered around the issue of being able to detect and prevent catastrophic failures.

This overarching theme guided another examination of our data in which we extracted the categories used to present our data below: 1) the use of many sensory cues, 2) the variable likelihood of failure, and 3) the utility of integrating multiple viewpoints.

Centrifuge Lab Observation

In October, 2003, two members of our research team spent three days observing scientists conducting a geotechnical centrifuge experiment. The data we collected consisted of video recordings of the control room and the individuals conducting the experiment. We were easily able to fade into the crowd and observe unobtrusively, asking questions and taking notes during relatively quiet times.

The first day of the centrifuge experiment was spent finalizing the preparation of the soil box specimen. The box had been filled with a precise mix of soils and structures over the preceding two weeks. It had been transported via forklift from the specimen preparation building to the centrifuge rotunda the night before we arrived. After the specimen was placed on the centrifuge arm, the scientists plugged over 100 sensors into the data acquisition system and tested them. Additionally, video cameras were placed on the specimen in the proper locations, and various other parameters were checked in preparation for spinning. There was little activity in the control room on the first day, so we gathered no video data.

The second day was spent primarily in the control room, where we videotaped activity for five hours.

Activities on this day included testing instruments without spinning the centrifuge, and then spinning up slowly to gather baseline data.

The third day was also spent primarily in the control room, with the centrifuge spinning. Another five hours of video data were gathered during this activity. Activities on this day were largely similar to the previous day, except that baseline data were gathered at full speed and simulated earthquakes took place. At multiple points in time, it was difficult for the EE researchers to discern precisely what was taking place with the specimen, and much negotiation and discussion ensued.

Following the observations, videos were transcribed, along with a brief description of who was in the shot and what was taking place. These transcripts were used for the analyses described below.

To analyze the data, we used inductive qualitative techniques. First, we identified *uncertainty episodes* where a breakdown in the normal workflow occurred. The breakdowns took two forms: miscommunication or misunderstandings between researchers conducting the centrifuge experiment, and confusion about unexpected or anomalous instrument readings. We then examined each uncertainty episode for evidence of the cause of the breakdown, and how it was resolved so that work could be resumed.

Study 1: Failure Prediction during Experiments

Specimen failure is most likely to occur very early or very late in the testing process. Interestingly, failures that occur early in the testing process are always undesirable, while only some failures late in the testing process are undesirable. This is because early failure is typically a sign of a flaw in the design or implementation of the specimen or testing apparatus, and occurs before the desired data have been collected. Late failures, on the other hand, occur after such data have been collected and the data collected during failure is often part of the planned testing protocol. As a specimen nears its predicted point of failure, however, it could succumb to the forces exerted by the equipment earlier than expected, or in an unpredicted fashion. Thus, there is a strong desire to exert sufficient force on the specimen such that it fails (collapses), but retain sufficient control that it does so in a controlled and safe manner. When asked to describe what they do during a test, all participants but one mentioned that they look for signs of potential failures. Respondents also reported that not knowing where failures might come from mandates vigilance and, many believed, physical presence in the laboratory. In exploring the details of how local failure prediction occurs, we noticed three themes that are elaborated below.

Sensory Cues

One theme that we observed in exploring our data on failure prediction is that earthquake engineers tend to integrate multiple sensory and information streams in the process of predicting possible failures during experiments. Participants indicated that they regularly relied on multiple information sources during an experiment.

First, most of our participants reported looking at numerical or graphical displays of data from sensors and instruments on the specimen itself, and we confirmed this to be true in our observations as well. Participants looked at these data displays to ensure that all the sensors were working properly, as one participant indicated, “I want to make sure the instruments are working, that the data are coming in and being recorded.” In light of the costs in terms of both time and money associated with experiments, the importance of data integrity is not surprising. Participants also reported looking at the data to make sure the experiment was progressing as expected, and that there were no extreme anomalies. This is typically accomplished by looking at a chart of force (or stress being placed on the specimen) vs. displacement (the degree to which the specimen is moving). One participant noted that on his tests, “if we can’t explain the graphs, we stop immediately. If we get data that are surprising, but not crazy we’ll keep going.” The interesting implication here is that experiments necessarily involve some uncertainty, but there appears to be a significant and deliberate effort to mitigate risk by detecting anomalous behavior and determining whether it is within the scope of the investigation and potentially informative ("surprising") or evidence of a potential failure that might be present in the system that must be detected ("crazy").

Most participants also reported looking at the specimen to predict failures and spot potential trouble. One said that, "we are examining the specimen itself, looking around for visible signs of distress, like cracking." This is frequently combined with looking at the numerical data to supplement understanding of what is taking place. One participant provided a nice description of moving between these information sources:

I look at the force vs. displacement plot, because a change in slope on this plot means that something significant is going on. Next, you have to figure out where, how and why this is happening. You do this by walking around and looking.

Thus, we see that the integration of numerical data and visual inspection of the specimen can supplement each other.

Some participants also reported relying on hearing the test in order to predict failures. Hearing was typically integrated with viewing onscreen data and looking at the specimen.

There is also some evidence to suggest that participants with more experience in EE testing are better able to understand and integrate multiple sources, particularly auditory information. The only people who mentioned auditory information had prior experience.

Variable l ikelihood of Failure

Because of their experience, we would expect faculty members and technicians to be the best-equipped individuals in a lab to detect potential failures. In some labs, only technicians are permitted to control the testing equipment, so they are always present during experiments. Faculty members have more demands on their time, but indicated the importance of their presence at tests to help predict failures. Because they frequently cannot be present for the entire test, we would expect them to be present when it was most likely that a potential failure would be spotted. We therefore asked faculty if they typically attended entire tests, and asked their students during what parts of the tests faculty were present. Responses indicated that faculty typically showed up only for the first few and last few shaking events on a specimen. This is closely related to the belief that, as we mentioned above, failures tend to occur early and late in the tests. One participant indicated, for example, that:

I'm always there for the first test on a particular specimen, because I need to train the students on the things they need to do…like making sure the test frame is not creating a physical anomaly. Students have a tendency to just roll forward without checking these things.

Similarly, many faculty indicated that they are not present for the bulk of the tests on a specimen. One participant said that she is, "not physically there watching the whole time, certainly not." Another said that, "after a while I gain confidence. I'll just show up to see what's going on and then leave."

Multiple c ollocated Persons

The third and final theme we observed related to failure prediction is a reliance on multiple collocated persons, both in detecting failures and in making decisions about how to prevent them. The presence of multiple persons at any test has its origins in safety concerns. Virtually all labs have a strictly enforced safety policy stating that no testing equipment may be used when fewer than two people are present. This has the effect that multiple people are involved in making the crucial decisions about how the experiment is to move forward.

First, one senior faculty member pointed out that multiple people in the lab means that "there are different accounts of what happened, like people's reports at the scene of a car accident." Integrating these multiple human sources of information can increase the clarity and understanding of what is taking place in the test.

Second, we found countless examples of informal meetings—what one participant referred to as "powwows"—in the lab, in which the students, technicians and faculty members decided together how to proceed:

When things go awry, we tend to powwow in the lab. There are usually multiple professors, we meet in the control room with [the lab manager] and the student, and try to sort out what's going on.

This is valuable in that it allows for the integration not only of multiple perspectives on unfolding events, but also multiple forms of expertise. Multiple forms of expertise enable some specialization during the experiment. One senior technician reported that he would "often send somebody out to stand in a particular place and keep an eye on things." Another participant, a student, suggested that he likes to have "one other person around to mark cracks, take pictures, [and] take notes." Many participants we spoke with also indicated that they participate in the "powwow" and have a significant amount of influence on what takes place, but often defer final authority to the laboratory technician, who is typically the most experienced with the test equipment. It is through the collective awareness and sensitivity, combined with communication between collocated parties that potential failures can be detected and prevented during tests.

STUDY 2: A CENTRIFUGE EXPERIMENT

We focus here on a geotechnical engineering experiment that uses a centrifuge to simulate and evaluate building foundations and piles that will sit in the ground, under earthquake-like stresses. In this sort of test, a large box is filled with precisely placed layers of sand and clay to comprise a scale specimen of a field environment (see Figure 2). Video cameras and a variety of electronic sensors (strain gauges to measure structural strain, accelerometers to measure ground motion, etc.) are then placed on the specimen box for data gathering. This box is then placed on a large centrifuge and shaken while the centrifuge is spinning to simulate an earthquake. While it may seem that simply shaking the box without spinning it would suffice to simulate an earthquake, the centrifuge serves the important role of increasing gravitational forces to improve the accuracy of the simulation (Zimmie, 1995)

Centrifuge modeling is a particularly interesting domain for the present discussion because it is similar in important ways to the experience of remote participants. The simulation cannot take place until the specimen spinning in the centrifuge has achieved the desired force of gravity (60 G's, in the case described below). At that point, the soil box is inaccessible, and cannot be observed directly. This creates the interesting situation of researchers dependent entirely on information provided via multiple instruments—primarily video views and numerical sensor data—in order to observe and troubleshoot.

There were four people who were primarily involved with the experiment, to whom we have assigned pseudonyms as follows (see Figure 3). There were others present to observe and help but these people did not play a significant role in the episodes we present below.

- **Lisa**, an inexperienced graduate student, was the primary investigator. Her thesis was based on data gathered during our observations, and she had final say on all matters of design, procedure and analysis. Lisa had never conducted a test before, and received substantial coaching from others.
- **Bill** manages the centrifuge facility, and has been actively involved with centrifuge research since the facility's inception when he was a graduate student there. He was responsible for all technical and logistical operations.

- **Justin** was a senior doctoral student who had been involved in many centrifuge tests prior to this one. He was Lisa's primary source of advice.
- **Luke** was employed as a technician by the centrifuge facility and was responsible for controlling the centrifuge itself. He had been involved in many prior experiments, but his understanding of the research was largely confined to technical and mechanical matters.

Figure 3. The centrifuge control room

r esults

Our data from the centrifuge experiment provided us with insights into how the researchers were able to reach a shared understanding when uncertainties stemming from distance arose. Despite these difficulties, the centrifuge experiment was successfully completed; in all cases where uncertainty caused work to stop, the work was eventually resumed. The examples we discuss illustrate three instances where the researchers coped with uncertainties by either obtaining more information, or re-grounding. Checking for more information generally resulted in simpler and faster resolution. Looking up readings or procedures from previous days was common, as was verifying the state of the specimen by referring to the live video feeds coming from inside the centrifuge. Water table height was measured by using a video camera aimed at a ruler physically placed in the specimen for this purpose.

In the example below, Justin and Bill have observed some strange readings from their instruments. They speculate that water leaking from one part of the specimen to another is causing several instruments to short out, which might result in the strange behavior they had observed. A discussion ensues about just what exactly is the level of the water table in the specimen, and whether they should add or remove water when they stop the centrifuge spinning at the end of the day.

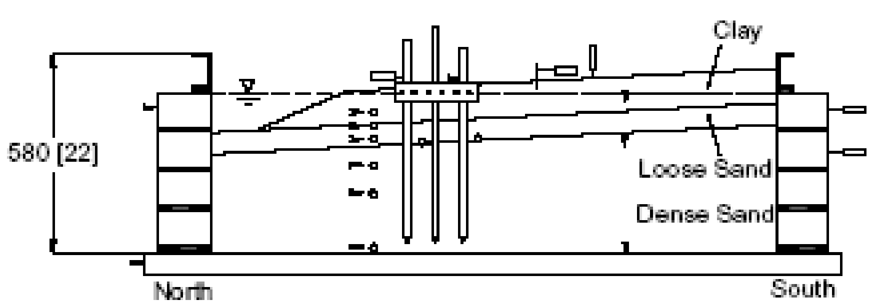
Justin: *I think it might be that there's water leaking.*

Bill: *What I was thinking was whether you'd want to change water pressure, add water, subtract water*

Justin: *When we spin down? I think it's right where we want it. (Points to video screen.) That's gotta be really close to the crest of that slope, but we should calculate the pressures. Maybe using one of the ones in the sand.*

Bill: *You want to be at 7.8, right. And you're at 8.5, so you're .7 centimeters high.*

Figure 2. Schematic side-view diagram of the soil box in a typical centrifuge test



Justin: *Yeah, I don't know why that is. Maybe that thing tipped or something. Usually we see a bit more slant on the water table too. It might be physically moved around a little.*
Bill: *Do you think it's possible that, what would it be high or low? Do you think that water table might be a little bit higher or lower than normal, Luke?*
Luke: *It shouldn't be.*
Justin: *Yeah, it's the same line. (Points to line drawn on video monitor to mark water level.)*
Luke: *Same line, same spot.*

The uncertainty about whether water leakage is responsible for instruments shorting out is answered when Bill and Justin check the line drawn on the video monitor in a previous test to mark the water level, and find that today's water level is identical.

A much more difficult situation to resolve occurred when verifying information in the control room environment and more precise communication were not enough to resolve the uncertainty that caused work to stop. In the following example, Bill, Justin, and Lisa are troubleshooting a sensor that was working intermittently. The sensor worked at lower centrifuge speeds, but as the spinning got faster it stopped providing readings. The three researchers begin by visualizing the data they had collected earlier to pinpoint where the sensor was failing:

Bill: *So what are you going to do with that one channel?*
Lisa: *Set the gain to 100 and see what happens*
Justin: *I have a feeling when we spin down it's going to come back*
Bill: *But what does that...Ok, Lisa, plot that one. Plot the one that's 10 volts. Ok, so it failed suddenly. That's what I'm wondering. Did it progress to 10 volts or did it fail suddenly?*
Justin: *Yeah, it just...fails. Where was that? About 3500? Which one was P10? (Bill walks closer to data screen)*
Lisa: *78*
Justin: *78? Go ahead and put that back in. It was right when we started spinning up from 20-40. Kinda weird, huh?*

At this point they had identified the point at which the sensor cuts out, and everyone was in agreement. However, they still need to figure out what to do about the faulty sensor. First, Justin and Bill react favorably to Lisa's suggestion of setting the gain on the faulty sensor channel to 100:

Justin: *I don't know. I guess the risk of setting it to 100 is that it'll do the same thing, which I think will happen. It's going to go to zero when we spin down, and then we set it to 100 and then spin up and then it goes to minus 10 again. I think we should spin down and terminate it, because you could be getting some crosstalk error...* (unintelligible speech).
Bill: *But you're not going to get any data. The risk of losing data is low.*
Justin: *Right, the risk of losing data is low, so I think that's a good option.*
Bill: *Gain at 100. Even if it goes out of range again, you're not going to get any data.*

Then, a mismatch between Bill's and Justin's representation of what happens when the gain is changed occurs. A brief discussion ensues. By the final line, Justin and Bill are in agreement and have returned to Lisa's original suggestion. Lisa, meanwhile, is fairly silent throughout this exchange:

Justin: *Yeah, we can adjust the noise resolution too, so that it's like it's gained to 500 except the noise will just be 5 times bigger, does that make sense? We set the D to A range from instead of -10 to 10 you set it -2 to plus 2. Then it's not going to amplify the signal its just going to give you more data in the range where you expect data*
Bill: *Actually it does amplify. It has an amplifier.*
Justin: *Oh, really, so that's why the noise is big-*

ger. I always thought the noise was 5 times bigger, but I had to apply a factor as if it was amplified at like 100 instead of 500.

Bill: *Right, it's a gain number*

Justin: *You mean the actual load? The real physical load?*

Lisa: *No, the axial load*

Justin: *The axial load? No because we're going to gain it to 100. If we gained it to 100 and then set it to -2/+2, it goes out of range.*

The above example illustrates a situation where uncertainty occurred due to a mismatch between what Bill and Justin thought would happen to their instruments if a particular change were made. Because they were discussing troubleshooting options and had not yet decided on a course of action, it was not possible for them to simply change the gain and see what happened. Instead, re-grounding occurred when Justin explained what he thought would happen, and Bill corrected him.

The centrifuge experiment provides an interesting case that approximates remote participation, to the extent that it is impossible for the researchers to interact with the specimen directly. As a result, they must rely on instruments to "remotely" monitor the experiment. As our examples show, the researchers rely on the data they receive, and their own diverse views and perspectives, when troubleshooting problems. They also are able to negotiate and discuss them together, because the views are shared. It was not important for them to be near the specimen; it was important for them to be able to discuss the information they received about the specimen and decide upon a course of action. Everybody had the same views, and the same level of responsibility for a successful outcome of the experiment.

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These studies present an interesting and potentially useful contrast in people's perceptions of their information needs and, by extension, their grounding needs. When confronted with the possibility of remote participation in their research, the engineers we spoke with in the first study were concerned that they would be unable to detect and respond to potential failures or errors because they would not have enough information about what was taking place in the experiment. In the second study, on the other hand, information was significantly constrained due to the spinning of the centrifuge. Failure prediction was still possible, however. What seemed to matter in this case was not having access to vast amounts of video or sensor data. To be sure, these were useful. But they were not always consistent and did not offer a complete explanation of what was taking place. Rather, what was most important in resolving these scenarios was access to persons with relevant experience and diverse perspectives. It was through interpretation and discussion of whatever information was available that conflicts were resolved and common ground was re-established.

One key question from this case comparison is how the second study can inform the first. In other words, what lessons does the centrifuge experiment hold for remote participation in laboratory experiments more broadly. On the one hand, there are many possible lessons. The centrifuge, after all, is an extreme case of remote participation in that all participants are remote. On the other hand, this trait also creates an equality among participants that will rarely be replicated in other laboratory settings, where at least some participants are likely to be local and able to interact with and directly manipulate the specimen.

How then do we derive general lessons for teleparticipation from the centrifuge case? One thing that was particularly clear during the centrifuge case was that having input from many sources helped resolve issues and problems in ways that enabled the experiment to move forward. We therefore argue first that one aim of teleparticipation be to allow remote participants to contribute their diverse viewpoints. Second, in cases where there are both local and remote participants, we argue that teleparticipation technologies themselves can be used to increase the diversity of viewpoints that are represented.

Put more formally, it was agreed on by our participants that having multiple observers increases the likelihood that an impending failure can be detected. Imagine an observer who has a certain probability of detecting the cues to an impending failure given that a failure is imminent. We would denote this probability as $P(D|F)$ or the probability of Detection given Failure. If $P(D|F)=0.5$, then in the presence of impending failure, this observer would be able to detect the cues 50% of the time. We can calculate the probability that at least one of n observers will detect an impending failure as:

$$P(D|F)=1-(1-P(D_1|F))...(1-P(D_n|F)) \qquad (1)$$

assuming that all observers are statistically independent. This means that with two detectors, one with a probability 0.5 and one with a probability of 0.4 of correctly predicting an impending failure, the probability that at least one would detect the impending failure is

$$P(D|F)=1-(1-0.5)(1-0.4)=1-(0.5*0.6)=0.7 \qquad (2)$$

Further, with the addition of any statistically independent detector, i with a $P(D_1|F) > 0$, the global detection probability will increase. The false alarm rate will also increase, of course, but such an increase would likely be tolerated given the high costs associated with a missed detection. This is strongly akin to Weick (1995)'s observations on the value of "requisite variety" in an organization's repertory of beliefs:

The greater the variety of beliefs in a repertoire, the more fully should any situation be seen, the more solutions should be identified and the more likely it should be that someone knows a great deal about what is happening. (Weick, 1995)

At first glance, this would appear to indicate that each additional observer who is physically present at a test would increase the global probability of detecting an impending failure. However, our analyses suggest that individuals who are physically co-present during a test are likely to have positively correlated detection probabilities. That is, because they share the same sensory-rich environment and are able to interact with one another, they are likely to rely on similar bits of evidence in making their judgments. In addition, there are psychological and sociological processes, such as groupthink (Wason, 1960) and confirmation bias (Janis, 1972), that may lead their judgments to be correlated. The more highly correlated the individual detection performances are, the lower the benefit of additional observers becomes (such that, if all observers were perfectly correlated, the likelihood of at least one individual detecting an impending failure is no higher than best detector's individual probability).

While it may be natural for people to think of remote participation facilities in terms of providing a low fidelity imitation of the environment that individuals experience when they are physically present, such facilities may also be re-conceptualized as environments in which benefits may be garnered through a different representation of the problem. In certain contexts, a "beyond being there" approach, in which remote observation tools are designed to complement the information that is available to those who are attending a test, could theoretically allow remote participants to play the role of less correlated observers—thereby improving global detection performance.

Birnholtz et al. (2005) found that remote participants who were not involved in decision-making did not need high-bandwidth interaction capacity to participate in the way that they wanted to. We suggest that it might be possible for these same people play "grounding support" roles—that is, exploit the fact that they're not involved in decision making and make them inputs into decision making. To do so, remote participants would have to be able use information that physically present observers cannot or do not use. The effect would be not only an increase in failure detection capacity, but also a potential increase in enthusiasm for and adoption of remote participation technologies as a result of this new capacity.

One example would be to implement filters that highlight features of interest on streaming video. Physically present observers are not likely to rely on streaming video given that they can directly observe the specimen in front of them. For example, if remote participants could view video of a live test with overlays indicating visual features that are difficult to discern in person, such as out-of-reach portions of a specimen, they would be able to offer more statistically independent observations than additional physically present observers could.

It would, of course, be possible to provide similar video views and filters to a co-present observer, but we contend that physically present observers will already be occupied by a great deal of higher-fidelity sensory information, making it difficult to attend to additional views, while a remote participant would be more likely to have attention resources to spare. Additionally, while local participants could choose the role they play, remote participants do not have that freedom, and may best be thought of as either having no active role or a constrained active role.

This presents something of a paradox for theories of common ground. The prevailing wisdom is that more information is better, and that shared information supports reaching a shared understanding of of a situation. However, diverse perspectives could actually support better decision-making. This follows from a stream of recent work suggesting that optimizing for the very best and most accurate and most realistic information is not always appropriate, be it in thinking about excuses for not answering one's phone (Aoki and Woodruff, 2005), ambiguity in design (Boehner and Hancock, 2006), or coupling a video view to movement (Birnholtz et al., 2008).

It is also true, however, that adding non-correlated remote observers increases the potential amount of information confronting the co-present research team (Birnholtz and Horn, 2007). In addition to providing remote participants with different views, then, another implication of this work is the need for systems to aid in the integration and interpretation of the input provided by multiple human observers. In some important ways this is akin to research currently underway in the area of sensor and data fusion (Bisantz et al., 1999), and may benefit from those techniques. Future work in this area should extend beyond case studies, to better map out the dimensions of the space of modes of participation, and more rigorously define the grounding needs and constraints for situations where remote participants contribute diverse perspectives to the decision-making process.

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KEY TERMS

Beyond Being There: Exploiting unique attributes of technology to enable experiences that would not be possible in face-to-face environments, as opposed to using technology in attempting to replicate the experience of being there.

Collaboratory: A set of technologies and resources for connecting geographically disparate people, research facilities/apparatus, and data for the purposes of education and research.

Cyberinfrastructure: The set of shared computing, software and networking resources that enable the transformative use of novel technologies to enable discovery and novel modes of collaboration.

Common Ground: A state of mutual understanding among conversational participants about what it is that is being discussed

Grounding: The conversational process of negotiationg a shared understanding among multiple participants about what is being discussed.

Requisite Variety: The notion that a certain amount of diversity in viewpoints and perspectives is required for groups and organizations to address complex problems as they emerge.

Teleparticipation: The involvement of persons who are not physically present in a physical activity or event taking place in the real world

ENDNOTE

[1] Portions of this chapter were previously published in: Birnholtz, J.P and Horn, D.B. (2007). Shake, rattle and roles: Design implications from experimental earthquake engineering. *Journal of Computer Mediated Communication*, 12(2):673-691.

Section VI
Socio–Technical Evaluation

How to measure and evaluate socio-technical systems

This section discusses socio-technical evaluation, and what we mean by the “success” of a socio-technical system. It addresses questions like:

1. What is socio-technical evaluation and why is it important?
2. How can one measure socio-technical “performance”?
3. What are examples of useful socio-technical evaluation criteria?
4. What are the theories/principles behind a socio-technical evaluation?
5. What are the problems of socio-technical evaluation?
6. How is socio-technical evaluation useful to designers, managers and users?
7. How does socio-technical evaluation relate to other forms of evaluation?

Prologue
Socio-Technical Evaluation

Starr Roxanne Hiltz
New Jersey Institute of Technology, USA

Man is the measure of all things.

—Protagoras, In Plato Theaetetus, 160d

The chapters in this section are concerned with how to measure the impacts of, or "evaluate," socio-technical systems. What are the most important issues and approaches in socio-technical evaluation? This of course depends first of all on one's definition of socio-technical systems, and secondly, on one's methodological proclivities.

Carrol et.al's definition in their chapter will be adopted for this introduction, along with an expansion of their opinion about the "most important evaluation question" for this type of system. They state, "Socio-technical systems are social systems that incorporate technological infrastructure." They then mention what I will label "Question 1: " *the most important question in understanding socio-technical systems is how their technological infrastructures modulate collective capacities for performance and experience*." Of course, they will not have any effects all if they are not used, so I would add another important question 2: *What determines acceptance or use of these technologies in the first place?*

Aswering this set of basic questions leads to two futher sets of fundamental choices and questions for the researcher:

Question set 3: *What theoretical frameworks are available* in information systems research that may be helpful in understanding acceptance and impacts of socio-technical systems? *And how might these theories have to be modified to help understand systems that are meant to support primarily social-emotional needs* of virtual groups and virtual communities, rather than supporting the work of a formal organization?

Question set 4 is*: What methods of research are likely to be most fruitful* for understanding acceptance and impacts of this type of system? Are some methods more suited to answering different questions that arise at different stages of the cycle of software development and use of socio-technical systems? Are any modifications or innovations to "standard" methodologies necessary to evaluate this type of system? For example, "impacts" are on the community or society as a whole in addi-

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tion to its individual members/ users; how does one measure information systems impact at the group, community or societal level, rather than only at the individual level?

Question sets 3 and 4 will be briefly treated here. Then we will close by listing some other questions and issues for socio-technical evaluation, which the reader should keep in mind for this set of chapters, but which will not be discussed in this brief introduction.

Some Useful Theoretical Frameworks

Information technology (IT) acceptance research has resulted in many competing models, each with different sets of acceptance determinants. One of the most basic is the Technology Acceptance Model (TAM), originally put forward by Davis (1989). Intention to use a technology is a function of two main determinants, according to this theory, perceived ease of use and perceived usefulness. Various extensions to this theory added variables that might affect these two constructs, or moderate the relationship between them and behavioral intension to use a system. Venkatesh et. al (2003) combined variables from eight prominent models into a unified model. An issue might be, are the determinants of use for socio-technical systems different than those for more traditional information systems? One would presume so. Another issue is, since the "user" is the society or community, maybe there are different connotations to what is "easy" and what is "useful."

Giddens' (1979) theory of structuration is the basis for information systems research that addresses appropriation, or how people adopt and adapt technology to the tasks they need to complete. DeSanctis and Poole (1994) applied Adaptive Structuration Theory to construct a sociotechnical explanation of technology impacts that models technology use as an evolving social. Adaptive Structuration Theory describes a process whereby a software system offers a set of structures to a group, but it is the process the group goes through as it uses those structures for its own ends that matters. As a group adapts a technology, it in effect re-structures that technology, as the technology becomes enmeshed in the group's decision processes and outcomes. This idea that technology itself is changed through use is called appropriation, a term that has been used in information systems research to describe the process by which people adopt and adapt information technologies to the tasks they carry out. In particular, people from different cultures are likely to make different adaptations, as described in some of the chapters that follow.

A third theoretical framework that has been used a great deal for organizational information systems is "task-technology fit" (Goodhue and Thompson, 1995). However, social software is especially likely to undergo extensive "adaptive structuration" whereby the users appropriate the system in ways that were not anticipated by the developers; therefore it is likely that the "tasks" will be shifting across time and cultures or virtual communities, and thus the definition of the "task" to measure may also need to shift. The chapter analyzing the socio-technical gap in social networking systems is related to this theoretical approach, in that the authors attempt to develop the overall task of "increasing social capital" into three separate constructs or components.

Methodological Issues and Innovations

The great divide in information systems research has been between those who favor qualitative inductive methods (such as field observation and interviews using open ended questions) , and those who favor quantitative, deductive methods (such as laboratory experiments and surveys that are designed to test specific hypotheses). Increasingly, researchers have put forth the opinion that life cycle research should combine both kinds of methods. Qualitative methods may be especially appropriate for the early stages of the software life cycle, when one is trying to discover users' needs or understand what aspects of the interface are negatively affecting ease of use. Conversely, quantitative methods may be more appropriate for trying to untangle a complex web of effects of use of a system not just on an individual, but on the whole user community. Certain quantitative methods that have been relatively neglected in information systems research, such as social network analysis, may be especially suited to this type of system. On the other hand, one of the mainstays of studies of the effects of Group Decision Support Systems in the past, the laboratory experiment, may not be very useful for trying to determine the long term impacts of social software such as social networking sites or knowledge-building wikis on the very large user communities that may form around these sites. Survey research may be an especially good fit for studying large user communities, but a necessary first methodological step is to build and test measures of constructs for the "usefulness" or impacts of this type of system. Examples of this methodological work that follow include the development of the "community collective efficacy" construct by Carroll and colleagues, and Holland's scale for "affective satisfaction".

Once the research community has developed appropriate theories and methods for evaluating socio-technical systems, we can then move on to further interesting questions, such as:

- What is the usefulness of socio-technical evaluation?
- How does socio-technical evaluation relate to other forms of computer and information systems evaluation?

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Chapter XL
Community Collective Efficacy

John M. Carroll
The Pennsylvania State University, USA

Mary Beth Rosson
The Pennsylvania State University, USA

Umer Farooq
The Pennsylvania State University, USA

Jamika D. Burge
The Pennsylvania State University, USA

abstract

Socio-technical systems are social systems that incorporate technological infrastructures. At the group level of analysis, the most important question in understanding socio-technical systems is how their technological infrastructures modulate collective capacities for performance and experience. This research addresses collective capacities with respect to various sorts of communities—interest communities, professional communities, and residential communities. One question the authors have pursued is how technological infrastructures can enhance beliefs about collective capacities, as operationalized in Bandura's social-cognitive construct "collective efficacy". In this chapter, the authors first review Bandura's conception of collective efficacy as a social extension of his cognitive construct "perceived self-efficacy". They then discuss the development of our own community collective efficacy scale, and its use in understanding a range of community-oriented attitudes, beliefs and behaviors in the context of the Blacksburg Electronic Village community network. The next three sections describe applications and extensions of community collective efficacy to three on-going community informatics projects. In each of these cases, the authors explain how the community collective efficacy construct is being applied and extended.

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Bandura's (1997) definitive book on perceived self-efficacy makes a comprehensive case that people can accurately gauge their own capacities to cope with challenges, and to achieve given levels of performance. People can do this across a wide range of circumstances. Judgments of perceived self-efficacy (PSE) are generally quite specific—"I can lift 150 pounds." They are empirically reliable, predictive of many other important behavioral and subjective variables (such as actual performance), and they are distinct from many other types of self-judgments. For example, PSE is not the same as self-esteem; the latter is a generalized appraisal of self-worth, not a specific belief about a specific capacity. PSE is also not a recollection; if I actually *did* lift 150 pounds, and I recall that, then my judgment is based on memory not on perceived self-efficacy.

PSE is operationalized through Likert survey items that present a brief challenge scenario, and ask for a judgment on a scale of confidence that the challenge can be met. Schematically, an efficacy item has the form "I can do X even if Y". Examples would include the following two examples; the first illustrates perceived dietary self-efficacy; the second parental or family responsibility self-efficacy.

I can control my carbohydrates even while vacationing at Beervana.

Despite a light snow shower, I can be on time for my parent-teacher conference.

We conceptualize self-efficacy as depending on what might be called a "capacity analysis"—a notion intended to be understood on analogy to "task analysis". Where a task analysis enumerates the action components comprising a task, a capacity analysis enumerates the different capacities comprising successful participation in a domain. Thus, perceived dietary self-efficacy probably involves resisting junk food, excessive salt, gluttony, and sugary deserts as well as beer. The parent-teacher conference item could be part of a scale of perceived parental efficacy in the context of other items involving bedtimes, parameters for sleepovers, making time to read together, and so forth, or it could be part of a family responsibility self-efficacy scale in the context of items involving paying bills on time, developing a college fund, planning for vacations, calling various in-laws, and so forth.

Bandura and his students focused on perceived self-efficacy, but extended the concept to collective efficacy—that is, to beliefs about collective capacities. Much of the early work on perceived collective efficacy involved the beliefs of teachers about the capacities of their classes or of their schools, for example, beliefs that the school could perform above the 50th percentile on standard mathematics tests.

Starting in 2000, we developed and investigated another specialization of collective efficacy that we called "community collective efficacy" (Carroll & Reese, 2003). Our first study focused on the physical community of Blacksburg, Virginia. We were interested in how beliefs about community collective efficacy might affect use of the Blacksburg Electronic Village, a very prominent second-generation community network (Carroll, 2005). Subsequently, we have investigated community collective efficacy in other communities (State College, Pennsylvania), and in other types of communities (a learning community, a scientific research community).

co MMun It Y collect IVe eFFIcac Y In the blacksbur G electron Ic VIlla Ge

As part of an extensive study of community-oriented technology, we developed a community collective efficacy (CCE) scale. Our original scale had 13 items, and our current scale has 17. The scale reflects a capacity analysis of challenges more or less any community would have address: (1) assist economically disadvantaged, (2) increase tourism, (3) improve roads, (4) improve quality of life, (5) improve quality of education, (6) preserve parklands, (7) handle mistakes and setbacks, (8) improve quality of community facilities, (9) present united community vision, (10) quality and access to services by disabled people, (11) commit to common community goals, (12) clean air and water, (13) work together, (14) resolve crises, (15) enact fair laws, (16) create resources for new jobs, and (17) improve services for senior citizens.

Typical obstacles to the community's ability to attain these goals, numbered to match the capacity they were paired with, include: (1) problems with the economy, (2) maintenance of unique character, (3) opposition from adjacent counties and states, (4) limited resources, (5 and 17) inadequate help from the state of Virginia, (6) population growth, (7) discouragement, (8) difficulties, (10) inadequate help from the federal government, (11) work and family obligations, (12) commercial development, (13) a great deal of effort, (14) negative aftereffects, (15) conflicts in the larger society, and (16) changes in the economy. Item (9) mentioned no explicit obstacle, though it might be assumed that social entropy would tend to undermine a united community vision. The CCE scale was incorporated in a large survey investigating how people participated in their local community, how they felt about the community and about themselves in the community, and how they made use of information technology for community-oriented activity as well as more generally. Our scale items, from Carroll et al. (2005), are given below:

1. Despite occasional problems with the economy, we can assist economically disadvantaged members of our community.
2. Our community can present itself in ways that increase tourism while maintaining its unique character.
3. We can greatly improve the roads in Blacksburg and Montgomery County, even when there is strong opposition from adjacent counties and states.
4. I am convinced that we can improve the quality of life in the community, even when resources are limited or become scarce.
5. Our community can greatly improve the quality of education in Montgomery County without help from the Commonwealth of Virginia.
6. Despite a growing population, our community can preserve parklands in Blacksburg and Montgomery County.
7. As a community, we can handle mistakes and setbacks without getting discouraged.
8. Our community can cooperate in the face of difficulties to improve the quality of community facilities.
9. I am confident that we can be united in the community vision we present to outsiders.
10. Our community can improve quality and access to services for people with disabilities without help from federal government.
11. Despite work and family obligations, we can commit ourselves to common community goals.
12. We can ensure that the air and water in our community remain clean despite commercial development.
13. The people of our community can continue to work together, even when it requires a great deal of effort.
14. We can resolve crises in the community without any negative aftereffects.
15. Our community can enact fair laws, despite conflicts in the larger society.
16. I am confident that our community can create adequate resources to develop new jobs despite changes in the economy.
17. Our community can greatly improve services for senior citizens in Blacksburg and Montgomery County without help from the Commonwealth of Virginia.

As part of our analysis, we constructed exploratory path models involving constructs we measured, including CCE. We found that social and civic use of the Internet, being informed about one's local community, and number of personal associations were all predicted by CCE. In other words, people in Blacksburg who reported strong beliefs about

CCE made greater social use of the Internet, made greater civic use of the Internet, were better informed about what was going on in the community, and had more friends and other associates.

Factor analysis identified four underlying dimensions of CCE: "Managing conflict"—handling dilemmas and tradeoffs with respect to shared access and resources, loads on items 1, 2, 4, 14, 15, 16; "Sustainable development"—balancing goals and policies with respect to growth and the environment, loads on items 3, 6, 12; "United Action"—cooperating, working together, agreeing, and handling mistakes and disappointments, loads on items 7, 8, 9, 11, 13; "Social Services"—support for quality education, and quality and access to services for senior citizens and people with disabilities, loads on items 1, 5, 17.

We repeated our path analyses substituting the four first order factors of CCE. We found that Managing Conflict predicted social use of the Internet, that Sustainable Development predicted civic use of the Internet, United Action predicted being informed about the community, and Managing Conflict predicted number of associations. In other words, the first order factors further articulate the overall effects of CCE. Additionally, we found that Managing Conflicts predicts activism in the community.

One interpretation we made of these data is that the first order factors help to differentiate relatively active community involvement (through the relationship between Managing Conflicts and associations and activism) and relatively passive community involvement (through the relationship between United Action and being informed). See Carroll, Rosson and Zhou (2005) for further details.

a wIreless coMMunIty network

As more and more people connect to the Internet via wireless technology, municipalities around the world are also trying to determine ways to provide wireless networks to their constituents (Mahmud, et al., 2006). A municipal network would support a variety of civic-oriented activities through the use of location-sensing applications. State College in Pennsylvania is considering developing a network infrastructure that would provide wireless to everyone within its borough. This section describes the application of a community collective efficacy scale for *Wireless State College*, a municipal wireless project that emphasizes civic applications for wireless Internet.

We are interested in studying how the Internet can be leveraged for government communications. We believe that a municipal wireless network can encourage new forms of civic engagement, such as community members taking a more active role in decision-making. Additionally, a municipal wireless infrastructure could help local nonprofit organizations carry out their civic missions. To investigate this hypothesis, we are soliciting input from members of non-profit community groups. We are asking them to share their thoughts about how a municipal wireless network might help them do the work of their organizations. We are also exploring community members' general expectations, hopes and concerns about municipal wireless. Since many communities have experienced a decrease in civic and social involvement in recent years (Putnam, 2000; Bellah, et al., 1986), a community wireless network could present an opportunity to bring people back together and develop and greater sense of belonging and connectedness.

Our research team is working with the borough and a community of non-profit organizations to implement location-sensing applications that would be available on the network ubiquitously. In particular, we are developing location-sensing applications that would, for example, allow users to (1) event-blog about local happenings and (2) quickly mobilize volunteerism efforts, which we call place *place-based blogging* and *volunteering-on-the-fly*, respectively. Developing these applications, however, requires that we first understand people's behaviors about and expectations from a community wireless network.

We have developed a wireless community survey that solicits input from community members about how they use wireless technology. The focus of the survey is to investigate both community members' current use of wireless networks and their understanding of benefits (and concerns) of a community-wide wireless network for State College. However, an important part of designing technology for users within a computing community is to understand their behaviors and beliefs about working together. Thus, a major component of this survey is an adaptation of the CCE scale used in our BEV research. For the remainder of this section, we will adapt and apply the CCE scale to investigate and understand the self-perceived efficacy of a community towards a community wireless network.

We use the collective community efficacy (CCE) scale in our community wireless survey in much the same way as it was used for the BEV (Carroll, et al., 2005). In particular, we want to investigate how citizens' beliefs about community collective efficacy might affect peoples' use of a wireless community network. Understanding community collective efficacy in the context of developing and deploying a wireless community network is important because we have a strong method of analysis for users' initial state of competency.

We use a 15-item scale that uses many of the same items from CCE scale (Carroll and Reese, 2003) used for the BEV: (1) assistive economically disadvantaged, (2) improve quality of education, (3) improve quality of education, (4) handle mistakes and setbacks, (5) improve quality of community facilities, (6) present united community vision, (7) quality and access to services by disabled people, (8) commit to common community goals, (9) clean air and water, (10) work together, (11) resolve crises, (12) enact fair laws, (13) create resources for new jobs, and (14) improve services for senior citizens.

As with the BEV, we believe that using these items helps us gauge people's beliefs about the issues their community may have the capacity to address. Our rationale is that measuring community collective efficacy allows us to assess peoples' willingness to share community resources (i.e., a wireless network) and work through social and political difficulties within the community (Carroll and Reese, 2003; Carroll, et al, 2005). Below are the items from the CCE scale.

1. Despite occasional problems with the economy, we assist economically disadvantaged members of our community.
2. I am convinced that we can improve the quality of life in the community, even when resources are limited or become scarce.
3. Our community can greatly improve the quality of education in Centre County without help from the Commonwealth of Pennsylvania.
4. Despite a growing population, our community can preserve parklands in State College and Centre County.
5. As a community, we can handle mistakes and setbacks without getting discouraged.
6. Our community can cooperate in the face of difficulties to improve the quality of community facilities.
7. I am confident that we can be more united in the community vision we present to outsiders.
8. Our community can improve quality and access to services for people with disabilities without help from federal government.
9. We can ensure that the air and water in our community remain clean despite commercial development.
10. The people of our community can continue to work together, even when it requires some compromise.
11. We can resolve crises in the community without any negative aftereffects.
12. Our community can enact fair laws, despite conflicts in the larger society.
13. I am confident that our community can pull together adequate resources to develop new jobs despite changes in the economy.
14. Our community can improve services for senior citizens in State College and Centre County despite cutbacks in social security.

We also added a new item that reflects the community's capacity toward racial harmony. This item was added in an effort to understand the community's attitudes toward fellow residents of differing backgrounds and cultures. Having an understanding (and appreciation) of diversity in the community helps to build social capital. Communities that have the capacity to "bridge ties" build *social capital* (Kavanaugh, et al., 2003). Communities that have high levels of social capital are more likely to have a high quality of life, when compared to communities with lower levels of social capital. Communities with higher levels of social capital are more likely to bond and mobilize for collective action.

I believe that our community does a good job of establishing and maintaining race relations.

Since our adapted scale uses many of the same items as the CCE scale used in the BEV, we will have identical underlying dimension of CCE, i.e., "managing conflict", "sustainable development", "united action", and "social services". Essentially, peoples' beliefs about their community collective efficacy might play a role in their use of a community wireless network. We are currently in the process of administering the survey to civic groups within State College, and our next steps phase will be analysis of the results. Our final analyses will also include community members' individual perceptions of technology use (Internet, wireless) for personal and community-oriented activities.

A Developmental Learning Community

Research over the past two decades has emphasized the importance of learning communities—self-organizing groups of learners who work together on authentic tasks, describing, explaining, listening to, and interpreting one another's ideas (Lave & Wenger, 1991). Learning communities often structure their learning by scaffolding that is embedded in both the activities and the tools of the community (Bruner, 1960). Learners also develop by participating in the discourse of their community, where they encounter and contribute to the situated negotiation and re-negotiation of meaning (Dewey, 1910). Within this context, one of our ongoing research projects is studying *developmental learning communities*—inter-connected groups that organize their learning activities into phases and their members into developmental roles. The learning in such communities is developmental in the sense that members successively traverse phases and roles. An example would be a university research group comprised of undergraduate students, graduate students, post doctoral students, and faculty.

A defining feature of a developmental learning community is that its members understand—implicitly or explicitly—that there are *phases* that they progress through as the result of gaining community-relevant knowledge and skills. Some developmental communities emphasize mastery of skills (e.g., a martial arts community), where different skill levels are labeled to acknowledge members' progress (for instance "apprentice", "practitioner", or "master"). Movement from one developmental phase to the next happens when the member meets a community standard or practice that often also includes a change in status for members, perhaps a skill test of some sort, cumulative knowledge or experiences that are judged in some fashion, a prescribed level of insight that is expressed by the member, or a critical episode that persuades the community of the member's progress.

Another characteristic of developmental communities is the *community expectations* for member behavior at different phases. We assume that members share an understanding of behavior and interactions that are appropriate at different phases—for example, how they should relate to more junior members (outreach, scaffolding, other forms of mentoring); those at their same level (sharing, comparison, synthesis of experience); and those at higher levels (requesting help or mentoring, respect for suggestions).

Members of developmental learning communities also have a *shared motivation* to promote their own and others' development. One criterion for joining a development community is committing to its developmental goals, that is, being willing to spend effort in "bringing others along." We believe that social ties may be important in creating and sustaining this motivation and commitment, because socially-connected members are more likely care about one another, both by reading out to enlist new members and by encouraging the growth by existing members. A developmental community may also provide rewards for members' efforts to promote co-members' learning, such as increased social capital or more explicit forms of recognition.

We are currently studying the formation and activities of an emerging developmental learning community – the *wConnect* online community of women in Penn State's College of Information Sciences and Technology. Women join the community with the explicit aim to attract, mentor, and otherwise aid the development of less-expert members, or with the goal of receiving such support from more-expert members. It differs from similar communities (e.g., a chapter of the Association for Women in Computing) in that undergraduates leverage personal social ties they have maintained with their high schools, using these to contact girls with quite varied interests (e.g., sports, theater) so as to increase general awareness of computing among young women. Alumni members contact and interact with undergraduates on a similar basis. This project illustrates an effort to apply our concept of developmental community as a guiding pattern for the creation of a learning community.

A central goal of *wConnect* is that its members will support each other at their varying levels of expertise and confidence with respect to education and careers in computing. The support is a mixture of explicit outreach activities (e.g., workshops organized by university students for high schools students, or by alumni for undergraduates) and more indirect mentoring or social support (e.g., online discussions, interactive online forums). We anticipate that individual members will experience increased self-efficacy with respect to computing, but also that as the community articulates and pursues its goals, its collective efficacy as a developmental organization will increase. The following items were created to track CCE for the *wConnect* community:

1. I believe that *wConnect* can develop technology-related workshops that are interesting enough to attract participation of female high school students disinclined toward computing.
2. Even though it means addressing the unpredictable constraints of an unfamiliar setting, *wConnect* can organize and deliver effective high school workshops.
3. Despite a lack of computing background among participating high school students, *wConnect* is able to design hands-on computing workshops that teach basic concepts about information and computer science.
4. Even though few high school participants will have personal links to IST student members, *wConnect* can encourage continued participation in the community by the high school students after a workshop has occurred.
5. Although every member of *wConnect* is an individual with person-specific characteristics, the community can recognize members' needs and support each person to expand her understanding of information science and computing.
6. Although IST student members are very busy with coursework and other interests, *wConnect* is an effective resource for sharing concerns and activities related to education and careers in computing.
7. Despite a lack of technical background in building online community systems, *wConnect* can acquire and refine the skills needed to support its online activities.
8. Although IST graduates have moved on to busy careers in other places, *wConnect* enables women alumni to meet and develop social ties to current members of IST.

9. The internship and career options for IST women are varied and confusing, but *wConnect* helps its members to understand the pros and cons of different options.
10. While IST female alumni are primarily focused learning technical skills for their current work context, *wConnect* enables them to develop and refine their personal and professional leadership skills.

The *wConnect* community is still in formation, but it already includes young women at all levels of development: high school, early college, late college, and professional. We are now moving to the phase of implementing and evaluating online activities aimed at helping these individuals to identify with and move through the developmental phases. We plan to administer the CCE scale above at regular intervals, using it as a primary metric in the success of this work.

a technIcal scIentIFIc coMMunItY

This section describes the design of a community collective efficacy scale for a virtual community of computing and information technology researchers. Our study context is *CiteSeer* (Giles et al. 1998): a free public resource providing access to the full-text of nearly 700,000 academic science papers and over 10 million citations in the computer and information science domain. CiteSeer currently receives over approximately 1.5 million hits a day and is accessed by 150 countries and over a million unique machines monthly. It is currently hosted and maintained by the College of Information Sciences and Technology at the Pennsylvania State University (http://citeseer.ist.psu.edu).

It is traditional practice in the technical computer and information science community to make research documents available at the time they are first written through technical reports series managed by various laboratories and academic departments. More recently, this practice has been transferred to the World Wide Web (Goodrum et al. 2001). CiteSeer actively and automatically harvests these documents and automatically builds searchable and indexable collections, promoting creative scientific discovery and reuse within the computer and information science community. Even though search engines such as Google actively index CiteSeer, users come to the CiteSeer engine for unique information such as citation counts and domain dependent citation links not provided by Google or Google Scholar.

Digital libraries such as CiteSeer have not typically been investigated from the perspective of communities. Digital libraries are repositories for information search and retrieval, but they are also collective resources that attract people and help to form scholarly communities. After all, scientific communities have traditionally formed around key intellectual resources such as collections of books, or special equipment such as cyclotrons (Wellman, 1999). Users are doing more than visiting a website, they are building knowledge, sharing knowledge, and more. They are participating in online scientific *communities of practice* (Wenger, 1998).

The CiteSeer population is an implicit community of practice. CiteSeer users have the basic characteristics of a community of practice—domain of knowledge, community of people, and shared practice—but they do not have any online mechanism in CiteSeer that allows them to see, stay aware of, and interact with one another. From our earlier studies with CiteSeer users (Farooq et al., In Press (a)), the most significant result is indeed that users want to collaborate around the intellectual resources of a digital library in ways similar to that in an online community of practice. In our ongoing work, we are providing collaborative support for CiteSeer users to interact and work with each other online around CiteSeer's intellectual resources (Farooq et al., In Press (b)).

For the purposes of this chapter, our goal is to adapt and enhance survey subscales for community collective efficacy used in the Blacksburg Electronic Village to help us to understand the self-perceived ability of the CiteSeer scientific community to successfully be *creative* using the digital library and its intellectual resources.

The logical connection between technical scientific communities and creativity is an obvious and important one. Technical scientific communities such as CiteSeer are virtual infrastructures that can support creativity between geographically distributed scientists. However, the connection been creativity and how technical scientific communities can foster creativity has been understudied (Carroll and Farooq, 2006). We leverage existing work on creativity to develop collective efficacy scales for measuring the self-perceived ability of users in the CiteSeer scientific community to be socially creative with their peers. Specifically, we want to capture a member's beliefs about the creative capacity of his/her technical scientific community.

In the scale we are currently developing, we identify goals as creative capacities of members in the CiteSeer technical scientific community. A community is defined broadly as a member's immediate research group and larger professional network that he/she is a part of. For instance, for Professor John Doe, his research group in Artificial Intelligence (AI) would be his community encompassed in the larger framework of the computer and information science collective doing research in AI. We have adapted this framework based on Csikszentmihalyi's systems model (Csikszentmihalyi, 1999).

Based on two sources of existing work on creativity, we have developed ten scale items for measuring collective efficacy in technical scientific communities. The first five items are based on Farooq et al.'s (2007) framework of a creative scientific process in groups and the subsequent five items are based on Csikszentmihalyi's (1999) characteristics of a creative scientific community. Following is a list of these items with their associated rationale.

As a research group, we can take advantage of minority ideas despite an overwhelming majority for consensus.

Dissenting or minority opinions stimulate creative thought (Nemeth and Nemeth-Brown, 2003). It is the situation when initially unpopular views still get considered and remembered, thus making the group's total inventory of ideas richer.

Our research group is capable of pooling unique ideas from every member even though everyone would like to conform toward common and shared ideas.

Part of the reason for suboptimal performance in creative groups is that members desire consensus. Unique ideas can exist among a group of otherwise majority opinion holders. The majority achieves influence as it exerts social pressure. This is known as groupthink, arising from a situation marked by homogeneity of its members, strong and directed leadership, group isolation, and high cohesion (Janis, 1982).

Every member in our research group is willing to share their unique ideas without fear of criticism from the group.

A necessary condition for creativity is for group members to leverage their domain-specific knowledge and engage in unique information sharing (Nickerson, 1999). Typically, groups resort to common information pooling for reasons such as fear of criticism from the group or other social influences such as *normalization* (Moscovici, 1974).

We can effectively reflect on the group's objectives, strategies, and processes even when we are against tight deadlines.

Shared understanding is the extent to which members collectively reflect on the group's objectives, strategies, and processes (West, 1996), which is an essential condition for creativity. Group members can often overlook shared understanding by not evaluating decisions and planning adequately.

Our research group can critically evaluate and funnel down multiple ideas into a single research opportunity without compromising overall novelty.

In addition to divergent thinking, convergent thinking allows groups to select from available options and put these ideas into practice (Milliken et al.

2003). Creativity is dependent upon both divergent and convergent thinking.

Our research group can publish novel results in highly rated journals despite the rigorous review process.

Creative ideas are only creative if they are accepted by one's field. Without some form of social valuation, it would be impossible to distinguish ideas that are simply bizarre from those that are genuinely creative (Csikszentmihalyi, 1999, p. 321). Csikszentmihalyi (1999) refers to *gatekeepers* as the people in the field who deliberate over this process.

Our research group is fully capable of acquiring external research funding even with the stiff competition from other researchers in our area.

Having adequate material resources, such as funding from the National Science Foundation, is essential for driving the creative process. A wealthier community is able to make information more readily available, allows for a greater rate of specialization and experimentation, and is better equipped to reward and implement new ideas (Csikszentmihalyi, 1999, p. 322). Whereas subsistence societies have fewer opportunities to encourage and reward novelty (Csikszentmihalyi, 1999, p. 322).

We can make a significant paradigmatic impact in our research area despite opposition from the community against radical adjustments to the area's fundamental concepts.

Creativity occurs when a person (or a research group) makes a change in a domain, a change that will be transmitted through time (Csikszentmihalyi, 1999, p. 315). Some domains are easier to change than others, depending in part on how autonomous a domain is from the rest of the community culture that supports it (Csikszentmihalyi, 1999, p. 320).

Our research group would likely hire an innovative junior researcher who has a different intellectual bent in the area.

Persons who are likely to innovate tend to have traits that favor breaking rules (Csikszentmihalyi, 1999, p. 327), though the challenge here is to convince the community about the potential virtual of one's novel approach.

Our work can easily become mainstream despite the protective boundaries formed by long-standing and senior researchers in the area.

An essential part of being creative is to have access to what Csikszentmihalyi (1999) refers to as *memes* (technical procedures, knowledge base, etc). For one's work to be accepted by the larger community, it has to surpass the protective boundaries around those memes. With time, people who benefit from the ability to control memes develop protective boundaries around their knowledge, so that only a few initiates at any given time will have access to it (Csikszentmihalyi, 1999, p. 317). Rules and knowledge can become the monopoly of a protective class or caste (Csikszentmihalyi, 1999, p. 320).

Though we have not validated these ten scale items through empirical studies, these items are theoretically motivated from and grounded in empirical studies by way of existing work on creativity (Csikszentmihalyi, 1999; Farooq et al. 2007). Our next step is to administer an online survey of these items with CiteSeer users and progressively refine the scale through multiple iterations.

a FInal word

Though the past several years, we have used CCE scales in an increasing variety of ways. Initially, we regarded the development of collective efficacy as a direct indicator of the quality of "community" (e.g., Carroll et al. 2005), and the scale items as instruments for making a capacity analysis of a community. In our more recent work we now also regard CCE as indicating a community's readiness to approach higher order challenges such as organizational learning and creativity.

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Blacksburg Electronic Village (Carroll, 2005): A very prominent second-generation community network in Blacksburg, VA. The first application of the community collective efficacy scale. Results indicated that community collective efficacy predicted social and civic use of the Internet, being informed about one's local community, and number of personal associations.

Community Collective Efficacy: A specialization of collective efficacy that measures residents' capacities of their community; adapted from Albert Bandura's (1997) conceptualization of perceived self-efficacy.

Community Collective Efficacy Scale: Scale used to understand a range of community-oriented attitudes, beliefs and behaviors.

Developmental Learning Community: Inter-connected groups that organize their learning activities into phases and their members into developmental roles. The learning in these communities is developmental in the sense that members successively traverse phases and roles.

Socio-Technical Systems: Social systems that incorporate technological infrastructures. These systems allow for the investigation of collective capacities, as well as the impact information technologies have on community-oriented activities, such as civic engagement.

Technical Scientific Community: A virtual community of computing and information technology researchers, specifically those in the computer and information science domain.

Wireless Community Network: A wireless network infrastructure that connects communities of users to the Internet; also called a municipal wireless network.

Chapter XLI
An Analysis of the Socio-Technical Gap in Social Networking Sites

Tanguy Coenen
Vrije Universiteit Brussel, Belgium

Wouter Van den Bosch
Katholieke Hogeschool Mechelen, Belgium

Veerle Van der Sluys
Independent Scholar, Belgium

abstract

This chapter views social networking sites as supporting social capital and the advantages which derive from it, namely emotional support, information exchange, and a capacity for concerted action. Social capital is subdivided in three types: relational, cognitive, and structural. The authors derive a number of social needs from these types of social capital and discuss how the social networking sites considered in this study support or fail to support these needs with technical features. The contributions of this chapter include the dimensionalisation of the socio-technical gap in social networking systems and a discussion of elements that reside in the gap.

It is hardly possible to overrate the value… of placing human beings in contact with persons dissimilar to themselves, and with the modes of thought and action unlike those with which they are familiar… Such communication has always been, and is peculiarly in the present age, one of the primary sources of progress.

—John Stuart Mill (1848)

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Introduction

This paper investigates socio-technical systems. The constituents of these socio-technical systems are people and technology. More precisely, users pursue a certain goal and must therefore interact with others through technology. This introduces a social dimension in the system[1]. As the social interaction takes place through the technology, the technical dimension mediates the social dimension. The social dimension also influences the technical dimension, as the interactions between the users of the system create a number of social needs which the technical dimension must meet. If the social needs are not met, we refer to this discrepancy between social and technical dimensions as the socio-technical gap or, as Ackermann defines it:

The social-technical gap is the divide between what we know we must support socially and what we can support technically. (Ackerman 2000, p179)

As, in our perspective, the influence runs in both directions, between the social and the technical dimensions of the system, it can be said that the social and the technical component co-evolves.

We therefore propose to expand the definition offered by Ackermann of the socio-technical gap by stating that there are also social practices which emerge, based on the opportunities proposed by the technology. In the type of socio-technical system under study—internet technology and the interaction it supports—new technologies are appearing every day. Still, it is not always clear how social practices can adapt to the technical possibilities in order to better realize the social goals of the system's participants. Whereas this constitutes an interesting research theme in itself, this chapter only investigates the socio-technical gap regarding the way the technology meets the needs of the social component.

Social Networking Sites as Socio-Technical Systems

In the last decade, social networking sites (e.g. Facebook, mySpace, linkedIn, Orkut, Xing, etc…) have become among the most popular internet applications. In a recent overview, Boyd & Ellison (2007) define them as:

web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system. (Boyd & Ellison 2007, p 2)

This is a very basic definition, which to our knowledge is applicable to all existing social networking sites. Still, most sites provide much more than these 3 basic functions. Also, the definition does not point to the socio-technical nature of social networking sites, as there is no mention of the interaction which commonly takes place on these sites. We therefore propose to apply another definition:

Social networking systems are web-based systems that aim to create and support specific types of relationships between people. (Coenen 2006, p 75)

This definition alludes to social interactions, as this is necessary to create and maintain social relationships. While this definition seems more general than the one mentioned before, it more reflects the interactive nature of social networking systems.

In previous work, three functional subsystems have been distinguished that apply to social networking sites: the individual subsystem, the dyadic subsystem and the group subsystem (Coenen 2006, Coenen et al 2006). The *individual* subsystem contains the functionalities which pertain to the individual. This includes the way she presents herself to others and settings which the individual can make with regards to the way she wants to use the system. Thus, the socio-technical system is composed of the individual as she interacts with the system and with herself.

The *dyadic* subsystem contains the functionalities through which a person can manage the attributes of his relationship with another person. Among many features, this includes the ability to add a person as a friend, to label another person as "sexy" or to send a message to someone else. Here, the socio-technical subsystem is composed of 2 people and the technology over which and with which they interact. The whole of the dyadic spaces can be traversed, creating the ubiquitous social network representation. Social networks in social networking sites are represented as egocentric networks, in which the user is at the center of his own community. This reflects a trend coined by Wellman (2003), who claims that social life is moving away from community-based life towards networked individualism.

Finally, the *group* subsystem includes the technical means to interact with groups of people. This subsystem contains e.g. public blogs and forums. This socio-technical subsystem is composed of a group of people and the technology over which and with which they interact.

The above definition by Boyd & Ellison (2007) only describes the individual and dyadic subsystems. Granted, these are the areas in which social networking sites distinguish themselves from prior groupware or computer-supported collaborative work systems. Still, most social networking sites also provide heavily-used group subsystems. Providing a picture of social networking sites that neglects the group as a socio-technical system seems to be an impoverished version of the facts, especially as the group level has an influence on the other subsystems in the whole.

PURPOSE OF THE SOCIO-TECHNICAL SYSTEMS

In order to better understand the nature of the socio-technical components of social networking sites, it is necessary to discuss the purpose of the constituents in the three above mentioned subsystems. It was explained before that the systems as we see them have technical and social components. The subsystems are in fact created by the technical system components and the number of people that can interact with each other and with the technical system component. The nature of the subsystems thus derives from the technical component. It can therefore be said that the purpose of the technical components of each subsystem is to generate the subsystem in itself. For example, the purpose of the user profile in the individual space is to provide the functionality of the identity space.

This is different for the human components of the socio-technical subsystems. Social networking systems create and maintain relationships between people. These relationships, together with the advantages that derive from social relationships are currently being studied under the label of social capital, defined as

the sum of the resources, actual or virtual, that accrue to an individual or group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and relationship. (Bourdieu & Wacquant 1992, p119)

In the light of the previously proposed definition, which sees social networking systems as creators of social relationships, it follows that the core purpose of social networking systems is to create and maintain social capital.

But why would one want to do this? Resnick (2001) categorizes the resources which accrue from relationships over an information system as emotional wellbeing, information and an improved capacity for concerted action. We will assume that these are the prizes that can be gained by interacting in the offline social mode and that they in part constitute the motive for interacting on social networking sites. Indeed, maintaining the social relationships from which social capital ensues is one of the most obvious added values of social networking sites.

Therefore, we believe social networking sites should be discussed in relation to social capital.

The degree to which the social capital related functionalities on offer in social networking systems meet the identified needs, will determine the socio-technical gap in the context of this paper. Combining these purposes with the presented subsystem approach to social networking sites will allow us to provide a more fine-grained approach to the social needs in social networking systems. In the remainder of this section, we discuss various purposes and the social needs which derive from these purposes.

Deriving Emotional Wellbeing from Interaction with Other People

One of the main reasons why social networking sites are currently being used is to derive a sense of wellbeing from interacting with others. A large part if not the majority of current social networking site users are aged under 20, a populating group well known for having special needs in terms of emotional wellbeing. The success of systems like Facebook is sometimes attributed to the fact that many students in the United States need to leave the geographic area in which they grew up to go and study at university. This is not always an easy process, as the youth need to leave behind the social networks on which they relied in earlier years. Social networking sites make it easier to keep in touch with a larger and more dispersed social network, from which people can derive emotional wellbeing, attenuating the "friendsickness" effect (Ellison, Steinfield & Lampe 2007).

Exchanging Information with Other People

Another reason why people use the networking features of social networking sites is to exchange information. The information benefits that can be derived from social capital have been widely studied (e.g. Granovetter 1973, Hansen 1999, Burt 2000). This is one of the elements driving the networking practices of people in various industries, as they come together to meet others at fairs, receptions, club meetings, etc…

For example, Ellison, Steinfield & Lampe 2007 report that people are using Facebook to "crystallize relationships that might otherwise remain ephemeral". They suggest that through Facebook, it is easier to leverage the informational advantages of having weak tie conduits into social clusters, other than the ones a person belongs to. In other words, they propose that using a social network site makes it easier to ask things to people you don't know well and would otherwise not ask anything of.

An Improved Capacity for Concerted Action

Many complicated activities require contributions by a number of people. It will be easier to complete such activities if social capital exists, prior to starting the executing of complex group actions. Social capital can allow groups to overcome some costs of cooperation, like a lack of trust or common understanding.

An example is a software development project. Imagine two cases: one with pre-existing social capital and one without. In both cases, a team of people is assembled to work on the software development project. In the case where social capital does not pre-exist, issues may occur regarding trust. For example, people may not reveal their own ideas to others, from fear that others in the team will steal their idea. Also, communication between the different members of the team may be hindered due to a lack of common understanding of concepts. This is often the case when people have no history of interaction and results in a situation where they find it hard to understand exactly what the other is saying, which can lead to frustration and harmful misunderstandings. In the case where common understanding pre-exists, the odds are better that the communication will run smoothly.

The Components of Social Capital

Before starting the discussion of the social needs which derive from the social-capital related purposes discussed above, we must briefly introduce the components of social capital. What are the elements that are bundled under the label social capital and allow people to accomplish the purposes described in the previous section?

Nahapiet & Goshal (1998) discern three different components: relational, cognitive and structural social capital.

Relational Social Capital

The relational component of social capital covers parameters influencing relationships, like trust, norm and values, obligations, expectation and identity. These elements influence what will flow over social relationships. People will for example only be willing to share certain knowledge with people they trust.

Cognitive Social Capital

Cognitive social capital refers to the development of cognitive elements that allow communication to occur between actors. This includes shared meaning, representations and interpretations. Routing information and performing a concerted action, two of the advantages of social capital described above, can be facilitated if people are able to explicate their own cognitive perspectives and interpret the cognitive perspectives of others (Boland & Tenkasi 1995). This is also the case for situations where there is a pre-established division of cognitive labor that allows people to specialize in certain domains (Wegner 1986), as we will explain in more detail later in this paper.

Structural Social Capital

The structural component of social capital addresses the network structure of people's interactions. It covers the creation and dissolution of social relationships and the overall structure of the networks that are formed by these relationships. All the social relationships taken together produce a social network that spans our planet by interconnecting people.

A person's social network can be thought of as communication paths, over which information is acquired from different parts of the social realm. Structural social capital is a general category under which different social network theories can be classified, like the strength of weak ties (Granovetter 1973), structural holes (Burt 1992) or network closure (Coleman 1990).

Social Needs in Social Networking Sites

In this section, we describe a number of needs of users on social networking sites. These needs have been identified through literature study and our own insight resulting from designing and using social networking sites. Categorization of the needs is done based on the type of social capital they represent.

Social Needs Related to Relational Social Capital

Generalized Reciprocity

Norms describe the accepted behavior within a group of people. The following quote is revealing as it describes how norms play a role in the evolution of loose social relationships into more community-based interactions.

When people are thrown together, and before common norms or goals or role expectations have crystallized among them, the advantages to be gained from entering into exchange relations furnish incentives for social interaction, and the exchange processes serve as mechanisms for regulating social interaction, thus fostering the development of a network of social relations and a rudimentary group structure. Eventually, group norms to regulate and limit the *exchange transactions emerge, including the fundamental and ubiquitous norm of reciprocity, which makes failure to discharge obligations subject to group sanctions.* (Blau 1964, p 90)

Without norms, it can be hard to know how to behave and what to expect from others. A norm that is particularly influential to the construction of social capital is the norm of reciprocity, according to which a person who provides something to a person in the group can expect something back from this particular person (direct reciprocity) or from another, non-particular person in the collective (generalized reciprocity) (Gouldner 1960). Especially the generalized reciprocity norm is powerful in eliciting behavior which can facilitate information routing and concerted activities in social collectives. To summarize this section, we formulate the following social need:

Social Need 1: *Stimulate generalized reciprocity*

Trust Building

Trust is an expectation that others will act in a way favorable to one's interest, even if they have an opportunity to do otherwise. (Resnick 2001, p9)

Trust is an important component of relational social capital and a prerequisite of many of the interactions in which social networking site users are involved. Trust is built on past interactions and influences future interactions. Still, it can be transferred over social networks. Trusting people who are being trusted by the people you trust yourself is a common way in which initial trust is established. The same is true with distrusting people who are being distrusted by the people you trust. Such initial trust can be an important facilitator to the creation of new social relationships, which alter the structure of one's social network.

Social need 2: *Stimulate the establishment of trust*

Social Needs Related to Cognitive Social Capital

Individual and Collective Meaning Negotiation

Constructivist epistemology (Fosnot 1996) teaches us that there is no singular way of perceiving the world. Every person has a different path through life and therefore accumulates different knowledge. This heterogeneity leads to problems in communication, which is essential in allowing social capital to yield its benefits (Boland & Tenkasi 1998, Ackerman 2000). Meaning can be negotiated through communication, but not all means of communication are effective ways to negotiate meaning.

Social need 3: *Support meaning negotiation*

Nuanced Social Activity

Ackerman (2000) remarks that people are very nuanced in the way they interact with different social partners. The manner in which they interact with one person may not be suitable for interactions with another person. The difference between the two interaction modes can be very small, but very significant. People change the way they interact with each other based on their perception of the people with whom they interact.

Social need 4: *Support nuanced social activity*

Transactive Memory

People who build social capital by closely working together under prolonged periods of time create an understanding of who holds what knowledge (Wenger 1986). When a certain bit of knowledge is needed, people can engage in a transaction with other people in their social network, to obtain the specific knowledge. In this way, a kind of distributed group memory is created, which people can access by engaging in transactions, hence the name *transactive memory*. If a transactive memory system is present in the environment in which a person functions, the individual can be freed from accumulating a very broad array of knowledge types and can focus more on specializing in other knowledge types.

Social need 5: *Support transactive memory*

Awareness

In online environments, people prefer to be aware of who is also present in the virtual space (Ackerman 2000). In this way, they can adapt their social behavior, for example by doing things that attract the attention of certain other people.

Social need 6: *support awareness*

Social Needs Related to Structural Social Capital

Identity Building

Being able to evaluate another person's identity is essential if any communication is to ensue. As Simmel (1906, p 441) put it: "That we shall know with whom we have to do, is the first precondition of having anything to do with another."

Social need 7: *support identity building*

Creating Social Relationships

Creating new relationships greatly impacts the shape of the social network and therefore the structural social capital of the individual. Initially, hopes where high that social networking sites would be able to expand the social network of its participants. This would hold great promise in a whole number of areas of human activity, ranging from breaking social isolation to the improvement of human creativity.

Recently, however, data collected in social networking sites has started to suggest that the current generation of social networking sites is not very effective in creating such new relationships. Strong online social relationships seem to reflect relationships which have been forged offline (Coenen 2006, Ellison, Steinfield & Lampe 2007).

Social need 8: *support the creation of new social relationships*

Maintaining Social Relationships

Many social relationships are created as people share a focus, defined as

a social, psychological, legal or physical entity around which joint activities are organized. […] Foci can be many different things, including persons, places, social positions, activities and groups. (Feld 1981, p1016 & 1018)

Indeed, people often build relationships in e.g. a geographic area or around a certain job. As they move away to another area or change jobs, social relationships can become inactive. This atrophy of social network ties is detrimental to the structure of the social network, but keeping up many social relationships can be very costly in terms of time and effort.

Social need 9: *maintain social relationships in a time and cost efficient way*

Technical Features in Social Networking Sites

The previous section has described some important social needs, related to the different types of social capital. In this section, we present a model of common technical features in 5 different social networking sites. The sites in our analysis (Facebook, mySpace, Orkut, Xing and linkedIn) where selected on the basis of their popularity at the time of writing.

Method

To identify the socio-technical gap we deduced the needs of the users starting from the assumption that expanding social capital is something people want to do because it is essential to human kind. As much of the insight in social sciences can be seen as a reflection on people trying to manage their social capital, we believe there is some support for this assumption.

Still, it can be argued that this deduction does not completely reflect the needs of the user and that a better way to gather user needs would be to measure them through for example a survey or an analysis of user behavior. However, it is a long standing insight in systems design that users are very often unable to identify their own needs, especially concerning new technological paradigms. For instance, who would have thought ten years ago that people would feel the need to use social networking systems and use them on a massive scale? Therefore, we believe the use of deduction instead of user requirements measurements is a valid way to discuss the socio-technical gap until better ways of predicting user needs have been identified.

The following method was adopted to analyze the technical components of social networking sites. The technical components where synthesized in a common use case diagram[2].

1. Each author created a separate use case diagram of 1 or 2 social networking sites. Communication on the nature of these use case diagrams was kept minimal, to ensure that each researcher was minimally influenced by the perspectives of the other researchers.
2. The different use case diagrams where discussed by the authors, and it was decided of each use case if it was common to all social networking sites, or specific to just one site.
3. The different use case diagrams where combined into one diagram, representing the features that are common to most social networking sites.

The use cases, represented as ovals in figure 1, are implemented in different ways in the various sites that where analyzed. The numbers in the use cases indicate the number of sites in which a given feature was encountered. Figure 1 shows features which where found in 3 sites or more, in order to support our claim that the presented features are common in the majority of the analyzed social networking sites.

The Socio-Technical Gap

In this section, we explain the exact nature of the various use cases in Figure 1 and the social needs which they meet.

Social Need 1: Stimulate Generalized Reciprocity

In order for generalized reciprocity to become wide-spread in the system, a signaling function is necessary, telling other people in the system to what degree another user has been carrying out activities to the benefit of third parties. Such a signaling function is particularly useful when obtaining information from others and when carrying out concerted activities. This can be done through a reputation management system (Kollock 1999), in which a feedback signal is coupled to the user's profile when a certain task is performed for one or more other people. This is a transaction-based way of building reputation. Points can be attributed automatically, or by the recipient of the service. These systems have the potential of being very productive, but were not a part of major social networking sites at the time of our analysis. One exception is Facebook, for which a number of reputation applications have been written that can be plugged into the platform. Still, very few of these applications feature a transaction-based augmentation or diminishing of reputation. Furthermore, no single reputation mechanism seems to have gained wide-spread acceptance.

Social Need 2: Stimulate the Establishment of Trust

Currently, trust is mainly created offline (Matzat 2005), through repeated interactions. This does not mean that trust cannot be created through online interaction. Instead, it points to the fact that in social networking systems, most social relations have been created offline, during face-to-face encounters.

At the time of writing, very few features existed in social networking sites that aim to increase trust. As was explained before, trust can be passed on in a transitive way, by trusting the opinion of people you trust yourself. However, few systems feature ways of expressing trust towards others. This could for example be done by labeling a relationship in the dyadic subsystem with a label indicating that a user trusts another user, which amounts to adding semantics to social relationships.

One feature found in linkedIn, but by no means common to other sites[3], is the recommendation feature. With this technical function, it is possible to attest to certain aspects of a person's character or previous work experience. If a person you trust writes a recommendation to a person you don't know well, it is likely that your trust towards the latter will increase.

Another example of a feature that can increase trust was found in Orkut, where users are able to write testimonials about users in their network. These testimonials are displayed on the user's profile page. The value of testimonials is increased by a rating feature that enables Orkut's users to evaluate people in their network on a number of values, one of which is 'trust'. When a person with a high trust score writes a testimonial about someone else, the perceived credibility of the testimonial is increased.

Another technical function which is found in figure 1 is the group management function. Consider an interaction between person 1 and person 2, both members of the same group in which a norm exists and is enforced by the members of the group. The

Figure 1. use case diagram representing the common technical features in the social networking sites Facebook, mySpace, Orkut, Xing and linkedIn. (I = individual subsystem, D = dyadic subsystem, G=group subsystem). Numbers in round braces refer to the number of sites in which the technical feature was encountered.

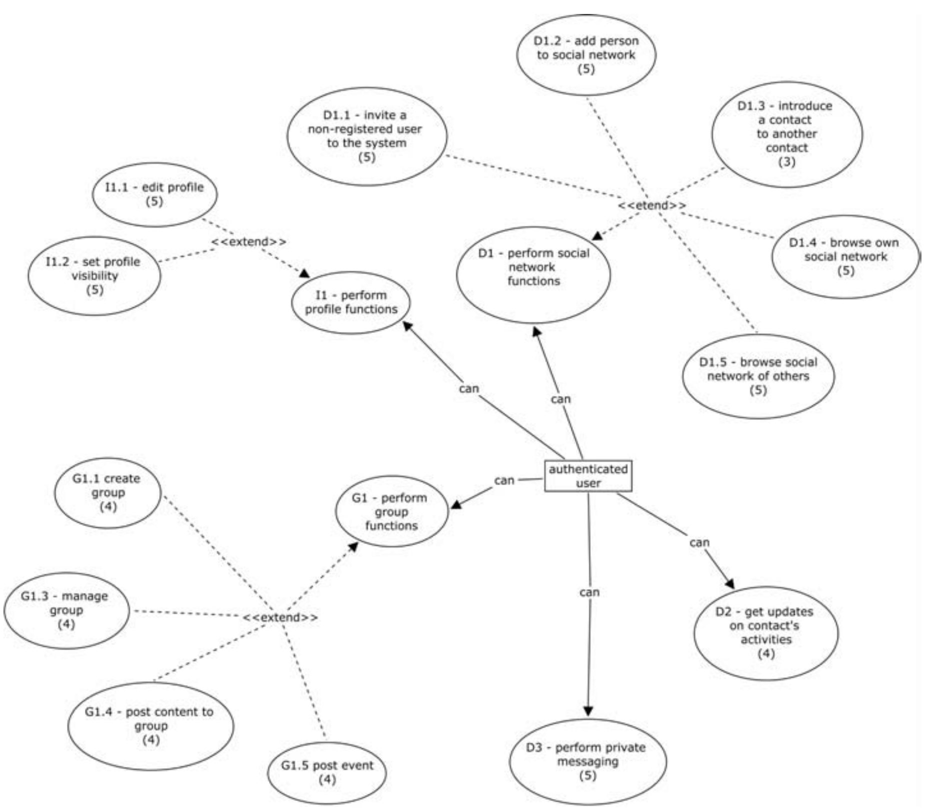


Table 1. the socio-technical gap regarding social capital in social networking sites

Social need	Component of social capital	Type of social capital	Subsystem	Supported technical feature	Missing technical feature part of socio-technical gap
1. Stimulate generalized reciprocity	Relational	• Concerted action • Information exchange	• Group	• Create group (G1.2) • Manage group (G1.3)	Transaction-based reputation management
2. Stimulate the establishment of trust	Relational	• Concerted action • Information exchange	• Group • Dyadic	• Create group (G1.2) • Manage group (G1.4)	Trust increasing features at dyadic and group level
3. Support meaning negotiation	Cognitive	• Concerted action • Information exchange	• Group • Dyadic	• Perform private messaging (D1)	Complex meaning negotiation through boundary object creation
4. Support nuanced social activity	Cognitive	• Concerted action • Information exchange • Emotional support	• Dyadic • Individual	• Set profile visibility (I1.2)	
5. Support transactive memory	Cognitive	• Concerted action • Information exchange	• Individual	• Edit profile (I1.1)	Dynamic, bottom up ways of representing user expertise
6. Support awareness	Cognitive	• Information exchange • Emotional support	• Group • Dyadic	• Get updates on contacts activities (D2)	
7. Support identity building	Structural	• Information exchange • Emotional support	• Identity	• Edit profile (I1.1)	
8. Support the creation of new relationships	Structural	• Concerted action • Information exchange • Emotional support	• Dyadic	• Perform social network functions (D1)	Integrate collaborative technologies in order to support collective action
9. Maintain social relationships in a cheap way	Structural	• Concerted action • Information exchange • Emotional support	• Dyadic	• Perform private messaging (D3) • Get updates on contact's activities (D2)	

norm is very broad and states that group members should always act in each other's interest. An interaction between person 1 and person 2 can be facilitated by this norm, as person 1 will be more disposed to believe that person 2 will act in his interest, thereby increasing trust (cf. the above definition of trust). Thus, group norms can foster trust and features which support norm building can therefore also support the creation of trust.

Still, the number of social network site features which increase trust is limited. As trust is crucial to the creation of social capital, we find this to be an important area of future improvement. This can be done both at the dyadic and group level. Trust-related features hold most promise for improving the information access and concerted action benefits of social capital.

Social Need 3: Support Meaning Negotiation

Meaning negotiation can occur through communication. Therefore, the communication features that exist in the different social networking sites contribute to the meaning negotiation process. But if the topics around which meaning negotiation should take place are complex, email-like or forum-like functionalities are inefficient.

In such cases, meaning negotiation can take place by explicating and re-combining the perspectives of a number of people. This can be done through *called boundary* objects, which exist on the boundaries of different cognitive perspectives. Boundary objects represent the concepts in one's perspective and the relations that exist between these concepts (Boland & Tenkasi 1998).

We have found no support in current social networking sites for complex meaning negotiation through boundary object creation and therefore commit it to the socio-technical gap. If such features where to be included in social networking sites, they would most benefit the information access and concerted action benefits of social capital.

Social Need 4: Support Nuanced Social Activity

The way one interacts varies greatly according to the interaction partner(s), which is currently supported in social networking sites by means of mechanisms for the setting of profile visibility options (use case I1.2 in figure 1). This use case represents the ability of the user to define which parts of one's profile are accessible to whom. In this way, the different parts of a user's profile can be made visible to different audiences. The specific implementation varies a lot between sites, ranging from a binary mode where either everything is accessible to anyone or to no one (linkedIn), to a very fine grained mode where the visibility of different profile fields can be made accessible to specific contacts (Xing). Such features are common to the way people communicate their identity, which contributes to all the purposes of social capital, discussed above.

A relevant feature we found in Facebook permits a high degree of control of which people in one's network are provided with awareness of one's activities on the site. Activities that can be reported are e.g. which people are added to their network, which messages they have posted and which scores they have received on a variety of third-party applications. The user is able to define which people in the user's network are kept up to date of what sorts of actions. This is related to the support of awareness, as described later.

Social Need 5: Support Transactive Memory

The profiles in social networking sites provide a certain amount of information on expertise. In addition, many sites provide full text search options for the content on the site. Both the search option and the profile information can be used to determine who to approach with a certain question. Still, the transaction, necessary to have the person who owns a certain bit of knowledge contribute the knowledge to the person who is looking for it, requires trust and a history of interaction. This type of trust is related to the reciprocation norm discussed before. Therefore, the functioning of a transactive memory system in a social networking site will depend on social needs 1 and 2 concerning reciprocity and trust. Features belonging to this category have the potential of impacting information access and concerted actions.

The creation of expertise indexes could be automated by e.g. the collection of web-based folksonomy[4] information. Both "tag clouds", which are relatively unstructured, and more structured network visualizations, can provide interesting clues regarding the expertise and perspective of social networking site users. Examples, developed for our own social networking site prototype called Knosos[5] are shown in figure 2. These examples illustrate a bottom-up and dynamic way of creating expertise overviews which can represent expertise for users of social networking sites[6].

Social Need 6: Support Awareness

MySpace and Facebook are examples of sites where it is indicated which of a person's contacts are currently logged in on the site. However, in general, support of awareness in social networking sites is currently poor. This could be due to the fact that they constitute environments in which communication is mainly asynchronous, making it is less important to know who is also using a certain part of the system at the same time.

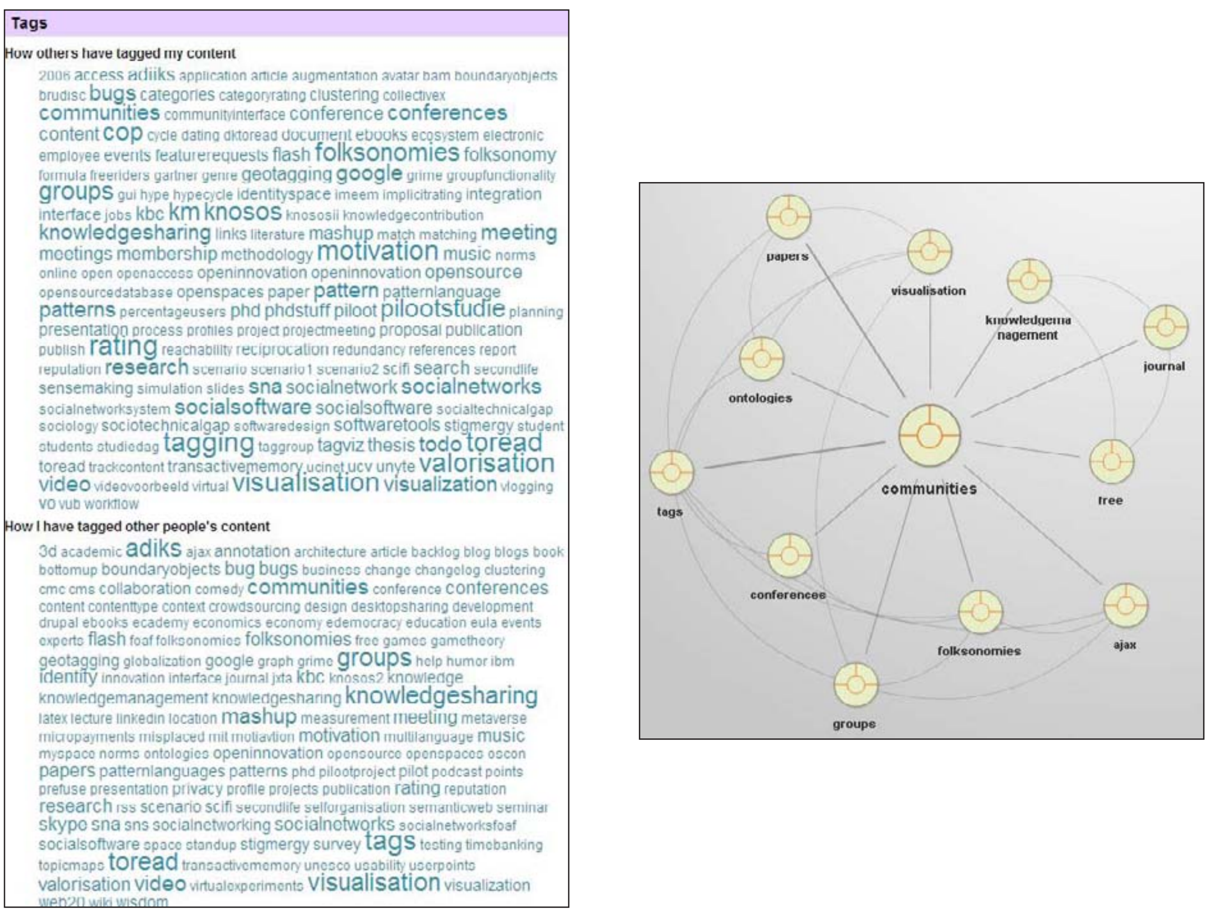
The situation is somewhat different for peripheral awareness. Many social networking sites are already featuring elements allowing users to get a peripheral view of the activities undertaken by their contacts in the system. This is important to social capital, as it presents a low cost way of staying in touch with the lives of your contacts. Examples of activities reported in this way in Facebook include the posting of photos, adding new people as contacts or changing profile information. Another feature found in Facebook is the publication of one's status, allowing other's to see what a particular person is currently doing.

Awareness-related features are most likely to benefit the information exchange and emotional support dimensions of social capital.

Social Need 7: Support Identity Building

Profiles in social networking sites provide a basic but essential way of getting to know others. This facilitates communication in general and therefore impacts all benefits of social capital, as they all rely on communication. For years, people have gone by without a profile on the web. Either they did not have a place to host their profile or content or they lacked the skill to create web-pages. Social networking sites have changed this by providing both a hosting solution and a way to create web-pages without needing to learn languages like html. These

Figure 2. Unstructured tagclouds (left) and a more structured tag visualization (right)



profiles can be very complex, containing different types of information, like professional information, educational background, but also tastes in books, music, movies, etc.

Profile information can be provided either explicitly or implicitly. Explicit methods allow the user to manually provide information by filling out a form with a number of text fields. Implicit methods gather information automatically from a variety of sources. This can for example be done through a collection of tags on del.icio.us[7], which might give an indication of a person's interests. Another example is the representation of musical tastes through tools like audioscrobbler[8], which gather statistics on the music one listens to and allows its users to publish this information on other platforms. Implicit methods hold much promise, as they do not require continuous attention from the user in order to stay up-to-date.

Whereas one could think that tastes in types of entertainment would not have its place in more professionally oriented sites like linkedIn or Xing, we would argue that this type of identity building can be instrumental in creating new relationships. Indeed, the more informal aspects of identity are important to the creation of structural social capital, both online and offline.

Social Need 8: Support the Creation of New Relationships

All functions under use case D1 "perform social network functions" in figure 1 are aimed at browsing social networks and adding new contacts to one's own network. Still, social networking sites are quite bad at creating strong ties (Coenen 2006), characterized by frequent communication, emotional contacts and a history of reciprocal services

People do create new relationships on social networking sites, but these remain weak. A small number of users are very prolific at extending their social networks, but do this as a kind of contact collectors, aiming for relationship quantity instead of quality.

Another possible reason why few strong ties are forged on social networking sites is the fact that these sites do not foster much repeated collective action. Repeated collective action, like working on a common project, is the type of focus (Feld 1981) around which strong ties can take form.

Many tools are now present on the internet to enable collective activities to be undertaken in a distributed and synchronous or asynchronous way (e.g. synchronous collaborative document writing, voip, group polling for meeting schedules). These tools could be integrated into social networking sites in order to support collective action.

In creating new relationships, social networking sites could support all purposes related to social capital.

Social Need 9: Maintain Social Relationships in a Cheap Way

What is probably the greatest success of social networking sites as they existed at the time of writing is their ability to keep in touch in a relatively cheap way, which also impacts all purposes of social capital. Technical features like the ones supporting peripheral awareness, and identity building, discussed in an earlier section, are instrumental in allowing users to react to events in other people's lives. In addition, the communication features provided in social networking sites are a good way of maintaining social relationships. These internal communication channels are increasingly being used by youth, partially replacing email.

Limitations

The current nature of the internet is such that complete systems or new system functionalities are constantly being added to the collection of available internet-based tools. This is especially true in the light of the recent emergence of social networking system applications developed by users, as is the case on Facebook. This constant emergence requires a methodology that is able to track changes on the emergent social web. The method that was used in this paper represents a first attempt to create a research design capable of dealing with the increased functionality dynamism. Still, the adopted method has as a fundamental limitation that it does not produce statistics indicating the validity of the produced results. In addition, it does not formalize interpersonal subjectivity. The methodology could benefit by accounting for meaning negotiation processes and by producing statistics on intercoder agreement.

To tackle these concerns, we propose to further elaborate the approach used in this paper by using techniques from ontology design. This field has developed a number of methods that allow the development of ontological artifacts representing commonly agreed-upon meaning (e.g. MESS (de Moor et al 2006)). Combining these methods with statistics indicating validity, the evolution of the concepts in the ontology and the intercoder agreement would allow a more rigorous approach to the analysis of emergent functionality on the social web.

Future research

We see a number of challenges in the future of social networking sites. The first one is to meet the social needs that have been identified as being part of the socio-technical gap with regards to the support of social capital. Still, the way in which these needs can best be met is not necessarily by following the same development tradition as was done in the last 10 years in the social networking site business. New ways of developing applications have begun to emerge, using a plugin approach on an open API[9].

In 2007, Facebook was the first site to propose this way of extending its features and it is very probable that this approach has greatly contributed to the success of this site. The number of contributed applications that is currently available is large, meeting user needs which the Facebook developers could never have envisaged themselves. Open social, the Google-led initiative to standardize the API's of many different social networking sites, holds even greater promise. Indeed, it should allow applications, developed for the Open social API, to be useable on all social networking sites that conform to the API. This will warrant the investments required to develop more social networking site applications, which will consequently be deployable on different systems, thereby possibly spawning a whole new commercial sector.

Such a decentralized plugin architecture will allow new possibilities, like the assembly of a set of applications to meet the needs of a group with a certain objective. In addition, we expect social networking sites to become popular in organizations, e.g. to support knowledge management processes. It will then be relevant to be able to assemble a social networking site configuration which can quickly and cheaply be deployed in the organization, while making use of a social networking platform that is already popular among the employees of the organisation.

In such a constellation, an interesting role would be reserved for open source social network containers. These are information systems offering the basic social networking site features and data storage facilities. Especially the latter could be important to social networking sites in large organizations or organizational clusters, as these entities typically want their data to be protected from prying eyes and stored safely.

In the last 2 years, we have been involved in the development and deployment of such an open source social networking container, Knosos, based on the Drupal content management system. Such open-source content management systems are interesting vehicles on which to develop custom-made social networking systems that leverage open-social like applications.

conclus Ion

In this chapter we analyzed social networking sites from a social capital perspective. Social needs were discussed and we have indicated which needs are met through which technical features. The features in the socio-technical gap which were identified, are related to the stimulation of generalized reciprocity, the support of meaning negotiation, the support of transactive memory systems, and the creation of new social relationships. We suggest that these are promising areas in which to conduct research and for which to develop new technical features.

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Key Terms

Socio-Technical Gap: "The social-technical gap is the divide between what we know we must support socially and what we can support technically" (Ackerman 2000, p179).

Social Networking System: "Social networking systems are web-based systems that aim to create and support specific types of relationships between people." (Coenen 2006, p 75)

Social Capital: "The sum of the resources, actual or virtual, that accrue to an individual or group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and relationship." (Bourdieu & Wacquant 1992, p119)

Relational Social Capital: The relational component of social capital covers parameters influencing relationships, like trust, norm and values, obligations, expectation and identity. These elements influence what will flow over social relationships.

Cognitive Social Capital: Cognitive social capital refers to the development of cognitive elements that allow communication to occur between actors. This includes shared meaning, representations and interpretations.

Structural Social Capital: The structural component of social capital addresses the network structure of people's interactions. It covers the creation and dissolution of social relationships and the overall structure of the networks that are formed by these relationships.

Norm of Rreciprocity: according to this norm, a person who provides something to a person in the group can expect something back from this particular person (direct reciprocity) or from another, non-particular person in the collective (generalized reciprocity) (Gouldner 1960)

Endnotes

1. Note that the meaning of the term "systems" does not only refer to the technical components alone, but includes the people who interact with each other and with the technical component. This is derived from the way systems are described in systems theory, i.e. as a set of definable components, between which certain relationships exist.
2. Use case diagrams are a part of the UML software modeling language. Each diagram contains actors and the units of interaction which they carry out on the software, represented as use cases.
3. And therefore not listed in figure 1
4. A web-based folksonomy is a very loose and bottom-up set of keywords that are attributed to web-based resources
5. The Knosos prototype is accessible at http://www.knosos.be
6. For all their dynamics, the presented examples are less accurate ways of gathering information on people's expertise than other practices like competence management, which mainly rely on gathering qualitative data.
7. http://del.icio.us
8. http://www.audioscrobbler.org
9. An API (application programming interface) is a way for third parties to access the features of a software platform. It allows other programs to work with its functions and variables in a clearly documented way.

Chapter XLII
Situational Awareness in Collaborative Work Environments

Olga Kulyk
University of Twente, The Netherlands

Betsy van Dijk
University of Twente, The Netherlands

Paul van der Vet
University of Twente, The Netherlands

Anton Nijholt
University of Twente, The Netherlands

Gerrit van der Veer
Open University, The Netherlands

a bstract

This chapter addresses awareness support to enhance teamwork in co-located collaborative environments. In particular, the authors focus on the concept of situational awareness which is essential for successful team collaboration. Mutual situational awareness leads to informal social interactions, development of shared working cultures which are essential aspects of maintaining working relationships. First, an overview of the studies on team coordination and situational awareness support is presented. Second, a collaborative working environment is described for scientific teams in a molecular biology omics experimentation domain. Then, the results of practical case studies are discussed, as well as situational awareness support for scientific teams in collaborative environments. Finally, the authors discuss practical challenges in design and evaluation of group support systems for collaborative working environments and our multi-level analysis approach. The chapter gives new insights into how shared displays support group awareness, and how to design and evaluate interactive systems and visualisations that afford awareness in order to stimulate existing and new forms of collaboration in advanced working environments.

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Discovery is seeing what everyone has seen, and thinking what nobody else has thought

—Albert Szent-Gyorgy

Introduct Ion

The diversity of multiple disciplines in teams positively impacts collaborative problem solving (Coughlan and Johnson, 2006; Shalley and Gilson, 2004). It is essential to analyse how such collaboration takes place in daily work practices. Team collaboration can be supported by providing an appropriate environment and a certain context (Coughlan and Johnson, 2006). However, introducing a new environment and new technologies, like multiple visualisations on a large display, may increase the cognitive load of team members and influence the way they collaborate (Varakin et al., 2004). Awareness information in such shared workspace environment is always required to coordinate team activities (Dourish and Bellotti, 1992).

The overwhelming amount of visual information on multiple displays, and the multitude of personal and shared interaction devices in new collaborative environments lead to a lack of awareness of team members on ongoing activities, a lack of understanding of shared visualisations, and a lack of awareness on who is in control of shared artefacts. The focus of our research is on the awareness support of co-located teams working on long-term scientific projects in collaborative working environments. Understanding who you are working with, what is being worked on, and how your actions affect others, is essential for effective team collaboration (Dourish and Bellotti, 1992). Such shared awareness helps getting jobs done that cannot be done by a single expert, or by experts that only have a limited range of disciplines covered. Moreover, shared awareness also leads to informal social interactions and development of shared working cultures which are essential aspects of maintaining good working relationships in a team.

s ituational a wareness

Situational awareness (SA) concerns "knowing what is (and has been) going on", basically being aware of what is happening around you in the environment and having a shared understanding of the information. Before giving the extensive definition, we will first explain the importance of SA for team collaboration.

Situational awareness is expected to be an important determinant of team performance (Bolstad et al., 2005; Endsley, 1995). Especially in multidisciplinary settings situational awareness information is affected by abilities of individual members, their interaction with other team members, and the environment in which they collaborate (Bolstad et al, 2005). Various factors affect individual situational awareness formation: context (physical location, display arrangement and size, system capabilities etc.) and group aspects (communication, use of collaboration tools, team processes etc.). In order to assess SA during evaluation of collaborative interfaces or awareness displays, specific factors need to be identified relevant to a particular domain.

Situational awareness is critical in such complex multi-display environments that change rapidly and that provide a lot of information to keep up with. Recent studies (Borchers, 2006; Brad et al., 2002; Huang, 2006; Rogers and Lindley, 2004) clearly point out that people are less aware of their visual surroundings than they think they are. Data overload, fatigue and other stressors can undermine the development and maintenance of situational awareness (Boltstad, 2006). The phenomenon of change blindness shows that even if people have an accurate representation, they may still fail to notice changes (Martens, 2007; Varakin et al., 2004). Actively capturing attention at the location of the change by means of spatial cues improves the detection of the information and detection of changes. Therefore, it is of a great importance to design systems that support situational awareness and sharing of SA between team members in order to ensure that a collaborative environment supports efficient and effective team coordination and decision making.

Endsley's (1993, 1995) theory of situational awareness suggests that SA can be achieved by linking an objective state of the world to its mental analogue on three main levels: perception, comprehension and projection. Level 1 of SA—is perception of relevant elements in the environment. It is an active process whereby individuals extract salient cues from the environment. Level 2- embraces comprehension of the meaning of these cues. It involves integration of information in working memory (Salas et al., 1995) to understand how the information will impact upon the individual's goals and objectives. In this way an individual develops a comprehensive picture of the world in this way, or of that part of the world of concern to the individual. Level 3, projection, consists of extrapolating this information forward in time to determine how it will affect future states of the operating environment (Endsley, 1993). The third level of SA combines what the individual knows about the current situation with his or her mental model of similar events from previous experience, to be prepared for what might happen next.

In our research, we define SA as based on the three main aspects:

1. a person's previous knowledge and understanding of the situation, which contributes to identifying the source and nature of issues and problems;
2. detection and comprehension of the relevant perceptual cues and information from the environment, which supports comprehending multiple visualisations in their context;
3. interpretation of these and reconfiguration of understanding and knowledge in a continuous process during the group collaboration effort. This allows awareness of changes in the environment, knowing what team members do and have done regarding current events in the environment, and keeping track of work progress.

Henceforward we refer to *shared situational awareness* as to the amount of communality of the individual SA of team members on the three aspects defined above. Our research investigates the following questions: What does situational awareness mean in team collaboration? How can we support situational awareness in collaborative working environments? How can shared displays support shared situational awareness in practice? How can we design and evaluate interactive systems and visualisations that afford situational awareness in order to stimulate existing and new forms of collaboration?

t eam c oordination

There have been a series of studies investigating group processes in real world situations. However, the tasks used in these studies did not address scientific teams. Still, one can be just as creative in science as in design (Johnson and Carruthers, 2006). A recent empirical study by Johnson and Carruthers provides a good overview of the relevant theories on creative group processes. Results of this work are requirements for software tools to support specific creative tasks (Johnson and Carruthers, 2006).

Other empirical studies, although conducted in real work environments, focus only on team coordination in extreme collaboration scenarios (Blandford and Wong, 2004; Manser, 2006; Wilson 2006). *Extreme collaboration* refers to collaboration within *warroom* environments where teams work together synchronously in all phases using a variety of computer technologies to maximize communication and information flow. For instance, Manser et al. (2006) investigate coordination needs of cardiac anaesthesia teams in an operating room environment. The result of their study is a conceptual framework for the analysis of multidisciplinary team collaboration in complex work environments. A qualitative study by Wilson et al. (2006) reports the impact of a shared display on small group work in a medical setting.

Applying a human-centered approach, we need to analyse the actual context in which the collaborative system will be deployed (Carroll et al. 2006; Varakin et al., 2004). An understanding of the work context will help us to design technology that supports team members in their primary task at hand, and thus leads them to communicate and interact in a collaborative environment with prolonged involvement and, hopefully, better results. It will also help us to find out how new computing technology in collaborative environments, such as large shared displays, influence scientists' work and team coordination (Hallnass and Redstrom, 2002).

AFFORDING SITUATIONAL AWARENESS IN SCIENTIFIC COLLABORATION

In contrast to domains such as aircraft or plant operation control, emergency dispatch or crisis management (Mark, 2002; Sharma et al., 2003), scientific teams are not working in life-threatening situations and are not under constant strong time pressure. However, long-term scientific projects involve high costs and therefore it is hard to recover from any errors. Shared visualisations on large displays have proven to be helpful to support group discussions because the support situational awareness (Borchers, 2006; Huang, 2006; Rogers and Lindley, 2004). Other examples of teams using a large display to enhance awareness of their activities are programming and design teams (Biehl et al., 2007).

Evolving technologies in molecular biology produce vast amounts of data. Scientists in this domain are confronted with the problem of applying methods from different disciplines when analyzing and interpreting their data, such as statistical, mathematical and machine learning techniques. Moreover, integration of the results from heterogeneous information sources is a difficult but essential part of the analysis of experimental results. Current omics experimentation in molecular biology, for example in drug discovery and cancer research, is a complex, highly dynamic and multidisciplinary task that requires teamwork (Rauwerda et al., 2006; van der Vet et al., 2007). It is essential for life scientists to design the experiment precisely and accurately to ensure the statistical validity of the data. Timely spotting outliers and abnormal patterns in a huge amount of data is crucial for experimentation (see Figure 1). Recent studies showed that there is a strong need for visualising the omics datasets on a shared display for comparing and discussion among multidisciplinary scientists (Kulyk et al., 2007; Li et al., 2005).

Presenting visualisations on a shared display in a collaborative working environment can support group discussions (Borchers, 2006; Huang, 2006; Rogers and Lindley, 2004). Looking at the statistical representations of the same data on a shared large display enables scientists to assess the quality of the entire omics experiment at a glance (Kulyk et al., 2007). The visualisations on the various parts of the display are implicitly related, in the sense that they refer to the same experiment, but currently it is not always evident what this precise relation is. To prevent team members from getting lost and to support situational awareness, the relations between various statistical representations have to be explicitly visualised. In order to afford detection of changes in visualisations and to avoid change blindness, it is important to draw team members' attention to current changes without distracting them from the discussion.

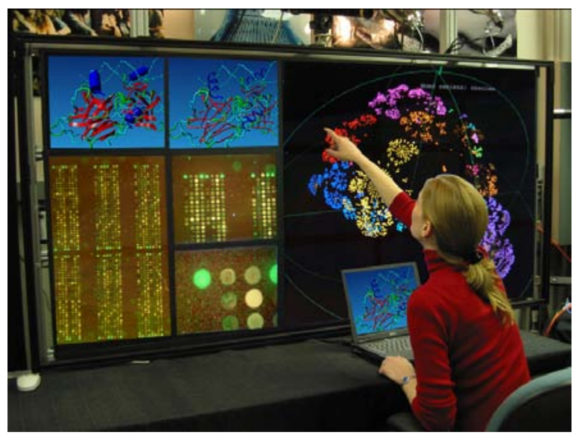
Multiple visualisations can be closely related, and therefore a change in a visualisation on one display will have to be related to visualisations on other displays in a manner pioneered by the Spotfire[1] system. In our case, however, the situation is more complex. Scientists in multidisciplinary teams use discipline-related visualisations. For example, in microarray experimentation, spotting the outliers and abnormal patterns in the large data set can be done only by an expert in both statistics and in molecular biology, by analysing a combination of various statistical representations and microarray scans. Another example is when, at the microarray

Figure 1. Scientists interacting with multiple visualisations in e-BioLab, MAD/IBU, University of Amsterdam

experiment design stage, a statistician needs to establish confidence intervals and statistical power of an analysis. However, only molecular biologists and microarray experts can assess whether it is experimentally possible in the wet-lab to increase statistical power or to avoid confounding by choosing a different experimental setup.

Molecular biology in general is a highly visual discipline (Campbell and Heyer, 2006). Visualisations play a large role in the analysis and interpretation of *omics* experiments (van der Vet et al., 2007), Figure 2. In the next section, the issue of collaborative working environments is addressed. We discuss how visualisations can support group discussions in such environments. We will also report our own experience on situation awareness support of scientific teamwork in a molecular biology context (Kulyk et al., 2007). We argue that situational awareness can be supported in such environments by bringing relations between various visualisations in the focus of attention at any particular moment.

Figure 2. A scenario in which a life scientist is interacting with multiple visualisations



Visualisations and Situational Awareness in Collaborative Environments

Until recently, most of the studies in scientific visualisations mainly address the design of integrated software visualisation tools, with "single user—single visualisation" interaction. However, as a study on collaborative scientific visualisations illustrates (Li et al., 2005), the picture becomes more complex in situations in which groups of users will be interacting with multiple visualisations and communicating with each other at the same time. In genomics research, there is a strong need for visualising the large genomics datasets during multidisciplinary collaborative discussions for comparing and sharing data among scientists (Li et al., 2005). Designing visualisations for multiple use to enhance exploration of heterogeneous information is a new challenge in cooperative work.

Much of the work on situational awareness cited before is relevant but has to be adapted to the specific needs of the multidisciplinary teams in omics experimentation: molecular biologists, microarray experts, bioinformaticians, and statisticians. The practitioners of the various disciplines involved in our research bring with them rich and often implicit background knowledge, as was found for scientists in general by Dunbar (1995).

The *e-BioLab* is a collaborative environment that aims to facilitate multidisciplinary teams during project meetings on molecular biology omics experimentation, with an initial focus on *microarray experiments* (Rauwerda et al., 2006). The goal of a microarray experiment is to simultaneously examine the expression level of all genes of a specific organism, in a cell type in a specific growth or stress condition. Microarray technology is currently one of the most important methods in genomics and is usually applied to unravel complex cellular mechanisms or discover transcriptomics biomarkers: genes whose expression profile can be used for diagnostic purposes or to monitor and predict cellular processes (Stekel, 2003).

In interpreting a microarray experiment in the e-BioLab, both the results of the experiment itself and those of statistical data analysis can be displayed in the form of visualisations on the large display, as in the example in Figure 2. In this way, team members can assess an entire microarray experiment. Moreover, in a multidisciplinary setup a large high-resolution display connected to online genomics resources can be used to construct models of biological mechanisms, thus enhancing omics experimentation and collaborative interpretation of the results. The largest tiled display is split into a number of displays, Figure 1 and 2. Visualisation of various statistical representations of the data on the tiled display enables scientists to assess the quality of the entire experiment at once. The visualisations on the various parts of the display are obviously related in the sense that they refer to the same experiment, but currently it is not always evident what the precise relation is. To prevent users from getting lost and to support situational awareness, the relations between various statistical representations have to be explicitly visualised. In order to enable detection of changes in visualisations and to avoid change blindness, current changes have to be put in focus of attention.

The complexity of multiple displays showing often complex visualisations can, as mentioned earlier, be reduced by employing attentive and proactive interfaces, also called notification services (Crowley, 2006). Such interfaces have to anticipate the context and provide an appropriate feedback without distracting the users from their main task. An example of such an interface for awareness and collaboration support is the persuasive displays environment designed by Mitsubishi Research Lab (Dietz et al., 2004). Such an environment can also include a *peripheral awareness display*: an information system or a graphical representation that resides in the user's environment and provides information within the periphery of user's attention (Plaue et al., 2004). Monitoring the peripheral display should cause minimal shift from the user's current focus of attention, allowing users to garner information without being distracted from their primary task. Most current peripheral display approaches use visual, auditory and tactile modalities for conveying the information. Our primary focus for this chapter is on the visual modality, since this is the main source of information in state of the art E-BioLabs. The information can be generated on the basis of multimodal cues sensed by the sensors embedded in the environment (Iqbal et al., 2005). The evaluation of such an awareness display is mainly focused on effectiveness and unobtrusiveness: the ability of the visual representation to communicate information at a glance without overloading the user (Plaue et al., 2004; Kulyk et al., 2006).

The next section gives an overview of various practical case studies on team coordination support in collaborative working environments. Our own case studies in different subdomains of bioinformatics are presented as examples (Kulyk and Wassink, 2006). We also introduce the assessment model of team situational awareness in collaborative working environments that can be used for human-centered design and evaluation during practical case studies. Finally, we discuss practical challenges in the design and evaluation of group support systems for collaborative working environments and our multi-level approach for the analysis of technology-mediated interaction. We end with a conclusion and discussion.

sItua t Ional awareness In oMIcs ex Per IMent at Ion

The support of multidisciplinary scientific teams in collaborative environments is centrally addressed within our BioRange project. As in any user-centred approach, user studies and task analysis are a core activity in our research (Bartlett and Toms, 2005; Javahery et al., 2004; van Welie and van der Veer, 2003). Contextual observations and interviews are conducted to find out how such collaboration takes place in daily work practice between biologists, bioinformaticians, and biomedical researchers and how we can support them (Kulyk and Wassink, 2006). The results of our studies underline that multidisciplinary collaboration is essential in molecular biology and bioinformatics. Visualisations of experimental and biological data are used for discussing the experimental results and for assessing the progress of an experiment. Scientists expect they will profit from multiple visualisations in a collaborative environment. At the same time, they point out the danger of overwhelming the viewer with too much information. They strongly prefer to collaborate face-to-face. This is also confirmed in studies for other user groups (McCowan et al., 2003; Nijholt et al., 2006; Rienks et al., 2006) and for scientific teams (Dunbar, 1995). The results of our exploratory study have been translated into requirements for the support of collaboration and multidisciplinary teamwork in bioinformatics, as well as into profile descriptions of novices, experts and scientific teams (Kulyk and Wassink, 2006).

In order to identify the key aspects and user requirements for collaboration support in the context of a scientific collaborative environment, we also perform an extensive task analysis of the current microarray experimentation practice, based on contextual interviews and observations (van Welie and van der Veer, 2003). Use case scenarios for empirical studies in microarray experiments are provided by our project partners (Rauwerda et al., 2006). Scientists from various disciplines: molecular biologists, microarray experts, bioinformaticians and statisticians, closely collaborate during such experiments. In particular, we aim to build a detailed task model of microarray experiments. A task model of the current work situation describing phases of a microarray experiment is currently being validated with domain experts.

As the literature confirms, creative problem solving in scientific collaboration can be supported by providing an appropriate environment and a context (Coughlan and Johnson, 2006). However, introducing a new environment and new technologies, as for example presenting multiple visualisations on a large display (see Figure 1,2), may increase scientist's cognitive load and influence the way project team members collaborate (Varakin et al., 2004). Awareness information in such shared workspace environment is always required to coordinate team activities (Dourish and Bellotti, 1992). We believe that situational awareness is a very important aspect of co-located team collaboration in complex environments, as other research confirms (Manser et al., 2006) (see section 2). Especially in the multidisciplinary settings, situational awareness information is affected by individual team members' abilities, their interaction with other team members, and the environments in which they collaborate (Bolstad et al., 2005). It is essential to provide situational awareness support in collaborative environments in order to support team's coordination needs and creative problem solving.

On the basis of our current findings from conceptual studies and requirements analysis, we are performing a series of practical case studies. We are conducting a series of real-life observations during the project discussions of multidisciplinary scientific teams in the e-BioLab (Rauwerda et al., 2006; van der Vet et al., 2007). Our aim is to get insight into how shared displays affect teamwork, and to contribute to the development of novel concepts to support co-located situational awareness in a scientific collaborative environment. In particular, we are investigating the effect of the large display visualizations on both individual and team situational awareness. We are also evaluating new designs to enhance the awareness by making relations and changes between different visualizations more explicit. For instance, during project meetings relevant visualizations on a tiled display will be highlighted and other ones will become faded. In this way, a presenter can draw the attention of other team members to visualizations relevant to the expertise of particular scientists, Figure 2. In addition, a notification of the annotations made on visualizations is essential to make all team members aware of the changes.

c oncepts for sa s upport in Scienti.c Collaboration

We are currently exploring various alternative solutions for SA support in collaborative environment for scientific teams (van der Vet et al., 2007).

For instance, a *Highlighting on Demand* interface enables the team member who is currently controlling the tiled display to draw attention of the team by highlighting a certain visualisation using a slider on a personal interaction device (for instance, TabletPC or a WiiMote controller).

Another concept is a *Memory Board* interface, which automatically stores and visualises the history of changes on a shared display, allowing team members to go back in time and retrieve a certain annotation made on previous slides or visualisations. This board serves as a peripheral display, affording memorability. It supports level 2 of situational awareness, comprehension.

We expect a supporting effect of visualisation of status information about who is in control of a display or another shared artefact on a personal interaction device. This would make every member of a team aware of who is making the changes and what changes are made. We also intend to visualise the *control interface* on a shared touch display, as well as displaying it on a personal interaction device (e.g. tablet PC). Such an interactive interface enforces sharing and thus supports coordination mechanisms and group awareness on who is currently manipulating and annotating the visualisations. It also partially resolves the potential control negotiation conflict about the annotation of visualisations and about manipulation of the shared display.

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The complexity of communication processes in the co-located team and the use of a collaborative environment require the combination of a methodological approach to support situational awareness for team collaboration and a practical method to capture and analyse the dynamics of technology-mediated interactions in context. The nature of the interfaces as well as physical characteristics and affordances of the environment influence the way in which interactions occur (Fruchter and Cavallin, 2006). Therefore our approach for data analysis includes a combination of behaviour, interaction and environment analysis.

We will assess shared situational awareness of team members when we provide supportive visualizations on a shared large display. We aim at reducing disturbing factors that are considered distraction from the primary task. We intend to establish an indication of the relations between Situational Awareness, team satisfaction, group processes like decision making, and the perceived task performance. In our case multiple data collection techniques are used: direct observations to assess user behaviour based on a validated coding scheme (Biehl et al., 2007), screen capturing, video recordings, a validated post-questionnaire (Kulyk et al., 2006; Olaniran, 1996; Paul et. al., 2004), and a post-interview. Video recordings from several viewpoints combined with screen capturing of multiple displays, enables us to analyse several simultaneously ongoing interactions. In addition to the observations, post-interviews and questionnaires are carried out to obtain subjective judgements of the team members, e.g., on group satisfaction, awareness and distraction from primary tasks (Cadiz et al., 2002; Kulyk et al., 2006; Olaniran, 1996; Paul et. al., 2004). Group satisfaction will be assessed by a combined validated post-questionnaire featuring the group process and decision making (Olaniran, 1996; Paul et. al., 2004). We apply these questions to assess the perceived usefulness and impact of new *Highlighting on Demand* and *Memory Board* concepts on shared situational awareness of team members, on distraction from the primary task, and on team satisfaction with the group process and decision making process.

The three aspects of situational awareness described earlier, as well as recent related studies (Biehl et al., 2007; Blandford and Wong, 2004) are used to identify relevant factors of SA to design our questionnaire. We are adapting a computational model of shared situation awareness (Bolstad et al., 2005) to the context of our case studies. This model uses the Situation Awareness Global Assessment Technique (SAGAT)—an objective measure of situation awareness mainly based on work of Endsley (1995).

Our current observations and video analysis show that scientists tend to walk to the tiled display to inspect a specific detail of a visualisation, which indicates that they are treating the display different from a movie screen or a static projection. This points to the dynamic nature of interactions as reported in other studies (Tan et al., 2006). High resolution of the displays allows them to zoom on fine details. This indicates a high immersion, though possibly partially due to the novelty of the large displays.

Applying user study techniques and a multi-level method for data analysis will allow us to identify interaction patterns: natural ways in which team members interact with each other (behaviour patterns) and with the shared displays in the environment. Thus we may iteratively improve the design of SA support and construct a framework for the evaluation of how shared displays influence scientists' work and team collaboration.

Future Work

We will perform controlled comparative case studies on the impact of the Highlighting on Demand and Memory Board SA concepts. Our target groups for the first study are small multidisciplinary teams (3-5 members) working on joint projects and scientific omics experiments in life science domain. We will assess shared situational awareness of team members, providing supportive visualizations on a shared large display. We aim at reducing the distraction from the primary task, and establishing relations with team satisfaction, group process, decision making process, and with the perceived task performance. Analysis of user behaviour allows us to define interaction patterns.

In the second case study we aim at assessing the long-term influence of large shared displays on team shared SA in other domain(s) and different collaborative environment(s). We will apply the adjusted measurements of shared SA from the first study. Cross-culture and cross-organizational differences might show different effects compared to the first study. The first target group for the second study are software engineering teams.

Challenges in Merging Collaborative Workspaces

Although our primarily focus is on co-located collaboration in which situational awareness plays a crucial role, we also consider remote collaboration scenarios for future case studies in which *social awareness* (Röcker and Magerkurth, 2007) and *presence* (Bystrom, 1999) concepts are also of great importance. The study of Röcker and Magerkurth (2007) on the Hello.Wall display shows that people are apparently not always willing to publicly display their presence in the collaborative environment and prefer to set their own activity status. In our vision, this can be easily resolved by the abstract representation of the general current level of activity in the collaborative environment based on the level of activities of present members. Such an activity representation can provide awareness for the remote project members, and may raise curiosity and encourage them to join the team discussion remotely or even to walk to the building and take a look what is going on in the lab.

One of the future extensions on the e-BioLab environment is real-time teleconferencing in order to collaborate with other e-BioScience labs across the Netherlands. New challenges arise when we attempt to merge physical and virtual workspaces in collaborative environments. Figure 3 shows how 3D teleconferencing and natural documents sharing concepts[2] that were once presented for the future office vision, have been partially realised during the official opening of the e-BioLab.

We have to explore the transfer of information between different types of displays, between the virtual workspace and the real one. Control of the shared display remains a potential problem to tackle. Our expectation is that, just as in the physical environment, team members will develop their own coordination mechanisms, negotiating about the control over the central largest shared display. The shared visualisation of the control interface on a plasma touch display currently remains the optimal solution. Sharing enforcement is shown to positively impact coordination strategies, and therefore should work for the team better then several personal controllers. Furthermore, refined evaluation techniques and measures are needed in order to adequately address these aspects of collaborative work in such hybrid workspaces.

Conclusion and Discussion

A new wave of advanced collaboration environments, such as collaborative interactive environments (Borchers, 2006), multiple display environments (Huang, 2006; Rogers and Lindley, 2004) and our collaborative working environment (van der Vet et al., 2007) requires new methods for design and evaluation in order to adequately address all aspects of collaborative work. This chapter presents the research on group awareness support to enhance team collaboration in the co-located working environments in the context of molecular biology omics experimentation.

This chapter aims to provide new insights into how to design and evaluate systems that afford awareness in order to stimulate existing and new forms of collaboration in advanced working environments, as well as insights into how team members of various levels of expertise and backgrounds interact with new technologies in collaborative working environments. We present an overview of the state-of-the-art studies on team coordination and situational awareness support.

Figure 3. 3D teleconferencing and natural documents sharing concepts[2] affording presence (left); official opening of the e-BioLab at the University of Amsterdam by Dr Jason Leigh from the University of Chicago (right)

Furthermore, we discuss how visualisations can support group discussions and describe the collaborative environment for scientific teams in a molecular biology context. As a result we show that situational awareness is of a crucial importance in co-located team collaboration. We argue that SA can be supported in such environments by bringing changes and relations between multiple visualisations more in the focus of attention. We also report our results of an empirical case study and domain analysis translated into user requirements for the support of multidisciplinary collaboration of scientific teams. Finally, we discuss practical challenges in the design and evaluation of group support systems for collaborative working environments and hybrid workspaces, and present our multi-level approach for the analysis of technology-mediated interaction.

Practical case studies bring new insights into how new technology, in particular large shared displays, affects teamwork and contributes to the development of novel concepts for group awareness support. The main contribution of this chapter is the conceptual framework for studying situational awareness of multidisciplinary teams in collaborative working environments, as well as requirements and guidelines for new collaborative technologies to support situational awareness of teams based on the practical case studies. This work aims to inform the theory and practice of human computer interaction and design for collaboration support.

acknowled GMent

We would like to thank our collaborators Han Rauwerda, Wim de Leeuw, Timo Breit (MAD/IBU, University of Amsterdam), Tijs de Kler and Jorrit Adriaanse (SARA, Amsterdam) for their helpful feedback and for allowing us to use their lab and equipment in our studies. We also thank reviewers and other colleagues for their helpful comments and ideas inspiring this research. This work is part of the BioRange program of the Netherlands Bioinformatics Center (NBIC), which is supported by a BSIK grant through the Netherlands Genomics Initiative (NGI).

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Awareness is the ongoing interpretation of representations of human activity and of artefacts (Chalmers, 2002).

Collaborative Working Environment is a co-located shared workspace that facilitates groups during meetings. The workspace is enhanced with multiple collaborative systems and media, such as private and shared displays, tabletops, touch screens, cameras and other devices.

Extreme Collaboration refers to working within *warroom* environments where teams work together synchronously in all phases using a variety of computer technologies to maximize communication and information flow.

Group Awareness is the understanding of who you are working with, what is being worked on, and how your actions affect others, is essential to effective collaboration (Dourish and Bellotti, 1992).

Microarray Experiment examines simultaneously the expression level of all genes of a specific organism, in a cell type in a specific growth or stress condition. Microarray technology is currently one of the most important methods in genomics and is usually applied to unravel complex cellular mechanisms or discover transcriptomics *biomarkers*: genes whose expression profile can be used for diagnostic purposes or to monitor and predict cellular processes (Stekel, 2003).

Omics Experimentation is a research area in molecular biology that deals with *omes*: large or complete arrays of cell components, such as the genome (all genes) and the proteome (all proteins). For example, studies that encompass the whole genome are in general referred to as *genomics* studies, and studies that examine the expression level of all mRNAs (messenger RNA, which directs the synthesis of proteins) in a given cell population are called *transcriptomics*.

Peripheral Awareness Display is an information system or a graphical representation that resides in the user's environment and provides information or visual feedback in the periphery of the user's attention. Monitoring the peripheral display causes minimal shift from the user's current focus of attention, allowing users to garner information without being distracted from their primary task (Plaue et al., 2004).

Situational Awareness is the perception of the elements of the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future, and the prediction of how various actions will affect the fulfilment of one's goals (Endsley, 1995, p.36).

Shared Situational Awareness is a reflection of how similar team members view a given current environmental situation. Thus, if a team has a high degree of shared situational awareness, we can assume they are perceiving, comprehending, and interpreting the situation's information requirements in a similar manner (Bolstad et al., 2005, p.1).

Task Analysis is a domain-specific analysis of the current work situation, which combines such classical HCI techniques as contextual interviews, field observations, ethnography and interaction analysis (Jordan, 1996; van Welie and van der Veer, 2003).

Endnotes

[1] http://www.spotfire.com, last visited July 2008

[2] Amin, A., Kulyk, O., Metin, B., Schneider, J. (2004) Pervasive Office, Videoprototype presented at the Océ Design Competition, *European Symposium on Ambient Intelligence (EUSAI)*, Eindhoven, the Netherlands.

Chapter XLIII
A Scale of Affective Satisfaction in Online Learning Communities

Janet L. Holland
Emporia State University, USA

abstract

This chapter deals with research on the development and use of an assessment instrument for measuring affective satisfaction in online learning. The research used a One-Way Repeated Measures Analysis of Variance (ANOVA) design, and the measure was students' perceived affective community satisfaction. An increasing mean score trend combined with positive qualitative feedback provided indicators of an overall growth in students' perceived affective community satisfaction worthy of further investigation. Data was collected at the college level, although it has important implications for online socio-technical design at all education levels.

Education is a social process; education is growth; education is not a preparation for life but is life itself

—John Dewey

back Ground

In the literature, affect is defined as attitudes, motivation, and values; the expression of which often involves statements of opinions, beliefs, or an assessment of worth (Smith & Ragan, 1999). For this chapter, the affective learning community refers to creating a positive social emotional design to provide an environment conducive to influences of new ideas, knowledge, and experiences for building the collective knowledge base. Through social interactions the affective learning environment has the potential to tap into individuals' social emotional learning needs, by developing and maintaining motivation, caring, comfort, support, trust, acceptance, respect, group identification, and attachment to foster a productive learning community. By examining the underlying social structures we will be in a better position to work towards affective socio-technical designs for learning.

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The study examined whether online college students' Perceived Affective Community scores increase across time after exposure to affective guideline interventions. Knowing more about what is needed to create a socially successful learning environment can be used when designing and redesigning effective courses, especially with the current growth of online learning. The study sought to find ways of engaging students in building a socially successful affective online learning community through specific targeted intervention guidelines including practice and assessment activities. The goal was to find ways to improve the quality and effectiveness of learning within the social context of online socio-technical design.

It is critical to focus on the affective needs of the members, whether personal, professional, or social, in order to enhance the learning process, as "the power of a learning community is even greater, as it supports the intellectual as well as personal growth and develop of its members" (Palloff & Pratt, 1999, p. 163). Through the developing relationships and interactions, knowledge is primarily generated. Active, focused, relevant, meaningful, quality interactions assist students in meeting their personal needs and reaching their learning goals.

From personal experience and observations, an online threaded discussion forum provides a dynamic social environment where individuals may work collaboratively to both share and create new knowledge. Computer mediated online dialogue provides many opportunities for students to experience a real-world learning community with participants both observing and interacting to gain new knowledge. With proper interventions, students excel by making needed social and academic connections with peers.

Affective community behaviors relate to the core values and beliefs the individuals hold, supporting and affirming each student's self-image. By fostering a positive affective online environment, the individual's self-worth may be reaffirmed, by setting into play guidelines for fostering a positive learning environment to support the individual's affective emotional needs. Everyone wants to be cared about and respected for the unique perspective and contributions we make. Creating a learning environment where diversity of all opinions is appreciated and respected helps to build a positive, successful, and rewarding learning community.

Historically, cognitive theory has been used in an effort to increase learning gains. Recent findings in "neuroscience, psychology, and cognitive science itself present affect as complexly intertwined with thinking and performing important functions with respect to guiding rational behavior, memory retrieval, decision-making, creativity, and more" (Picard, et al., 2004, p.1). Too much emotion can interfere with productive learning. Too little emotion can also have a negative impact on the learning process. Students, who are "anxious, angry, or depressed do not learn; people who are caught in these states do not take in information efficiently" (Picard, et al., 2004, p. 5). "When basic mechanisms of emotion are missing in the brain, then intelligent functioning is hindered" (Picard, et al., 2004, p. 1). Learning in the online environment is not purely a cognitive function but rather a combination of both affective and cognitive. Changes in emotional states can allow different types of learning to occur.

Research has found a slight positive mood helps one to feel better and "induce different kinds of thinking, characterized by a tendency toward greater creativity and flexibility in problem solving, as well as more efficiency and thoroughness in decision making" (Picard, et al., 2004, p. 2). Physical evidence of the different emotional states evidenced in the brain show "different patterns of blood flow, providing one possible explanation for how affect influences brain activity" (Picard, et al., 2004, p. 2). It is important to keep in mind it is still not known exactly which emotions influence learning, thereby emphasizing the need to create and refine better assessment tools and continue to conduct research-based analysis. Positive intrinsic and extrinsic motivation, goal direction, valued contributions, and social emotional caring can help students to develop the needed positive identity for building a productive affective learning community (Picard, et al., 2004, p. 3).

The threaded discussion forum can be used to help students reflect not only on the content studied but also on their "emotional intelligence" (Goleman, 1995, p. 34) in order to learn and grow. Though individuals may not always agree with one another, they do want to be respected and appreciated for the valuable contributions they make.

Computer mediated online classes today are composed of a wonderful blend of different cultures and ages. Students engage in dialogue with people from all over the world to improve their knowledge and skills, to enhance careers, and to satisfy personal interests. An enlarged and updated view of this diversity relates to "less visible, deep-level characteristics such as attitudes, beliefs and values" (Driver, 2003, p. 150) based on their unique life experiences. When these diverse characteristics are combined in the online environment, learning can be greatly enhanced by gaining a global perspective of the issues studied in relation to the wide range of experiences.

It is through the sharing process students are able to benefit from the multiple sources of feedback provided by peers to broaden their own perceptions of the issues addressed. However, challenges can arise with the individual's need for acceptance. Therefore, it becomes important to help guide students to an appreciation of the multiple perspectives each student brings to the class. Some of the issues discussed in an online threaded discussion forum can bring these very powerful, personal, and passionate differences and issues to the forefront. There appears to be a fine line between conflict of opinions that is productive to learning and conflict that can damage effective online relationships. Through dialogue guidelines for expectations, monitoring, negotiation, and eventual integration of ideas, the development of a respectful learning environment, where differences are shared and appreciated, can be created. Affective community training should include teaching tolerance and acceptance of multiple perspectives and approaches as part of building a successful learning environment. These relationships are not automatically built in but, rather, are created by "standards of equality and honoring of diversity" (Kling & Courtright, 2003, p. 231).

Many communication challenges exist in the threaded discussion forum. When working in a text-based environment, it is easy for miscommunication to take place. When visual and aural cues for conveying messages are missing, it is important to take more time and effort to emphasize "clarity" when communicating (Loughlin, 1993). Clear communications can help "to achieve an understanding of one another and are thus [be] able to influence, and be influenced by others" (Jaques, 1992, p. 51). One way to clarify thoughts before posting to discussion threads is to type them into a word processing program first, so the writer has time to slow down and reflect before hitting the reply button. It is possible to increase collaboration and reflection with thoughtful consideration and rich and meaningful text-based communications.

Some students find online learning to be very lonely because of the lack of face-to-face contact in communication. One way peers and facilitators alike can help to combat the negative impact of isolation is through the use of visual symbols, such as "relational icons or emoticons" to attempt to add the more human artifacts of personal contact that are otherwise missing (Kuehn, 1993, p.1). There are mixed opinions about the value of the use of humor online. Some feel it facilitates positive social relationships by increasing the desire to belong or attach to the group. Sometimes, humor can be used as a way to release tensions. Others feel it is dangerous to use, as the messages can easily be misunderstood and cause hurt feelings. If humor is used, caution will need to be taken to try not to offend or hurt classmates.

Since appropriate measurement instruments were not available at the start of the research study for measuring the desired attributes of the affective community, they had to be constructed, tested, and implemented. Therefore, based on a review of the literature, Perceived Affective Community Satisfaction survey questions were generated and tested in an initial pilot study to examine the reliability of the questions themselves. Once the questions were tested and analyzed, appropriate survey items were included (Holland, 2008).

stud Y

The initial study questions were developed and tested for use in evaluating the affective learning environment. Three subsequent classroom pilot studies were then performed to determine the effects of implementing affective guidelines and interventions in an online learning environment and served to further refine the assessment instruments. Students' perceived satisfaction was measured with respect to the implementation of affective guidelines, observed individually then combined in a One-Way Repeated Measure Analysis of Variance (ANOVA) research design. The pilot studies were designed to examine whether online college students' perceived affective satisfaction scores increased across time prior to and after implementation.

The initial study served to test the reliability of the survey items created, since appropriate existing measurement instruments were not available for use. The survey assessment items were distributed to and responded to by a national audience through *T.H.E. Journal of Technological Horizons in Education* electronic e-mail newsletter.

Classroom pilots 1, 2 and 3 dealt with three statistical convenience sample groups of intact college level courses. The pilots served to refine the measurement instruments and, to serve for comparison purposes between different groups of participants, and to increase the overall number sampled. The research pilots controlled the course type and design. However, the classroom pilots had no control over the number of students enrolled or number of participants agreeing to participate. The following Table 1 reflects the dimensions implemented for affective training.

Table 1 below illustrates the dimensions used to train students on how to create an affective learning community.

The pilots were conducted over a five-week time span. After students read the course materials and were presented with the affective intervention training, they discussed the new content in the online threaded discussion forum. Following the weekly discussions, students responded to the Perceived Affective Community Satisfaction Survey.

The pilots were conducted at a small Midwestern University in the Department of Instructional Design and Technology using one instructor. Readability studies were conducted on the chapters from Lohr's (2003) textbook to establish a consistent difficulty level.

Participants. Students in the online class were geographically dispersed across the United States. The students included undergraduate pre-service working toward a degree, teachers or other professionals working to maintain accreditation including working towards a Master's degree, and individuals from industry or continuing education. The students enrolled in the course represented a wide range of background areas within Instructional Design and Technology. Students were able to respond at different times of the day, working on computers at the university, at home, or at work through the online learning environment.

d ata c ollection Materials and Procedures

A Quasi-Experimental Research Design was used since the group participants were based on a convenience sampling using an intact student group rather than a random sampling. The affective intervention and weekly survey questions were implemented using a single experimental group with repetitive measures.

The intervention sequence began with an instructor-led facilitation of the discussion forum beginning in week one. During the first week, no interventions were implemented to gather baseline data. In week two, affective community guidelines were added. Weeks three, four, and five were designed to observe the persistence of the intervention over time.

Measurement

Dependent variable survey data was collected to measure students' perceived satisfaction after exposure to the intervention variables, based on a 1-5 Likert type scale with 1) never; 2) rarely; 3) occasionally; 4) often; and 5) very often. The survey

Table 1. Dimensions for building an online affective community (Holland, 2008)

Dimension	Characteristics
1. Equal Access	All students have equal access to discuss issues in the threaded discussion forum.
2. Post Challenging Questions	Students post higher-level cognitive questions to become engaged in the class.
3. Respond to Challenging Questions	Students respond to higher-level cognitive questions to become engaged in the class.
4. Democratic	Practice social equality
5. Consensus Building	Areas of agreement reached by the group are stated.
6. Share Responsibility	Students and student peer mentors, both share autonomy and leadership by participating in the threaded discussions over the course content.
7. Acceptance	All students are considered part of the in-group.
8. All Contributions Valued	Each person's unique ideas, values, and beliefs are appreciated.
9. Willing to Explore Different Attitudes & Beliefs	Respect for attitudes and beliefs different from ones own.
10. All Inclusive	All students are expected to participate and contribute as mentors and mentees.
11. Supportive Collaborative	All participants will support and help each other in the learning process.
12. Positive Responses & Feedback	All participants will be praised for their valuable contributions.
13. Safe Secure	All opinions are respected, student confidentially is maintained, and problems are addressed privately.
14. Welcome Friendly	All students are socially accepted.
15. Build Confidence Success	Build on student success through praise.
16. Helpful	Willing to answer questions and share relevant resources.
17. Respond to Postings & Questions	Each participant will ask questions and respond to questions to build a collaborative learning environment.
18. Accommodate Various Learning Styles	When text based communications are not sufficient, supplemental multimedia materials will be provided. Emoticons can also help to provide emotional ques.
19. Thoughtful	Reflecting on the dialogue prior to posting will help in considering the feelings and impact on other students.
20. Knowledge Construction	By collaborating, students will expand their knowledge base.
21. Extend Course Content	Through dialogue student will be able to view course content through the unique perspective of other.
22. Respect	Student will care about fellow classmates and treat them accordingly.
23. Respect Different Learning Styles	Students will realize each student learns differently and will make efforts to help all students to learn.
24. Respect Different Backgrounds & Experiences	Different cultures, perspectives, experiences, and opinions will be appreciated.

was based on a 5-point Likert-type scale ranging from 1=Never, 2=Rarely, 3=Occasionally, 4=Often, 5=Very Often.

Once the data were gathered, statistical analysis was applied using a One-way Repeated Measures Analysis of Variance (ANOVA) to examine the results of the pilots. One additional questionnaire, with five-dependent variable questions and one open-ended question was used to gather qualitative input from participants to account for important information not revealed through quantitative measures.

Validity and Reliability

The analysis was conducted using a One-Way Repeated Measures Analysis of Variance (ANOVA) with one experimental group. The validity of the study was tested using Cronbach's coefficient alphas for internal consistency with estimates of reliability set to a .75 or higher level.

Pearson Product Moment Correlations were used to analyze the relationship between Pilots 1, 2, 3, with scores ranging from negative relationships of -1 to positive relationships of +1. The analysis was conducted to examine significances between study variables during each week data were collected. Correlation coefficients allowed the researcher to measure the strength of the relationship between two sets of scores. Scores of 0.7 or above were considered an acceptable correlation coefficient.

Data Analysis

As stated earlier, ANOVA was used to examine multiple dependent scores across the five-week study. Multivariate analysis was conducted using Roy's Greatest Root to reduce the responses over time to one dimension. The data analysis examined building the affective community. Students were provided a weekly Perceived Affective Community Satisfaction Survey to complete after the intervention and weekly discussions concluded. Scores were compared between treatment groups' repeated measures within all areas to determine potential post-test gains. Additionally, qualitative open-ended discussion comments were summarized to clarify students' perceived satisfaction.

Participant Demographics

Descriptive statistics included a national study testing of the survey instruments used, with three pilots encompassing intact consecutive online courses in higher education. As an example, in pilot 3 after refining the interventions there were 11 responses (n = 11), 3 (27%) were male, and 8 (73%) were female. Study participants' ages ranged from 21 to 55 (M = 31, SD = 0.88), with all participants reporting their age.

Descriptive Statistics

The survey instrument consisted of 16 question items on building a positive affective learning community. One open-ended question served as a concurrent measure of course satisfaction.

For Pilots 1, 2, 3, data was collected each week in an effort to observe whether any changes in survey response scoring or significant posting frequency resulted. Following the week two practice activity, one assessment was implemented to evaluate the effectiveness of training in the areas of building a positive affective community represented by the 16 survey items. The assessment consisted of providing students with the desired dimension and characteristic, and provided an example of how the features could be implemented, thus demonstrating understanding of the concepts. Data was collected during each week to observe whether changes occurred as a result of the study intervention.

Quantitative Analysis Results Pertinent to Hypotheses

The pilots were designed to test whether college students' Perceived Affective Community Satisfaction scores increase across time. The 16 items on the Perceived Affective Community

Survey (PACS) was developed for this study. However, this was a new scale and it was necessary to test the scale to examine item reliability. All of the items on the PACS were scored as: Never (1), Rarely (2), Occasionally (3), Often (4), and Very Often (5). Table 2 illustrates the five-week study with the week two interventions.

The item to total correlations in the reliability analysis were inspected, and no negative correlations were found, so it was not necessary to reverse score any of the items on the PACS.

The total reliability for the 16 items, with no items reversed, was calculated to be $\alpha = 0.9387$. While this is high, reliability is a factor of the number of items (N=16) and the method used to calculate reliability (Chronbach Alpha).

The construct of the Affective Community Satisfaction was defined as an assembly of students in an online classroom finding satisfaction in working together socially through interactions to share content, ideas, and experiences. Affective Community Satisfaction includes recognition, value, and praise expressed by their peers and/or faculty members for contributions made by students in the online classroom. Table 3 illustrates the weekly interventions.

The perceived affective community satisfaction survey scale consisted of 16 items. Items in this scale included: (a) I enjoyed participating in discussions, (b) I was inspired to do my best, (c) We formed a cohesive collaborative group, (d) the discussions provided a positive learning experience, (e) I was able to share my own personal experiences, (f) I felt connected to the class, (g) My contributions were acknowledged and praised, (h) my contributions were valued and respected, (i) I acknowledged and praised other students, (j) I valued and respected other students' comments, (k) group morale was high, (l) the group called me by name, (m) I was actively engaged in the discussions, (n) I felt comfortable asking question, (o) I felt comfortable asking for help, (p) I took initiative and responsibility for learning.

None of the items in this scale were reverse scored.

Table 4 below illustrates the perceived affective community reliability coefficient.

The second part of the study dealt with whether online college students' Perceived Peer Group Satisfaction scores will increase across time.

The 10 items on the Perceived Peer Group Survey (PPGS) were developed for this study. However, this was a new scale and it was necessary to test the scale to determine whether the underlying constructs emerged from the analysis. All of the items on the PPGS were scored as: *Never (1)*, *Rarely (2), Occasionally (3), Often (4), and Very Often (5).* The item to total correlations in the reliability analysis were inspected and, since no negative correlations were found, it was not necessary to reverse score any of the items on the PPGS. Table 5 illustrates the reliability coefficient. The total reliability for the 10 items, with no items reversed, was calculated to be $\alpha = .8858$. While this is high, reliability is a factor of the number of items (N=10) and the method used to calculate reliability. All 10 items on the PPGS were used in this analysis.

Perceived Peer Group was defined as students actively and mutually engaging collaboratively to discuss the course content using the online threaded discussion forum. It includes students supporting each other with regards to acknowledging and valuing contributions both socially and academically. Items in this scale included: (a) Peers helped me to learn, (b) interest was shown by asking questions, (c) differences in opinions were respected, (d) resources were openly shared, (e) peers were engaged in the course dialogue, (f) the forum was

Table 2. Weekly interventions

Weeks	Test Survey Instrument, National	Pilot 1 Class, Instructional Design & Technology, Web Design	Pilot 2 Class, Instructional Design & Technology, Web Design	Pilot 3 Class, Instructional Design & Technology, Web Design
Week 1	Test Survey Instrument	Teacher Led No Training	Teacher Led No Training	Teacher Led No Training
Week 2		Teacher Led Affective Community Guidelines	Teacher Led Affective Community Guidelines	Teacher Led Affective Community Guidelines, Training & Practice
Weeks 3, 4, 5		Observe Persistence	Observe Persistence	Observe Persistence
Post Pilots		Missing Data	Missing Data	Independent Rater

Table 3. Descriptive statistics for national perceived satisfaction survey (n = 51)

Variables	Mean	**SD**	**Score Min.**	**Score Max.**
Affective Community	63.01	10.76	19	80

socially rewarding experience, (g) all members were allowed to participate, (h) tasks were accomplished, (i) peers were receptive to my ideas, (j) and peers cared about my success. Table 8 below illustrates the reliability coefficients.

If a respondent answered *Never* to each of the items in this scale, the score would have been 10, while responding Very Often to each of the items would have resulted in a score of 50. Thus, a higher score indicated a higher level of agreement with the items in the scale.

Quantitative Results for Pilots 1, 2

The data collected during Pilots 1, 2 and 3, served as a way to continually improve the measurement tools and instructional methods implemented in the study design. Additionally, the data collected helped to serve for comparison purposes between the three different online courses to determine whether changes resulted from group differences.

One additional change resulted from Pilots 1 and 2, once it was realized exposure to interventions was not considered sufficient training or instruction. New materials were created and used in the third pilot. These included instructional materials, matching activities, and assessments over the guidelines. When instructional materials are to be implemented in a classroom setting, it is recommended the practice activities be further refined. The matching item format was confusing for some students since several responses were similar. The more open-ended assessment format was a much more accurate reflection of student ability.

Since data was missing and improvements resulted from pilots 1, 2, it was decided to focus on the data analysis for pilot 3. The pilot information was only used to examine potential group differences in an effort to be able to generalize the findings to other studies. Tables 6, 7, and 8 illustrate the means and standard deviations used for Pilots 1, 2, 3, for study data analysis comparisons.

Quantitative Results for Pilot 3

The pilot analysis revealed mixed significant differences on each unit as a whole, indicating Affective Community as a separate entity was statistically non-significant. Over time, the mean scores revealed an overall increasing trend with multiple significant weekly contrasts. These results point to the potential benefits of conducting a follow-up study with a larger sample size to increase the study power.

During the third pilot, week one began with teacher-facilitated discussions over the course reading material without the use of student intervention training or practice guidelines, in an effort to collect baseline data. Week two continued teacher-led discussions and the addition of the Affective Community Guidelines training, practice, and assessment activities.

The Affective Community Group Satisfaction (ACGS), as a model entity, was not significant ($F(4, 12) = .75$, $p = .5747$). Sixteen items were scored from 1-5, with a range of 16-80. The ACGS mean scores for weeks 1-5 includes, week one (M=71.27), week two (M=68.91), week three (M=72.64), week four (M=74.09), and week five (M=75.91). The overall

Table 4. Perceived affective community reliability coefficient

Scale	Number of Items	Cronbach Alpha
Affective Community Survey Total	16	0.9387

Table 5. Perceived peer group reliability coefficient

Scale	Number of Items	Cronbach Alpha
Peer Group Survey Total	10	0.885

increasing mean scores reflected an increasing trend over the five weeks of the study after receiving training guidelines, practice activities, and assessments. The only exception was reflected in a dip occurring during week two after the affective community guidelines were first introduced. Table 13 illustrates the study student response scale.

Students' ACGS survey responses were, on average, in the "Often" range of response during week one when using only teacher-facilitated discussion. Student responses were, on average, in the "Often" range of response during week two after implementing training and practice in using the affective community guidelines. Student responses were, on average, in the "Very Often" range of response post-intervention during weeks three, four, and five. Table 9 illustrates study multivariate test and multiple contrasts for the affective community satisfaction. Figure 1 illustrates weekly mean scores for the affective community satisfaction.

The pilot study was designed to test whether college students' Perceived Peer Group Satisfaction scores increase across time. The Perceived Peer Group Satisfaction (PPGS), as a model entity, was significant ($F(4, 36) = 3.10$, $p = .0274$). Ten items were scored from 1-5, with a range of 10-50. The PPGS mean scores for weeks 1-5 includes, week one (M=44.60), week two (M=44.27), week three (M=46.27), week four (M=46.91), and week five (M=47.73). The overall increasing mean scores reflected an increasing trend over the five weeks of the study after receiving training guidelines, practice activities, and assessments. The only exception was reflected in a slight dip occurring during week two after the affective community guidelines were first introduced.

Students' PPGS survey responses were, on average, in the "Often" range of response during week one. Student responses were, on average in the "Often" range of response during week two, after implementing training and practice in using the affective community guidelines. Student responses were, on average, in the "Very Often" range of response post-intervention, during weeks three, four, and five. Table 10 illustrates the study multivariate test and multiple contrasts for peer group satisfaction, Figure 2 illustrates weekly mean scores for peer group satisfaction.

Table 6. Pilot 1 means & standard deviations

Scales	Week 1		Week 2		Week 3		Week 4		Week 5	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Affective Community	68.33	9.19	68.33	9.19	65.10	10.07	69.20	8.97	71.50	4.84
Peer Groups	42.75	4.90	42.58	4.85	42.10	4.17	44.40	6.17	45.25	4.33

Table 7. Pilot 2 means & standard deviations

Scales	Week 1		Week 2		Week 3		Week 4		Week 5	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Affective Community	63.00	6.15	63.38	9.31	63.85	8.24	66.46	9.06	67.67	9.85
Peer Groups	39.15	4.71	40.92	5.41	40.15	4.34	41.69	5.17	42.33	5.80

Table 8. Pilot 3 means & standard deviations

Scales	Week 1		Week 2		Week 3		Week 4		Week 5	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Affective Community	71.27	7.54	68.91	8.85	72.64	7.63	74.09	6.62	75.91	3.56
Peer Groups	44.60	4.83	44.27	4.47	46.27	4.96	46.91	3.39	47.73	2.57

One-Way ANOVA Analysis of Pilots 1, 2, 3

Differences were examined for each of the measures across pilots 1, 2, 3. To this end, Table 11 demonstrates the results of the data analysis.

The Analysis of Variance (ANOVA) was used to test that there would be no differences between the students in each class for each measure by week. The data collected for the pilots was gathered over a five-week time span. The ANOVA statistical analysis calculated the individual group means and the combined overall group mean. The within-group variation was determined by examining the total deviation of each score from the group mean. The between-group variation was calculated by the deviation of each group mean from the overall mean. Ultimately, an F statistic was produced, representing the ratio between group variations and within-group variation. There is likely to be a higher statistically significant difference if the between-group variation is significantly greater then the within-group variation.

The ANOVA analysis was conducted using Pilots, 1, 2, 3, to look for statistically significant differences. By examining all three groups across each week, on each scale, significant differences emerged, reflecting changes in the delivery of the class and changes in students. The means and standard deviations for Pilot 1, 2, 3, can be found in Tables 6, 7, 8. Table 11 illustrates ANOVA for all weeks between Pilots 1, 2, 3.

During the first week of the study, no interventions were used to collect baseline data. Significant differences were identified between the three different groups composed of the study Pilots 1, 2, and 3.

The first area of statistical difference during week 1 was found within the Perceived Affective Community scale (F (2, 33) = 3.61, p = .038). The Affective Community scale included 16 items scored from 1-5, with a range of 16-80. The mean scores for the three groups included study Pilot 1 (M=68.33), Pilot 2 (M=63.00), and Pilot 3 (M=71.27), with the majority of student responses falling in the "Often" range for all three pilot groups.

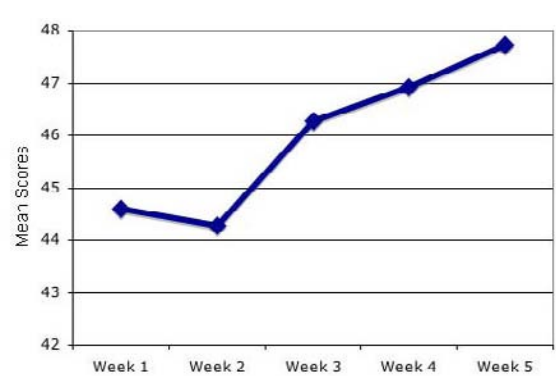
The second area of statistical difference during week 1 was found within the Perceived Peer Groups scale (F (2, 32) = 3.88, p = .031). The Peer Group scale included 10 items scored from 1-5, with a range of 10-50. The mean scores for the three groups included study Pilot 1 (M=42.75), Pilot 2 (M=39.15), and Pilot 3 (M=44.60) with the majority of student responses falling in the "Often" range for all three pilot groups.

During the second week of the pilot teacher-facilitated discussions were used with the addition of affective community training, practice, and assessments activity guidelines. No statistical differences occurred between the three pilots, indicating all three groups had similar response patterns.

During the third week of the pilot, the first area of statistical difference was found within the

Figure 1. Affective community satisfaction

Figure 2. Peer groups satisfaction



Perceived Affective Community scale (F (2, 31) = 3.45, p = .044). The Affective Community scale included 16 items scored from 1-5, with a range of 16-80. The mean scores for the three groups included Pilot 1 (M=65.10), Pilot 2 (M=63.84), and Pilot 3 (M=72.63). Student responses fell in the "Often" range for the pilots and in the "Very Often" range for the third pilot group.

The second area of statistical difference during week 3 was found within the Perceived Peer Groups scale (F (2, 31) = 5.63, p = .008). The Peer Group scale included 10 items scored from 1-5, with a range of 10-50. The mean scores for the three groups included study Pilot 1 (M=42.10), Pilot 2 (M=40.15), and Pilot 3 (M=46.27). Student responses fell in the "Often" range for the pilots and in the "Very Often" range for the third pilot.

Beginning with the fourth week of the pilot, no significant differences were found.

The first area of statistical difference during week 5 was found within the Perceived Affective Community scale (F (2, 28) = 4.02, p = .029). The Affective Community scale included 16 items scored from 1-5, with a range of 16-80. The mean

Table 9. Pilot 3 multivariate test & multiple contrasts for the affective community satisfaction

Contrast	Mean	Contrast	Mean	Contrast	Significant
Week 1	71.27	Week 2	68.91	F (1, 10) = 1.16, p = .3071	
Week 1	71.27	Week 3	72.64	F (1, 10) = 1.12, p = .3047	
Week 1	71.27	Week 4	74.09	F (1, 10) = 3.15, p = .1065	
Week 1	71.27	Week 5	79.91	F (1, 10) = 5.96, p = .0347	*Significant
Week 2	68.91	Week 3	72.64	F (1, 10) = 3.92, p = .0760	
Week 2	68.91	Week 4	74.09	F (1, 10) = 11.64, p = .0077	*Significant
Week 2	68.91	Week 5	79.91	F (1, 10) = 9.66, p = .0111	*Significant
Week 3	72.64	Week 4	74.09	F (1, 10) = 1.60, p = .3409	
Week 3	72.64	Week 5	79.91	F (1, 10) = 3.18, p = .1047	
Week 4	74.09	Week 5	79.91	F (1, 10) = 1.73, p = .2127	

* *Weekly Contrast Significance p≤.05*
** *Non-Significant Overall Roy's Greatest Root: (F (4, 12) = .75, p = .5747).*

Table 10. Pilot 3 multivariate test & multiple contrasts for peer groups satisfaction

Contrast	Mean	Contrast	Mean	Contrast	Significant
Week 1	44.60	Week 2	44.27	F (1, 9) = .48, p = .5052	
Week 1	44.60	Week 3	46.27	F (1, 9) = .75, p = .4082	
Week 1	44.60	Week 4	46.91	F (1, 9) = 3.60, p = .0903	
Week 1	44.60	Week 5	47.73	F (1, 9) = 5.60, p = .0380	*Significant
Week 2	44.27	Week 3	46.27	F (1, 9) = 3.71, p = .0861	
Week 2	44.27	Week 4	46.91	F (1, 9) = 4.65, p = .0593	
Week 2	44.27	Week 5	47.73	F (1, 9) = 10.16, p = .0110	*Significant
Week 3	46.27	Week 4	46.91	F (1, 9) = .19, p = .6719	
Week 3	46.27	Week 5	47.73	F (1, 9) = 1.67, p = .2289	
Week 4	46.91	Week 5	47.73	F (1, 9) = 1.81, p = .2116	

* *Weekly Contrast Significance p≤.05*
** *Significance Overall Roy's Greatest Root: (F (4, 36) = 3.10, p = .0274)*

Table 11. All Weeks ANOVA Between Pilots, 1, 2, 3

Scales	Week 1	Week 2	Week 3	Week 4	Week 5
Affective Community	F (2, 33) = 3.61, p = .038 *** Significance**	F (2, 33) = 1.37, p = .267	F (2, 31) = 3.45, p = .044 *** Significance**	F (2, 31) = 2.53, p = .095	F (2, 28) = 4.02, p = .029 *** Significance**
Peer Groups	F (2, 32) = 3.88, p = .031 *** Significance**	F (2,33) = 1.36, p = .269	F (2, 31) = 5.63, p = .008 *** Significance**	F (2, 31) = 3.14, p = .0526	F (2, 28) = 4.13, p = .026 *** Significance**

*****Significance p≤.05

scores for the three groups included study Pilot 1 (M=71.90), study Pilot 2 (M=67.66), and Pilot 3 (M=75.90). Student responses fell in the "Often" range for the pilots and in the "Very Often" range for the study group.

The second area of statistical difference during week 5 was found within the Perceived Peer Groups scale (F (2, 28) = 4.13, p = .026). The Peer Group scale included 10 items scored from 1-5, with a range of 10-50. The mean scores for the three groups included study Pilot 1 (M=45.25), Pilot 2 (M=42.33), and Pilot 3 (M=47.27). Student responses fell in the "Very Often" range for Pilot 1, in the "Often" range for Pilot 2, and in the "Very Often" range for Pilot 3.

Qualitative r esults from o pen-e nded Questions

Open-ended questions were posed both to confirm students' responses on survey items and to allow for input not addressed in the study design. The students' responses were subdivided into positive and negative responses. Student comments were combined from Pilot 1, 2, 3. The responses were taken from a weekly survey question item and open-ended online discussion thread. There were 37 positive comments and no negative comments made by students.

The first open-ended survey question asked students, "Do you have any other suggestions for course improvements?" The second open-ended question came from a closing online discussion thread, requesting students to "Share your reflections on the course this semester." The responses from the questions provided the qualitative data. This data became a valuable resource to compare against the quantitative results.

The positive qualitative comments on building the Affective Community revealed students' "increased enjoyment", "comfort", "confidence", "support", and "social connections" when learning in the online environment. It was interesting to note that the students had no negative comments on building the Affective Community. Yet, when the Affective Community guidelines were implemented during week two, a slight dip in the mean score occurred. It is logical to assume this may have been due to over-inflated results during the first week, when students were adjusting to a new online learning environment. Alternatively, perhaps the unknown use of instructor affective community modeling during the first week may have had an unknown influence, especially, when considering the overall increasing mean score trend over the five week time span and positive student comments. When comparing the mean score results to the student comments, they seem to be in alignment with student survey responses ranging from "Often" to "Very Often" on the Perceived Affective Community Satisfaction scale. Best of all, the students reported no negative responses in regards to building the affective community.

dIscuss Ion

The results derived from the affective survey instrument, during the pilot studies found non-significant differences in the area of building the

Affective Community as a separate entity. However, the increasing mean score and positive qualitative feedback indicate trends warranting further investigations with larger sized groups.

r eview of the Framework

The major theoretical constructs underpinning this study dealt with the examination of building a positive affective community. It was the intent of this research process to discover ways of improving assessment instruments to measure the quality of the social aspects of instruction used in online learning environments.

When examining the building of a positive affective community, the third pilot reflected no statistical significance at the .05 levels as an independent entity. The analysis did demonstrate weekly increasing mean score trends over the five week time frame, with the exception of a slight dip occurring during the second week when the affective guidelines, practice, and assessments were first introduced. The overall increasing mean score trends point out the need for further analysis with a larger sample size. When comparing the trends against the literature base, it helps to understand potential benefits cited in the literature as observed through the work of other researchers. As noted by Hall (2005), "affective learning or attention to the emotional part of learning has been undervalued in educational systems, it represents a part of learning that is becoming increasingly recognized as vital" (p. 1). The affective state "impacts how efficiently and effectively a learner acquires and processes information/knowledge" (Kort, Reilly, & Picard, 2005, p.1). By increasing the overall quality of affective learning, the community has the opportunity to grow in group confidence and excitement for the cognitive task at hand. The affective community is considered "vital to creating an identity that allows full participation in a community of practice" (Kahn, Mitchell, Brown, & Leitch, 1998, p. 794). The "community is a place where teachers and students can test ideas and make connections between what they are teaching and learning in their heads and feeling in their hearts" (Hall, 2005, p. 1). These connections can then serve as motivation, and satisfaction when working with peers online. Once students are actively engaged, an "emotional or intellectual climate conducive to learning" is possible (Harasim, 2005, p. 43).

Peer Groups reflected a statistical significance at the .05 levels as an independent entity. However, stricter analysis would have found this to be non-significant. The third pilot demonstrated weekly increasing mean score trends worthy of further analysis with a larger sample size. When comparing the trends against the literature base, it helps to understand potential benefits cited in the literature. Hall (2005) defines the collaborative peer groups as dealing with the social aspects of students working together to "co-create a community for learning where everyone feels valued" (p. 1). For social groups to be able to connect in meaningful ways requires a certain degree of "trust," "openness," "vulnerability," and "respect," (Hall, 2005, p. 2). Peer group interactions can be a critical component to social emotional engagement and learning at all levels. The "conversation and the sense of group cohesion are central features" to a productive learning environment (Newman, 1990, p. 102). These "conversations can have a variety of purposes, but in all cases a sense of community arises from the interactions" (Newman, 1990, p. 115). Online collaborative learning "highlights social and intellectual interaction" (Harasim, 1990, p. 39). The resulting collaborative efforts offer students the potential to develop the groups' "collective intelligence" through educational interactivity (Harasim, 1990, p. 41).

l imitations

Based on insights gained from data analysis, future changes would include shifting the starting date for collecting research data until the second week of the course or later. The newness of a class can potentially skew the initial baseline data collected. This may be especially true when students might be new to learning in the online environment and are still adjusting to the instructor and course materials. If students do not have any prior technology experience, the results may be altered somewhat by their efforts to try to adapt to the new learning format.

Various issues worthy of future research based on the findings of this study include developing positive affective communities in the online learning environment. This issue, and many others, should be examined in light of considering future refinements of the guidelines, survey instruments, instructional pedagogy, and interface design.

Guidelines with practice and assessment activities for building a positive affective community were implemented during week two. Many significant multivariate contrasts were found within the weekly scales during the study. Through additional research efforts in a variety of subject areas, with larger geographic dispersions, instructional guidelines may benefit from further refinement and improvements.

Due to the lack of an appropriate Perceived Affective Community and Peer Group Satisfaction Survey to be used in the online learning environment, one was created for this study. The survey instrument was determined to have a high reliability score and served as a good measurement instrument for this investigation. With additional refinements and testing, the overall model may be improved further, thus, providing quality tools for testing new teaching techniques and perfecting the measurement instruments used for the final analysis. The survey instruments could also benefit from additional testing on a broader range of subject areas, larger sample, and expanded geographic locations, with the potential for further refinements to be made.

As evidenced by the results of this study, simply discussing course content online is not enough to generate the desired quality of learning and interaction possible in the threaded discussion forum. By intervening with age appropriate training, guidelines, practice, and assessment instruments, work can continually be done to improve the quality of the instruction that is delivered to students.

When evaluating online dialogue, it is important to consider the multi-dimensional aspects of learning within the current social constructs. Online learning environments are a wonderful collection of unique individuals. Each student brings his or her own personality, culture, experiences, needs, goals, and learning styles. Just as the weekly multivariate contrasts, increasing satisfaction over time, and positive student comments demonstrated, interventions over time could have a successful impact on learners. In the end, it may not be the one good instructional intervention conducted but, rather, some combination of interventions required over time to make a real difference.

Interpretation of r esults

Non-significant outcomes were found in the area of the affective community as a separate entity. Overall, the study demonstrated increasing mean score trends with multiple significant weekly contrasts. These follow-up comparisons, however, were only significant at the .05 level, and many would not have been significant at the more conservative levels often chosen in follow-up analyses. The findings indicate the potential benefits of conducting follow-up studies with larger sample sizes to increase the study power.

This study extended the knowledge base by demonstrating overall increasing mean score trends and overwhelming positive student comments worthy of further investigation with a larger sample size. The strength of the pilot studies, overall, was a result of the intervention over an extended period of time. This finding is consistent when considering the diversity of learners in the online environment and the variety of learning needs and styles to be addressed. By integrating a variety of instructional strategies over an extended period of time, the pilots' demonstrated overall positive gains in mean score trends, and students' open-ended comments.

a ffective c ommunities

Positive affective learning communities allow students opportunities to connect with others both socially and intellectually to foster the groups' collective intelligence. In regard to building the affective community, past research indicated students benefited from an increased satisfaction, excitement, confidence, and ability to acquire and process new information efficiently. The pilots were designed to discover whether the interventions would increase students' perceived level of satisfaction within the affective community over a duration of five weeks.

The affective community demonstrated an overall increasing trend in mean scores with the only negative dip occurring during week two when the affective intervention guidelines were first introduced. However, the qualitative open-ended student feedback resulted in all positive comments with no negative comments posted. One possible explanation for the dip in scores when compared to student comments may have been due to over-inflated results due to the newness of the online course during the first week. Students may have been adjusting to the new course, instructor, and technology, or perhaps an unknown level of teacher modeling of the affective guidelines prior to implementation during the second week.

The Perceived Affective Community Satisfaction Survey contributed to the literature base by providing a new measurement instrument to be used in the online learning environment. The study assessment questions had a very high level of internal consistency and reliability with a total Perceived Affective Community score of ($\alpha = 0.938$).

Implications

Based on the results provided in the previous section, potential implications can now be considered. The areas examined include the building of a positive affective community to facilitate the online threaded discussion forums. The statistical analysis demonstrated no significance on the affective community, as an isolated construct. However, this finding is in conflict with the current literature base, increasing mean score trends, students' positive qualitative survey responses, and significant multivariate weekly contrasts at the .05 level. With the overall increasing mean score trend, it would be worthwhile to conduct a follow-up study with a larger sample size to increase the statistical power of the findings.

The open-ended qualitative feedback responses by students clearly reinforce the literature base and potential positive outcomes with students' strong overall perceived course satisfaction. These results indicate the importance of instructors to provide training within these areas by using guidelines, practice, and assessment activities. With exposure to interventions over a period of time, students were able to realize benefits and enhance their perceived satisfaction within the online learning environment.

Instructional designers will need to consider the implications of current research when designing instruction for students. Designing online courses requires an alignment of the pedagogy with current best practices to improve overall course satisfaction and to foster quality-learning opportunities. Course satisfaction can ultimately serve as the spark to inspire students to want to learn more, even beyond what the current course has to offer. It can serve as the catalyst to inspire future learning.

Future r esearch

One important component emerging from this research is the potential for developing a true affective community where students are able to support peer learning. This is accomplished through active participation, sharing responsibilities, ensuring the content is understood, extending the content, collaborating with peers, and supporting peers.

This study also revealed a need to continue working toward making improvements to online web-based learning management systems. By implementing effective interfaces that reflect the needed underlying age-appropriate educational pedagogy, instructors can better meet both the social and academic learning needs of their students. Often, the tendency is to think of learning systems as simply for gaining access to content. Quality learning is much more than this and needs special considerations. Web-based learning systems need to capitalize on building the affective community by improving the socio-technical design. Based on the findings of this study, it becomes apparent that this would be a great area for continued exploration and future development and growth.

After reflecting on this study and contemplating potential future implications for online learning, it becomes apparent there is a great opportunity to improve feedback about student performance for both instructors and students alike. This includes multiple types of contributions, including building the affective community. Since affective communities can contribute to a positive learning environment students find satisfying, it would be worthwhile to know when instructors are on track and when they need to make further adjustments. Online dialogue can become very large and unwieldy when trying to sort through and analyze for quality. By browsing various online websites, one can find a wide array of evaluation rubrics used to analyze online discussion threads. Some are based on participation, good contributions, grammar, spelling, understanding, relevance, clarity, community, references, collaboration, posting length, building on other responses, and relating posts to prior knowledge. Some are so open-ended and dependent on the instructor's interpretation that it would be very difficult and time consuming to implement. Perhaps part of the flaw stems from the lack of agreement on what goals are important and how they can best be accomplished. Only with a clear perspective can educators begin to implement appropriate measurement instruments aligned to meet social and academic goals.

Looking towards the future, perhaps the knowledge base could be accelerated further by developing and implementing automated feedback on the quality of online dialogue in regard to building the affective community. Students could then be provided information to learn how to self-regulate the quality of their own interactions. Developing and testing appropriate instruments will not be easy, but will be well worth the time and effort. Perhaps the solution will be found in the next generation of "automated response systems" (Taylor, 2001, p. 3). These systems could be used in the analysis of the electronic discussion threads by creating "intelligent" automated feedback for both students and instructors. From the information gleaned from the feedback, more would be learned and further improvements could be made on what teachers choose to teach (Hawkins, 2004). Developing truly intelligent educational systems could greatly expand and enhance the technology tools for "information and knowledge management" for both students and instructors alike (Jorgensen, 2005). In turn, this could open the door to further educational insights at an unprecedented rate. One research study is not likely to provide all the answers. Only with a willingness to be creative and try new ideas, listen to what is working for the students, adapt to changing times by being flexible, and hard work and persistence can educators continue to learn and grow with their students. Through questioning, research, testing, and analysis, the ongoing process of finding ways to improve the quality of teaching and learning can be continued.

c onclus Ion

Socio-technical design refers to the "human-computer interface and patterns of human-computer interaction" required for online learning (Scacchi, 2003, p. 2). Currently there is a "mismatch between what is required socially and what we can do technically" (Ackerman, 2007, p. 17) since human interactions are complex and tend to be context based. It will most likely take a concerted effort including "domain experts, designers, programmers, human-computer interaction specialist, marketing people, and user participants" working together to design and redesign flexible tools for unique learners, needs, and changing conditions (Fischer, 2007, p. 3). Creating flexible socio-technical infrastructures can assist in accommodating unanticipated shifts in learning needs. Flexible technologies such as providing learner controls can serve as a "catalyst for fundamentally rethinking what education and learning should and could be" (Fischer, 2007, p. 6).

Virtual environments like Second Life, Wikis, and many others provide us with examples of using a decentralized shared authority. Adding cool new cutting edge technology will not in and of itself lead to improved learning. Working towards a better understanding of the affective social needs will help us to make informed decisions as to appropriate socio-technical infrastructures to support quality online learning.

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Affective Community: The affective community is composed of learners engaged in building a socially successful and supportive online learning community where ideas, knowledge, and experiences can be shared and respected.

Collaboration: Students collaborate or work together with classmates in a team effort to expand the mutual generation of intellectual ideas, knowledge, and experiences in the online learning environment.

Dialogue: The dialogue, conversation, or text-based communications in the online learning environment are used for exchanging ideas, knowledge, and experiences.

Intervention: The act of intervening to make a change and observing the effect.

Online Learning Environment: The online learning environment refers to the e-learning environment used for knowledge acquisition within computer mediated digital systems.

Pedagogy: The science of instructional curriculum methods by instructors.

Socio-Technical design: The socio-technical design is the intersection between needed social supports and the computer mediated structure for supporting and extending effective interactions.

Chapter XLIV
Assessing the Social Network Health of Virtual Communities

David Hinds
Hinds & Associates, USA

Ronald M. Lee
Florida International University, USA

Abstract

In this chapter, the authors suggest how measures of "social network health" can be used to evaluate the status and progress of a virtual community. Using social capital theory as a foundation, the authors describe community health as the general condition of a community leading toward its advancement or decline, and show how social network analytical measures can be applied to existing virtual community archives to measure social network health. They describe the metric development and validation process and use their empirical study of 143 open source software project communities to illustrate how this process can be applied. Their hope is social network health metrics will be devised and integrated into host platforms for various types of virtual communities, thus providing socio-technical system designers and community managers with a valuable new diagnostic tool for tracking the status and progress of their communities.

Social network analysis can provide an X-ray of the way in which work is or is not occurring in these informal networks.

—Cross, Parker, Prusak, and Borgatti

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Introduction

Virtual communities have become a subject of considerable interest in both research and practice. These communities encompass a broad spectrum of initiatives ranging from social networking sites such as MySpace to online auction sites such as eBay to open source software initiatives such as Linux. While it is easy to cite many prominent examples of large and successful virtual communities, there are a great many other examples of such communities which have not been so successful. For example, only a small fraction of the 20,000 or more open source software projects launched each year actually produce useful computer software.

Because the number and variety of virtual communities continues to expand rapidly, there has been insufficient experience from which to recognize and validate a well-developed list of best practices for design or management. In such a challenging design environment, it is especially important to have evaluation metrics which can be used by socio-technical system designers to assess the impact of various design configurations. Such metrics are also quite important for community leaders wishing to monitor the progress of their communities and to assess the impact of changes in management approach or policy.

In the following section, we define what we mean by "virtual community" and "community health". We then use social capital theory to define one specific kind of community health—"social network health"—and we show how social network analysis offers a set of tools and measurements for quantifying this construct. To assist in creating useful metrics, we refer to a typology of virtual communities and then describe the process for developing and validating the metrics. We use our empirical study of open source software communities as a case study to demonstrate how this process can be implemented. In our conclusions, we discuss the implications for socio-technical systems design and virtual community management.

The Health of Virtual Communities

Virtual Communities

While various definitions have been offered in the literature, a simple definition is adopted for the purposes of this chapter:

A virtual community is a population of individuals with shared or complementary interests who interact across a host platform.

Viewed from a socio-technical system perspective, our definition makes explicit the social aspect and the technical aspect. The social aspect is the population of individuals and their interests and needs. In some cases, the members of the population may have a single shared interest as in a socializing community where the members are generally seeking friendship and a social experience. In other cases, the population may consist of individuals with two different but complementary interests or needs, as with a knowledge sharing community where some members have an interest in providing knowledge while other members have a need to seek knowledge.[1]

The technical aspect of the virtual community is the web-based host platform which is provided by a hosting organization. We view this host platform as including not only the enabling technologies, such as wikis, blogs or databases, but also the rules and policies which govern the behavior of community members. The host organization will typically provide some general policies while individual community managers will often provide more specific policies geared to the needs of their particular community.

Combining a population and a platform, a set of interactions will emerge and in some respects the community itself is defined by this set of interactions. In this context, the notions of "community" and "interaction" are broadly interpreted and can involve either direct interactions among individuals (e.g. as in threaded conversations) or indirect interactions through the collective creation, modification, and use of persistent digital goods (e.g. as in interactions through a digital repository such as the Wikipedia). Taken together, the technology and policy components of the platform provide a *protocol of interaction* for the virtual community. This protocol essentially represents a set of affordances and constraints which can have a significant influence on the nature and success of the community that emerges.

Community Health and Success

In assessing the performance of virtual communities, there are various possible ways of defining and measuring "success" depending upon the perspective of the evaluator as well as the type of community involved. For example, Lin et. al. (2007) studied "web-based knowledge communities" and used Preece's (2000) community success framework to validate a research model which related usability and sociability factors to community success. In a study by Leimeister, et. al. (2004), the authors reviewed the literature for success factors in virtual communities and noted the different definitions of success associated with the different stakeholder groups. They identified 32 success factors and then assessed their importance using a stakeholder survey. In a paper devoted to success measures for open source software project communities, Crowston et. al. (2004) presented a range of measures that could be used to assess the success of projects. Their measures included system and information quality, user satisfaction, use, individual or organizational impacts, project output, process, and outcomes for project members, as well as the opinions of participants with respect to users, products, processes, developers, uses, recognition, and influence.

There are clearly a wide variety of success and performance measures proposed for virtual communities and synthesizing these various concepts can be a significant challenge to the socio-technical system designer wishing to create and implement practical measures of community evaluation. In order to assist in this process, it is useful to separate out the overt success measures, such as community activity or output, from other kinds of measures. As seen on Figure 1, the success measures include usage and activity indicators, such as the number of system users or number of page views. In some cases, success measures may also include statistics regarding output of the project (e.g. quantity of software produced by an open source software community) or impact of the community beyond its boundaries (e.g. new laws passed as a result of the efforts of an activism community).

While these kinds of success measures are fundamental and well accepted, they are in some respects superficial, in that they do not address the deeper underlying issues which lead to success. For example, we can count the number of developers who participate in an open source software community, but this measure does not address the underlying causes or factors as to *why* these individuals chose to participate (or not). These deeper (and sometimes hidden) kinds of outcomes might include user opinions or complaint levels, as well as social factors such as the perceived satisfaction of member needs or technical/operational factors such as the perceived quality of the host system or community processes.

These deeper factors can be viewed as measures of "community health". Using this health metaphor, we can view a virtual community as a kind of organism whereby the organism has certain attributes which indicate its state of health. Based on this perspective, healthy attributes will tend to lead to community growth or at least to smooth functioning and the sustainability of existing community activity, while unhealthy or pathological attributes may be an indicator of ailments that will lead to community decline and possibly death. Extending this metaphor, the more overt success measures such as activity or output can be viewed as the "vital signs" of the community.

With an organism, the obvious symptoms are sometimes not sufficient to diagnose the illness and special diagnostic tests may be required. We extend this idea to measures of community health and view these measures as a kind of diagnostic test which can be used to detect the presence of underlying problems which, in some cases, may be hidden with no obvious symptoms. For example, users may be disgruntled over changes to a platform policy, and this problem may not become obvious until community activity levels drop as these individuals abandon the community. A community health measure may be able to detect this kind of problem before it can negatively impact the success of the community.

Social Network Health

In this section, we develop the concept of "social network health". In doing so, we first discuss social capital theory and show how this theory can be used to illuminate the community health concept and to identify three different types of community health: cognitive, relational and structural. We then discuss the field of social network analysis and show how various social network measures could be defined as metrics for evaluating the social network health of virtual communities.

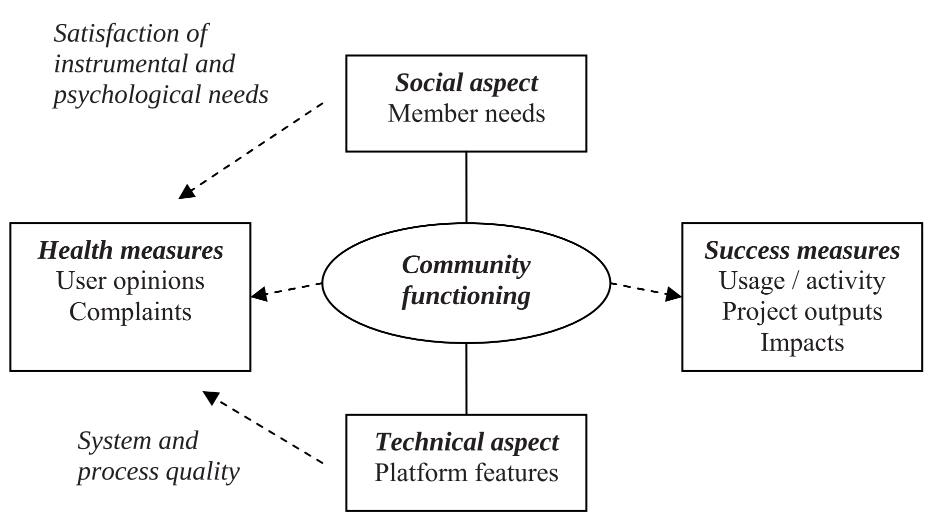
Social Capital Theory

Social capital theory is very broad and has been applied in many areas of management and organizational research. This theory is based on the premise that certain kinds of social attributes have value to the group and/or to individuals within the group. These attributes can be viewed as a kind of "capital", similar to how one might think of financial capital or human capital. These attributes are referred to as "social capital".

In general terms, social capital theory provides a collective context in which individual relationships are embedded within a network of relationships (Granovetter, 1985). Social capital is viewed by Bordeau (1986) and others as consisting of both the network itself and the assets that may be mobilized through the network. Social capital concepts can be applied at an individual level, considering individual benefits, (Burt, 1992) or at a group level, considering group benefits (Putnam, 2000). Groups can be defined as teams, communities, organizations, and even regions and nations (Fukuyama, 1995). In our case, we use the group-level perspective for discussing the notion of community health.

Nahapiet and Ghoshal (1998) identify three dimensions of social capital including cognitive, relational, and structural. The cognitive dimension includes the shared vocabulary and narratives of the

Figure 1. Health and success measures for a virtual community (source: Hinds & Lee, 2008)



social group. The relational dimension considers the constructs of trust, norms, and identification. The structural dimension considers constructs of network ties, network configuration, and appropriable resources. In a structural context, social capital theory uses an information processing paradigm to explain how social network structure affects social outcomes at the individual level and at the group level. Social ties are viewed as conduits for the flow of information, knowledge, or other resources.

Using our health metaphor, we can define a "healthy community" as one which possesses a sufficient level and type of social capital. Applying the three dimensions of social capital, we identify three different kinds of community health to include cognitive health, relational health, and structural health. These represent different perspectives for understanding the notion of community health, and we recognize they are somewhat interrelated. For example, the way that the information flows are structured within a group (structural health) may have an impact on the relational attributes of trust and shared norms (relational health) that emerge.

While all three kinds of health are meaningful, we focus in on the structural kind and refer to it as "social network health". As a community evaluation concept, social network health is useful for two reasons. First, as we will discuss in the next section, it can be measured by applying social network analytical methods to existing data archives. This is especially useful for large communities in which managers may have difficulty monitoring community activities on a regular basis, either through personal vigilance or through the use of surveys or interviews. Second, the structural dimension of social capital theory provides two important assertions regarding the kinds of social network structures leading to positive outcomes, and these assertions are useful for suggesting possible evaluation metrics.

The first assertion of social capital theory is that social network structures with high "closure", or a tightly knit set of ties within the network, will facilitate the *utilization* of resources. Closure is seen to create cohesive groups, and this type of structure is expected to support shared norms and trust (Coleman, 1988). For example, in teams and workgroups, closure has been strongly connected with group effectiveness (Balkundi & Harrison, 2006). However, high closure can also have negative impacts on the network, for example as seen in the "groupthink effect".

The second assertion is that a social network structure with extensive bridging ties, which extend outside of the group, will facilitate the *access* to resources. At the group level, this is an extension of Granovetter's (1973) notion of weak ties and their positive impact on information transfer. Bridging also involves Burt's (1992, 2001) concept of "brokerage" in which brokering individuals can provide the network (group) with access to non-redundant information and knowledge. Again for teams, bridging has been shown to have a positive relationship with group effectiveness (Balkundi & Harrison, 2006).

Social Network Analysis

First seen in 1934 in the "sociograms" of Moreno (1934), social network analysis has grown into a large collection of methodologies, measurements, and tools that can be used for the description and analysis of social networks and social structure (Wasserman & Faust 1994). Within the context of social network analysis, social networks are mathematical representations of the relationships between social entities. People or organizations are represented as a set of nodes and the relationships (such as advice-giving or trade) are represented as a set of ties connecting the nodes. The primary mathematical foundation is provided by graph theory, and social network analytical methods draw heavily upon matrix algebra for coding and manipulating network data.

Social network constructs can reveal patterns not discernable with other methods, and these patterns may be reflected in quantitative social network measurements or they may be observed qualitatively in two- or three-dimensional graphical network representations. These constructs are most commonly defined at the group level or the individual level, although they are also sometimes applied at a subgroup level.

At the overall group level, the primary types of constructs used include density, centralization, cliques and components, and positions and structural equivalence (Wasserman & Faust, 1994). At the individual level, centrality is one of the most ubiquitous of the social network measures. It is typically described as a "location" of an individual actor within a network and it is associated with importance or prominence (Wasserman & Faust, 1994). At the subgroup level, Everett and Borgatti (1999) have defined the notion of class centrality, in which the centrality concepts normally applied to individual nodes are extended to subgroups. Questions which can be addressed with subgroup class centrality include: 'how central are the women within an organization, as opposed to the men?' or 'to what extent are financially-oriented individuals central to the advice-giving networks of the firm?'

Social Network Health Measures

Social network analysis provides a useful approach for operationalizing the structural dimension of community health in the form of social network health measures. These health measures are an effective and practical way of evaluating virtual communities because they can be adapted to many different types of communities and they can efficiently use existing data archives such as conversational text associated with forums, email, chats, and other kinds of data such as membership records or user profile information. In devising social network health measures, the socio-technical system designer should consider three kinds of options. These include the definition of nodes and links within the social network, the selection of relevant social network constructs, and the identification of community subgroups.

With regard to network definition, various types of networks can be defined, based on the nature of the nodes and the links. *Interaction* networks can be created where nodes are community participants and links are various kinds of interactions between the participants. Depending upon the type of community, these interactions might consist of conversation, game-playing, collaboration, or trade. Alternatively, *affiliation* networks can be created where one set of nodes consists of the community participants and the other set of nodes includes a set of organizational entities. In this case, the links are defined by the affiliation of each community participant with a particular organizational entity.

Regarding the choice of social network constructs, there are many options to consider. In this case, social capital theory can provide some guidance in that the concepts of closure and bridging are suggestive of certain social network measures. In particular, closure can be measured by "density", which is simply the actual number of links in a network divided by the total possible number of links. When applied to a conversation-based network, this can be referred to as "conversational density". Bridging can be measured by the average nodal degree for community participants in an affiliation network, where "nodal degree" is the total number of membership links that are connected to a given participant node.

The results of prior social network studies of communities may also suggest some relevant measures. For characterizing communities of practice, Schenkel et. al. (2000) define five structural properties which include: 1) connectedness, 2) graph-theoretic distance, 3) density, 4) core/periphery structure, and 5) coreness. In comparing and synthesizing her prior studies, Teigland (2003) notes there are significant differences in the social structures of different community forms. In a study mainly focusing on the "invisible" participants in communities (the "lurkers"), Rafaeli et. al. (2004) used a social network perspective to measure the activities of individuals as they moved from lurker role to active participant role. In the area of open source software project communities, Crowston and Howison (2004) examine 120 project teams from SourceForge, and analyzed interactions associated with the bug reporting archives by measuring and comparing the centralization measures of the different projects.

In some cases it may be helpful to identify community subgroups. These might include individuals who perform a certain role within the community or who have other common attributes, such as being members of a particular organizational unit or who share a particular profession. While social network analysis is capable of identifying subgroups based solely on network structure (e.g. as with clique identification or block modeling techniques), we suggest a priori subgroups, based on member attributes, are more useful in constructing social network health measures. These subgroup definitions can be overlaid on an interaction network and various kinds of subgroup metrics can be defined, such as class centrality (Everett & Borgatti, 1999) or subgroup density.

CREATING SOCIAL NETWORK HEALTH METRICS

In this section, we describe a process by which social network health metrics can be developed and validated. This begins with a description of a typology of virtual communities (Hinds & Lee, 2008), whereby different community types may be related to different member needs and a corresponding set of healthy structural patterns. We then describe a process by which this typology and other inputs can be considered in developing and validating social network health metrics.

A Typology of Virtual Communities

Given the broad diversity of virtual communities, it is reasonable to expect different types of communities will have different kinds of healthy social structures. For example, the member needs for approval, support, or friendship associated with socializing communities may require higher levels of conversational density, while the task-related needs of open source software developers in development communities may require low to moderate levels of such density. Essentially, each community type may have a different "healthy pattern" with regard to social network structure.

Various typologies for virtual communities have been suggested in the literature. For example, one typology offered by Dube et. al. (2006) is applied to virtual communities of practice and covers the dimensions of demographics, organizational context, membership characteristics, and technology environment. The authors specifically exclude "casual" online communities and focus on organizationally-created entities. In another effort, Hummel and Lechner (2002) studied 50 business-related virtual communities and proposed a set of five "genres of business-relevant communities" including 1) gaming, 2) interest, 3) business-to-business, 4) business-to-consumer, and 5) consumer-to-consumer.

In order to create a typology which can be mapped to different sets of social health measures for virtual communities, we used community purpose and member needs as the basis for differentiating the types (Hinds & Lee, 2008). With this approach, each community type is associated with a particular set of needs that community members expect to be satisfied through their participation in the community. Because virtual communities tend to be more successful if they are able to attract and motivate more participants, it is expected that community success will be closely tied with (and sometimes driven by) the extent to which participant needs are perceived to be satisfied by community members.

A total of seven needs-based virtual community types have been identified, as described below (Hinds & Lee, 2008). For each type, the key participants are defined, along with examples of the needs that these participants expect to satisfy through their community involvement. These needs may be instrumental (e.g. building software development skills, acquiring video content) or psychological (e.g. feeling support or acceptance). Of course, we recognize other typologies could be defined and this is just one possible set. We also recognize individual communities may have features of more than one type. However, we have observed most communities are associated with a single predominant type.

Socializing Communities

Virtual socializing communities are commonly associated with social networking sites and personal blogs. The primary member group consists of individuals wishing to socialize with others, especially those having shared interests. Member needs are those associated with socialization such as the need for approval, support or friendship. Examples of this type include communities formed around MySpace, Facebook, and Second Life.

Gaming Communities

Virtual gaming communities are often associated with massively multiplayer online role playing games (MMORPGs) such as EverQuest, although they may also include non-role playing games such as Full Tilt Poker. Members of these communities have an instrumental need to play a game with others, involving a need for competition, entertainment, and/or fantasy.

Content Sharing Communities

In content sharing communities such as video sharing sites like YouTube or peer-to-peer file sharing services like BitTorrent, some members are content providers and some are content users. Members of these communities may have instrumental needs to acquire a particular song or they may have psychological needs to express themselves artistically or to gain their “fifteen minutes of fame”.

Knowledge Sharing Communities

One of the broadest of the virtual community types, knowledge sharing communities are formed to support learning, opinion expression, and information dissemination, and are organized around sites such as Wikipedia or Slashdot. Primary member groups include knowledge providers and knowledge seekers. Some members have an instrumental need for knowledge on a particular topic while others have a need to build their reputation.

Activism Communities

Virtual activism communities are formed for the purpose of organizing the members for some type of offline action, such as with an online political action group or a consumer group. The primary member group includes those who have an interest in the action, such as the skilled immigrants who formed Immigration Voice. The member needs are instrumental and relate to the desired action.

Development Communities

Virtual development communities are organized for technological development and innovation purposes. The most prominent examples include open source software project communities such as Linux or Apache. Also included within this type are innovation communities such as ThinkCycle or IBM InnovationJam. Some members have instrumental needs to create and/or use designs or artifacts (e.g. software), to develop their skills, and they may also have psychological needs such as feeling a sense of challenge or accomplishment.

Exchange Communities

Virtual exchange communities are organized to support the economic exchange of goods or the matching of service providers to service users. In these communities, the primary member groups consist of buyers and sellers or service providers and service users. Examples include eBay and Craigslist.

Metric Development and Validation

A general process for developing and validating social network health metrics is depicted on Figure 2. The process begins with a series of inputs including an assessment of the community type and member needs (e.g. using the suggested typology[2]) relevant social theories such as social capital theory, different social network constructs, prior social network studies, and a consideration of data availability. Based on these inputs, a set of social network metrics can be developed for further consideration.

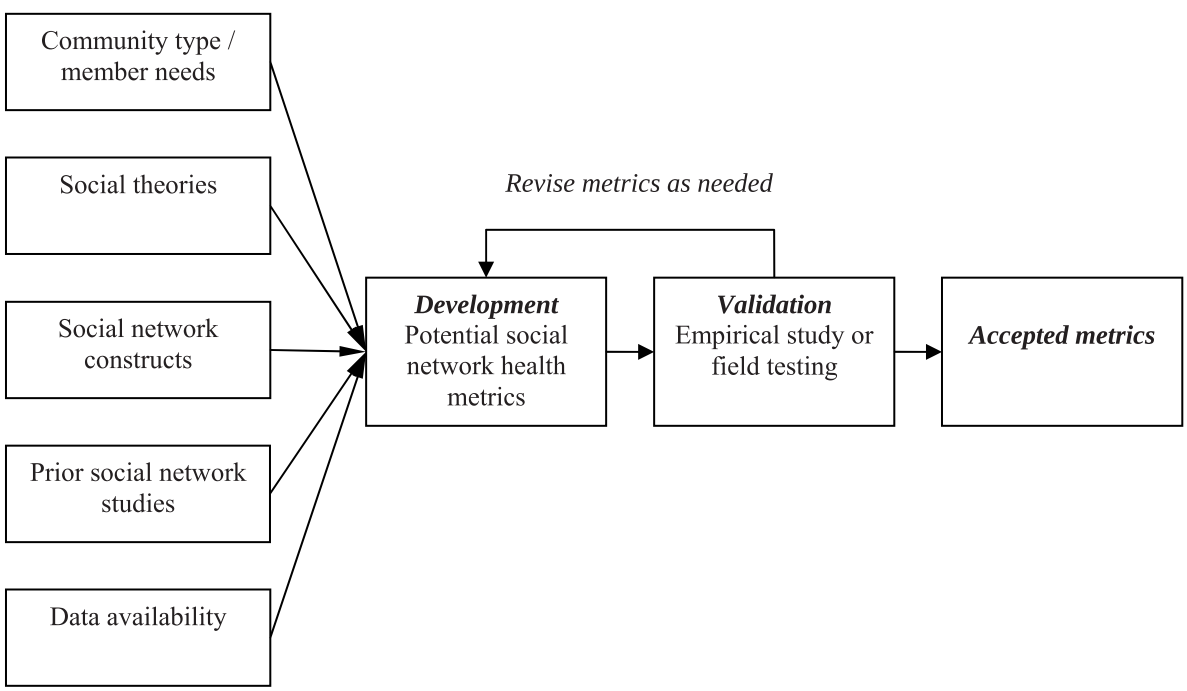
Once a set of metrics is defined, the testing and validation process can proceed along two possible tracks. One track involves performing an empirical study in which a sample of operating communities is selected and the relationship between proposed health metrics and community success variables is investigated based on data obtained from the virtual community archives over some observation period. (The case study presented in the next section is an example of such an approach.) The other track is to actually implement the proposed metrics in one or more host platforms and then to monitor their values over a period of time to look for changes in the metric that are concurrent with or consistently lag behind certain kinds of events such as rule changes.

Based on the results of the testing process, other metrics may be proposed and tested. If the empirical study shows significant correlation (and plausible explanation) between the suggested social network metrics and community success variables, then these metrics may be accepted for implementation. In the case of field testing, the health metrics which seem to plausibly correlate with concurrent events can be accepted. The plausible explanations resulting from the testing process are important because they allow the designer or manager to understand the meaning of the metric and to recognize the kinds of functional problems that may be indicated by negative values or time trends.

THE CASE OF OPEN SOURCE SOFTWARE COMMUNITIES

In this section, we use the case of open source software communities as an example to show how the results of an empirical study can be applied to create useful social network health metrics for a given population of such communities. We begin with a brief description of open source software communities and their host platforms. This is followed by a description of our development and testing process and the social network health metrics that were accepted.

Figure 2. Development and validation of social network health metrics (source: Hinds & Lee, 2008)



Open Source Software Communities and Host Platforms

The individuals participating in open source software projects are often seen as comprising a community. These communities have been described as having an onion-like structure, with a central core of highly active individuals, surrounded by other layers of progressively less active individuals. One example of this is presented by Ye et. al. (2005) in which the central core is composed of the project leaders and core members, with five outer layers containing active developers, peripheral developers, bug reporters, passive users, and stakeholders, respectively.

Open source software project communities are usually initiated by a single founding individual (or small group of individuals) providing the initial source code and setting the general direction for the project. The host platform is usually provided by a third-party hosting organization (e.g. SourceForge), although larger and more mature projects may form organizations to host their own communities. The key technological components of this platform include a source code repository (version control system), public forum facilities, and project web pages.

The initial source code provided by the community founder is entered into the project source code repository and this initial code represents the seed work product for further community development activity. Policies and rules for the project are sometimes provided in part by the hosting organization (e.g. requirement of transparency and use of an open source license) and partly by each project community manager/administrator (e.g. commit privileges, norms of behavior).

Development of Proposed Metrics

Following the process shown on Figure 2, we first considered open source communities to be an example of a development community, and we reviewed prior studies to identify the key interests and needs of community participants. We found volunteer[3] open source developers are motivated by instrumental factors associated with fulfilling a need, expertise development (learning), or enhanced reputation, as well as by psychological needs involving self-fulfillment, basic fun and enjoyment (Lakhani & Wolf 2005, and Raymond 1999). We also noted that enjoyment of group participation is not frequently mentioned as being an important motivational factor, but rather many open source developers are seen as "hackers" tending to be highly proficient but whose "fun" comes not from social activities but from solitary programming activities.

We chose SourceForge as a platform infrastructure for our data collection efforts. SourceForge is the most prominent hosting organization for open source software project communities, and over 100,000 projects have been registered with this organization. We selected the individual project community as our unit of analysis. While it is possible to think of all SourceForge participants as a single community, we chose to focus on individual projects to define our communities because each project is associated with its own particular platform, including specific interaction protocols defined and implemented by the project administrator. In effect, the "project community" is the population of individuals emerging to participate in the project.

After considering the availability of data on SourceForge, we used the social capital theory concepts of closure and bridging to define possible social network health metrics. For the closure concept, we defined an interaction network to consist of community members and their conversational links, where a link is defined if two members participate in a single threaded discussion on the project public forums. The closure concept is represented by the conversational density of this network, where density is calculated as the observed number of conversational links in the network divided by the total possible number of links. In applying this to open source software communities, we expected closure would relate to instrumental or task-related needs associated with producing and using the project software.

For the bridging concept, we defined an affiliation network where community members are one type of node and SourceForge projects are the other type of node. A link is defined as being present if a member of the focal project is a member of a SourceForge project. These links can be thought of as "bridging ties", and the social capital concept of bridging is represented by the average nodal degree of community members, calculated as the average number of links attached to a community member node. In effect, this measure considers the members of a focal project community and it represents the average number of projects in which these individuals are a member. We expected bridging would relate to instrumental needs associated with acquiring technical knowledge, solving problems, and possibly recruiting more developer members.

We reviewed the limited set of literature of prior social network studies of open source communities, and the general literature on open source software. Based on this review (and considering the availability of relevant data), we defined several community subgroups including the core, the periphery, and the administrators. The core and administrator subgroups were defined based on registrations obtained from the project records. The peripheral subgroup was defined by individuals participating in the project forums, but not registered with the focal project. Using these subgroups, we defined additional measures of density and bridging which might relate to the instrumental and psychological needs of these subgroup members such as perceiving a sense of identification with the project, as well as feelings of satisfaction and challenge.

t esting and Validation

We conducted an empirical study to test a set of possible social network health metrics (Hinds, 2008). In this study, we defined various hypotheses suggesting possible relationships between the proposed health metrics and a set of community success variables. We applied an unobtrusive research method in which we compiled and analyzed statistics from the public archives[4] of SourceForge.

In order to identify a relatively homogeneous population, we defined our study population to include projects using an open source license, in an early-stage of maturity, targeted to developers (as opposed to users), and not sponsored by corporations. We employed a time-adjusted observation window whereby variables were tracked for the two year period following the date of first software release, regardless of the actual start date of the project. This design resulted in a more homogeneous set of projects (all being at a similar stage of development), compared with other designs which selected the sample at a given point in time and, therefore, included a more heterogeneous group of projects (in various stages of development).

Four variables were chosen to represent community success including: 1) number of code commits to the source code repository, 2) number of software releases, 3) number of software downloads, and 4) number of project page views, all of which were measured over the two-year observation window. These variables were selected based on success criteria associated with open source software project communities, as compiled by Crowston, et. al. (2004), together with a consideration of the availability of data within the SourceForge project archives. The first two of these variables represented the output of the community in terms of the quantity of software produced, while the last two represented indicators of community activity. To some extent, these activity measures could be viewed as proxies for the quality of the software produced, because higher quality software will tend to generate greater levels of community activity.

A search for projects on SourceForge as of January 2006 which met the study population criteria (and which passed tests for data availability and integrity) produced a total of 160 project communities. After rejecting outliers, we analyzed data from 143 project communities with the use of linear regression and related methods. In performing these regressions, we controlled for the effects of total group size, core subgroup size, and conversational volume.

selected Metrics and their Interpretation

Based on the results of our empirical study, we found a significant negative linear relationship between conversational density and community success. This result was strongest for the conversational density of the entire group, although we also saw this negative relationship for the density of the core subgroup. With regard to the bridging metrics, we found no significant linear relationship between bridging and community success.

Considering the assertions of social capital theory, these were surprising results. In the case of closure, social capital theory as applied to teams predicts density should have a positive relationship with success, while the results of this study showed a significant negative relationship. In the case of bridging, the theory suggests bridging will also have a positive relationship with success, while in our study we found no significant linear relationship. In order to interpret these results, various conjectures were formulated based on a review of the open source software literature and informal discussions with open source software community members.

In interpreting the results for conversational density, it was noted that the most successful communities exhibited the lowest levels of density. Considering that density is the proportion of total possible links that are actually connected, a causal relationship between density and success would indicate that the lack of conversational links among members could somehow cause or logically lead to success. No plausible conjectures were identified which could explain such a relationship. Therefore, the possibility of a spurious relationship was considered whereby a third factor is identified which affects both density and success. Three such factors were noted including 1) modularity of the software architecture, 2) quality of the software documentation, and 3) effectiveness of the project rules (see Figure 3).

The modularity of the software architecture is recognized to be an important success factor for open source software projects (MacCormack et. al. 2006). Modular software architecture permits changes to source code within one module without significant effects on code contained in other modules. An ineffective modular design will tend to increase coding interdependencies in which the coding work of one developer is more likely to affect the work of other developers. In this case, conversational density will tend to increase as multi-person conversations are needed to discuss the impact of code changes and to investigate complex bugs which are more likely to arise. At the same time, success measures of output and activity will tend to decrease as developer productivity is reduced and as software quality is negatively impacted. If this conjecture is valid, then a high level of density may indicate that the modularity of the software architecture is lacking. Similar arguments can be made for the impact of clear and complete software documentation which makes the software architecture explicit, and for project rules which effectively describe the rights and responsibilities of community members.

For the surprising result that closure and bridging had no positive relationship with success, it is noted that open source software developers operate in a computer-mediated environment involving many types of software tools and computational artifacts. As a result, it is plausible that direct social interaction is of less importance in such an environment. For example, in traditional teams, bridging ties are important for gaining information from other teams and work groups, which often cannot be obtained without direct contact. However, in the case of open source projects (and especially the SourceForge platform infrastructure), a great deal of information about these other projects can be easily obtained from archival records, even with the assistance of search engines identifying relevant projects. Thus, while bridging ties are important for traditional teams where outside information may be difficult to obtain, these ties may not be important for open source project communities because of the transparency of the open source platforms.[5] In effect, the work in these communities does not seem to benefit from conversational density (see Figure 3). At the same time, a low level of density may contribute to meeting the psychological needs of participants by providing a favorable operating environment for "lone hackers" who often prefer writing code over socializing. For these individuals, dense conversations are to be avoided and may actually be distracting and demotivating.

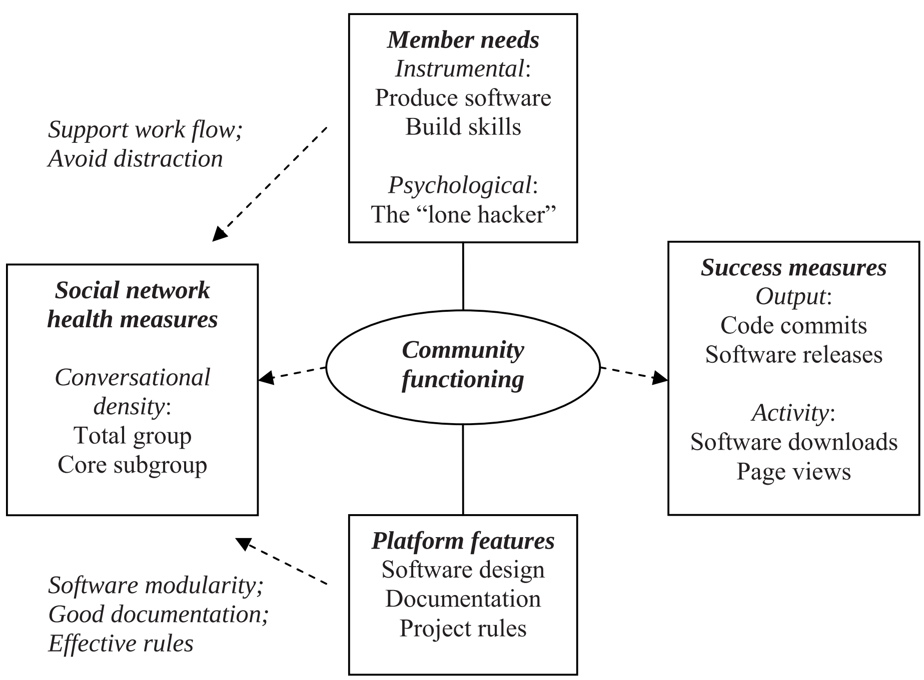
One key lesson learned in this case study is the need to conduct empirical or field testing, and to not merely accept the assertions of social theories or prior studies. Virtual communities are a new kind of phenomenon and prior theories may not be relevant. In our study, we found that social network theories of teams and work group effectiveness do not seem to apply to open source software project communities, even though the software produced by these communities may be virtually identical to the software produced by traditional teams.

conclus Ion

Social network health metrics can be defined as useful and practical for assessing the deeper underlying factors associated with virtual community success. In developing these metrics, socio-technical system designers should consider the community type and associated member needs, the assertions of relevant social theories, the possible social network constructs, prior social network studies, and the availability of data. In applying this approach to a study of early-stage open source software project communities, we found that successful communities are associated with sparse social networks, based on our finding of a significant negative relationship between conversational density and community success. Of course, these results are limited to the population that was studied and further research is needed to identify and characterize healthy social network structures for other kinds of virtual communities.

Using the approach suggested in this chapter, system designers can develop and validate social network health metrics for individual virtual communities or for homogeneous classes of communities. Calculation algorithms for the relevant metrics could then be integrated into host platform software and the results displayed as a type of meter

Figure 3. Social network health and success measures for an open source software project community (source: Hinds & Lee, 2008)



or dashboard object, indicating both current values and time trends for the metric. Virtual community managers could then use this information as a valuable diagnostic tool for assessing the state of their communities and for determining if increased vigilance and/or corrective action may be necessary. These metrics could also be of value if displayed to the community at-large, perhaps providing a type of feedback enabling the community to sense its own problems and to make appropriate adjustments without the need for direct intervention by the community manager[6].

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KEY TERMS

Community Health: The general condition of a community which may lead towards its advancement or decline. Community health can also be viewed as the absence of dysfunctional structures or processes.

Host Platform: A web site or network-based portal which enables interaction among virtual community members, including both technological components and policy components.

Social Capital: Social attributes of a group which are of value to the group or to an individual within the group.

Social Network: A graph theoretical representation of the relationships between social entities, in which the social entities are represented as a set of nodes and the relationships are represented as a set of ties which connect the nodes.

Social Network Health: A type of community health involving the structure of relationships and information flows within a community, where this structure can be represented as a social network.

Social Network Analysis: A large collection of methodologies, measurements, and tools that can be used for the description and analysis of graph-based social networks.

Virtual Community: A population of individuals with shared or complementary interests who interact across a host platform.

Endnotes

1. We recognize that some individuals may have both interests - sometimes providing knowledge and sometimes seeking knowledge.
2. The typology of communities presented in this chapter may also be useful for assessing other kinds of community health, such as cognitive health (e.g. shared norms) or relational health (e.g. trust). However, this is beyond the scope of the chapter.
3. We recognize that some open source developers are paid employees of sponsoring corporations.
4. We utilized data obtained directly from SourceForge.net, as well as data contained in SourceForge-based research databases which are compiled by the University of Notre Dame (2007) and by the Libre Project (Libresoft 2006).
5. However, it should be noted that the bridging metric in our study was based on membership data and not conversational data, because such data was not available. It is possible that a bridging metric based on a conversational network would produce different results.
6. Our thanks to the editors for suggesting this possibility.

Chapter XLV
Situated Evaluation of Socio-Technical Systems[1]

Bertram C. Bruce
University of Illinois at Urbana-Champaign, USA

Andee Rubin
TERC, USA

Junghyun An
University of Illinois at Urbana-Champaign, USA

abstract

This chapter introduces situated evaluation as an approach for evaluating socio-technical innovation and change. Many current evaluations simply identify the impacts of technology and deprecate alternate uses in their analysis. Situated evaluation instead calls for understanding how innovations emerge through use; this entails consideration of diverse uses, the contexts of use, and the reasons for the development of multiple realizations. The chapter presents a comparative study of different classroom uses of electronic Quill in order to demonstrate how this alternative evaluation can be conducted and to address the value of understanding and fostering diverse cultural appropriations of a socio-technical innovation.

What about the lay public as producers of technology and science? From the vernacular engineering of Latino car design to environmental analysis among rural women, groups outside the centers of scientific power persistently defy the notion that they are merely passive recipients of technological products and scientific knowledge. Rather, there are many instances in which they reinvent these products and rethink these knowledge systems, often in ways that embody critique, resistance, or outright revolt.

—Eglash, 2004, p.vii

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Introduction

Implementing an innovation entails making changes to an existing system of social practices. People involved with that system naturally want to know what those changes mean and are, therefore, drawn to calling for some sort of an evaluation. Based on the results of the evaluation, practitioners, policy makers, and administrators make their practical decisions about the fate of the innovation. They often focus on evaluation outcomes alone, but the setting of evaluation questions and methods is as important as the outcomes. Evaluation processes embed evaluators' assumptions about the innovation and its relation to the relevant social contexts.

In this chapter, we raise questions about the basic assumptions and limitations that standard approaches to evaluations have, and introduce *situated evaluation* as an alternative approach that aims to uncover, not the way that an innovation interacts with practice, but rather the very emergence of innovations through practice. Through a study of Quill, an electronic composition system that was developed for teaching writing in the early 1980's, we demonstrate how this alternative evaluation can be conducted. We also discuss the values, challenges, and methodological issues related to using situated evaluation in supporting further understanding of socio-technical innovations. As new digital technologies increasingly pervade aspects of our daily lives, the innovations-in-use issues that arose in Quill implementations are even more relevant today.

Questioning the Nature of Standard Evaluation

Standard evaluation practice tends to emphasize either formative or summative approaches. Formative evaluation is typically done during the development or improvement of a program and is conducted iteratively. Results are often informal and lead to recommendations for change. Summative evaluation provides information on the program's efficacy, such as improvement of student learning. In this chapter, we propose an alternative, which questions the basic assumption of "what" it is that is being evaluated.

In evaluating a new technology, researchers typically consider the innovation as a fixed object created by professional developers. They further assume that its benefits are somewhat fixed and known in advance with respect to social practice. For example, a program might be developed to help students learn a concept in science or to help a community engage in community building through better communication. Evaluation then becomes a way to improve that program or to assess its effectiveness. This is a reasonable approach, one that is fully in line with calls for reflective practice. But in its extreme form, the assumption that what the program actually is known prior to its integration into social practice becomes what Papert (1987) defines as *technocentrism*:

> *Egocentrism for Piaget does not, of course, mean "selfishness"—it means that the child has difficulty understanding anything independently of the self. Technocentrism refers to the tendency to give a similar centrality to a technical object—for example computers or Logo. This tendency shows up in questions like "What is THE effect of THE computer on cognitive development?" or "Does Logo work?"* (p. 23)

The problem here is that a technocentric perspective limits the scope of the evaluation, often making it difficult to see unexpected uses of an innovation. But, as any developer knows, technical innovations often result in unplanned uses and diverse readings of the innovation. Often, the variation in use is greater than the variation in programs, so that the claim to be evaluating a particular program becomes convoluted with discussions about faithfulness of implementation or effectiveness of the program per se versus effectiveness of its introduction.

One good example occurs in the discourse on online collaboration and learning systems. The early visions of new communication and information technologies asserted that their fundamental attributes could support innovative learning environments that promoted students' active participation, reflective thinking, attainment of self-discipline, and connections with the real world. However, this visionary perspective of educational computer-mediated communication has altered due to the unexpected effects of diverse teaching and learning practices.

For instance, Burniske (2001) designed and implemented several "telecollaborative" projects using e-mail, but eventually reported on the limitations of telecommunication for learning. Burniske's first project, "Project Utopia," used electronic mailing for having his students discuss utopia and dystopia with another colleague's students in a different location. Burniske judged that this project "had inspired a few constructive discussions, but many of them dissipated as students' imaginations, liberated from real-world concerns, took flight" (p. 36). Then he developed another project, "South African Elections' 94 Internet Project," which allowed e-mail exchanges among 11th and 12th grade students in South Africa and the U.S. However, he realized that students' discussions remained shallow and felt it difficult to improve the quality of the discourse. From these experiences, he started questioning the linear impact of new communication technology integration on student learning. Other scholars from critical perspectives have similarly questioned positivist views of technology's effects on practice (Bryson & De Castell, 1998; Bruce, Peyton, & Batson, 1993). These critical views have argued that new technologies do not generate social change, but are instead mutually constituted with social practice.

Standard (summative and formative) approaches have wide-ranging and important uses for evaluating socio-technical systems. But as they are usually carried out, they also have a crucial limitation related to examining the interaction of the technical innovation with the context in which the innovation is used. This makes it difficult to attend to the process of change, and consequently, to many of the concerns people have about innovations.

R. M. Wolf (1990) describes three key problems with standard evaluation. First, most evaluations do not identify the reasons for the observed phenomena. Thus, they do not say how the innovation can be improved, nor what aspect of it produced the measured effects. Second, not being able to account for why changes occur means that it is questionable to generalize to other settings in which the innovation might be used. Third, the development process often continues after the evaluation, so that most evaluations are effectively of innovations that no longer exist. Again, without knowing more about the situation and process or use, one cannot say whether initial results are still valid for the changed innovation.

Many researchers have proposed ways to attend more to the process of change. Some call for an emphasis on formative evaluation. Others call for broadening the range of measurement tools used for summative evaluation (Miles & Huberman, 1984). In *responsive evaluation*, evaluators become sensitive to the interests and values of the variety of participants involved with the innovation (Stake, 1990). Others call for multiple case studies across different settings to identify the variations and differences (Stenhouse, 1990). Each of these approaches makes a contribution to the study of socio-technical innovation and change. But often these methods fail to answer a basic question for a potential user: How can the innovation be re-created in one's own setting? Rather, they still designate which type of use is "acceptable" and which is "unacceptable." This leads us to raise a fundamental issue about the nature of evaluation: What is the "it" being evaluated?

sItua ted eValua t Ion

Situated evaluation is an approach to articulating the emergence of innovations through practice, assuming that innovations are mutually constituted by social practice and some external input. It starts with the common finding that a program operates differently in different settings. But rather than postulating that there is one program used in different ways, it asserts that multiple programs come into being through use. This ontological shift leads to different ways of analyzing, describing, and conceptualizing alternate, or even non-uses. A bibliography of situated evaluation studies can be found online at http://illinois.edu/goto/siteval.

A situated evaluation approach conceives technology users as active creators, rather than as "passive recipients of technological products and scientific knowledge" (Eglash, 2004). Users actively rethink the meaning and use of a technology and reinvent its practices by appropriating them within their situated, cultural contexts. Eglash (2004) calls this process *appropriating technologies*. We would go one step further to say *creating technologies*.

In these situations, we need a new type of evaluation that is open to new variables and sensitive to alternate uses and interpretations. This new concept of evaluation needs to focus on the *innovation-in-use*, and its primary purpose is to understand the different ways in which the innovation is realized and thus created. *Situated evaluation* then emphasizes the unique characteristics of each situation in which the innovation is used. With this approach, the object of interest is not the idealized form in the developer's specs, but rather, the realization through use. The "it" being evaluated is no longer the innovation (or even what we call the *idealization*), but the innovation-in-use, a situation-specific set of social practices. Recognizing the richness and the importance of the realization process also leads us to ask new sorts of questions for evaluation (see Table 1):

- What practices emerge as the innovation is incorporated into different settings?
- How well do the different uses of the innovation work?
- How can different realizations be improved?

KEY ELEMENTS OF SITUATED EVALUATION

Situated evaluation is a process of discovering relationships. Although it does not resolve into a simple, linear procedure, there are three major aspects of this process. First, it looks at the idealization of a technical system or program, in order to delineate as fully as possible what was intended by the developers. Second, it examines the settings in which a technology is used. Third, it analyzes the realization processes in different settings and generated hypotheses about how and why these realizations developed as they did.

The Idealization of the Innovation

We define the elements of the innovation as intended by developers as its *idealization*. An analysis of the idealization is part of a situated evaluation because it serves to characterize how participants in the setting of use might have perceived the innovation. It is also an index of the intentions of the developers, people who are often important participants not only in the initial creation of the innovation, but in its re-creation in context.

In contrast to the priorities for summative evaluation, the innovation is not privileged over any of its realizations; similarity to the idealization does

Table 1. Questions about innovations and change

Old Questions	New Questions
What can the innovation do?	What do people do as they use the innovation?
To what extent are the innovation's goals achieved?	How do social practices change, in whatever direction?
What constitutes proper, or successful, innovation?	What are the various forms of use of the innovation-in-use?
How should people or the context of use change in order to use the innovation most effectively?	How should the innovation be changed and how can people interact differently with it in order to achieve educational goals?
How does the innovation change the people using it?	How does the community fit the innovation into its ongoing history?

not count as more successful, and non-use can be as important to consider as "faithful" use. Moreover, the innovation is not seen as an agent that acts upon the users or the setting, but rather as one more element added to a complex and dynamic system. It would be more correct to say that the users act upon the innovation, shaping it to fit their beliefs, values, goals, and current practices. Of course, in that process, they may themselves change, and their changes as well as those to the innovation need to be understood as part of the system.

t he s etting in w hich the Innovation a ppears

The shift in perspective from the view that realizations are distortions of the ideal to one in which realizations are creations that result from active problem-solving has implications for the sorts of questions researchers need to ask in evaluating innovations. With this perspective, the social context in which the innovation is used becomes central. Questions relating to cultural, institutional, and pedagogical contexts need to be addressed. To answer these questions in full is a formidable task, but focusing on a few specific aspects may go far in providing what is needed for a situated evaluation.

t he r ealizations of the Innovation

The third aspect of a situated evaluation is to study the realizations of the innovation in different settings. This means, first, to examine the ways the innovation was used and search for the reasons that changes occur. This includes analyzing how the idealization was consonant or dissonant with existing social practices. It also includes studying how the innovation's use led to new social organizations. Second, is to look at the variety of uses across settings, treating each of these as an independent re-creation of the innovation, rather than as a data point for an aggregate statement about the innovation. Third, is to examine changes in the design of the innovation brought about by its use and the ways these changes relate to new practices.

c omparisons of s ituated e valuation with s tandard e valuations

A key difference between situated evaluation and the standard frameworks is that its purpose is to learn first how the innovation is used, not how it ought to be changed or whether it has claimed effects. Because it is concerned with actual use, it does not focus on the innovation or its effects, but rather on the social practices within the settings in which the innovation is re-created. This shift in focus has implications for the audience of the evaluation, the role of setting variability, the tools for evaluation, the time of assessment, and the presentation of results.

Focus

Standard evaluation is concerned either with properties of the innovation alone or with its "effects." In contrast, situated evaluation focuses on the way the innovation becomes social practices.

Audience

Situated evaluation results can be used by both users and developers. Users can make decisions not only about whether to use the innovation, but how to use it in their particular context. Developers can learn how to revise the innovation taking into account the variations in use.

Purpose

For situated evaluation, the audience is broad, as are the actions that follow from the findings. The results could lead to developers changing the innovation, to users changing their practices, to adoption of only parts of the innovation, or to deeper understanding of the process of use.

Variability of Settings

The central concern for situated evaluation is with characterizing the way an innovation comes into being in different contexts. Because the audience for the evaluation wants to know how to improve the use of innovation, it is useful to have a variety of contexts that they can compare to their own setting or to ones they might create. Thus, it is most appropriate when there are a variety of contexts of use, and differences across those settings.

Measurement Tools

With situated evaluation, the emphasis is on differences across contexts. This emphasis implies the use of qualitative tools, including observations and interviews that are structured to elicit information about recurring social practices in the setting and to draw out differences among realizations.

Time of Assessment

Situated evaluation can start once the innovation is developed enough to be placed in a classroom. This is in contrast to formative evaluation, which might start even earlier, in a laboratory setting. Situated evaluation can continue well after the developers have finished. It could be done before summative evaluation as a way to identify sites or issues to study, or afterwards as a way to study the process of change.

Results

Because a situated evaluation seeks to characterize alternate realizations, it requires multiple, detailed descriptions of specific uses. Changes need to be described using appropriate quantitative or qualitative representations, but more importantly, the reasons for changes need to be discussed and linked to characteristics of the settings of use. The process of change, including changes in the innovation, in the users, and in the setting, becomes paramount.

Situated Evaluation and Ethnographic Inquiry

Situated evaluation significantly differs from standard (summative and formative) evaluations that start with the given and ask how to improve it. Hence, evaluators who approach from a situated evaluation perspective would not simply identify the strengths and weaknesses of a technology and generalize the conditions for successful implementations. Situated evaluation also does not pursue wide and decontextualized dissemination of an innovation across different settings. Instead, through contrastive analyses and narrative accounts, evaluators seek to create a shared space for multiple technology users to reflect their values and practices so that they can continue re-creating their technology uses through practice. The audience for the evaluation would also want to compare to their own setting or to ones they might create.

Situated evaluation resembles the “sustained and engaged nature” of ethnography and extensively uses ethnographic methods, “long-term participant observation with in-depth interviewing” (Miller, Hengst, & Wang, 2003). To understand the process of change and to excavate different views or interpretations of socio-technical changes within contexts, situated evaluation demands evaluators’ relatively long-term and ongoing engagement. An’s study (2008) shows how ethnographic inquiry and methods have guided her situated evaluation of an alternative computer training practice implementing community service. According to her study, the methodological emphasis of situated evaluation needs to continuously create a dialectic between the “contextual” and “narrated” worlds in order to generate credible results throughout data collection, analysis and reporting. Different natural settings and uses of an innovation cannot be arbitrarily analyzed and compared in parallel. Rather, situated evaluation develops the researcher’s continuous and meaningful construction of knowledge through sensitive use of multiple research methods.

Situated evaluation is also based on the idea that the researcher-participant relationship can

Table 2. Comparisons among the three types of evaluation

	Formative	Summative	Situated
Focus	Innovation	Effects of the innovation	Social practices
Audience	Developer	User	User (but also developer)
Purpose	Improve the innovation	Decide whether to adopt innovation	Learn how the innovation is used
Variability of Settings	Minimized to high-light technology	Controlled by balanced design or random sampling	Needed for contrastive analysis
Measurement Tools	Observation/Interview/Survey	Experiment	Observation/ Interview
Time of assessment	During development	After initial development	During and after development
Results	List of changes to the technology	Table of measures contrasting groups	Ethnography

significantly shape the researcher's understanding of the insiders' perspectives. What enables scientific inquiry is not the elimination of subject errors or biases, but the researcher's on-going, self-reflective learning to understand the multiplicity and complexity of modern social reality by carefully observing practice. Hence, evaluators weave possible interpretations about the phenomena on the basis of what they hear and observe. In this sense, conducting situated evaluation is a constructivist and historical process of learning for evaluators to make meaningful knowledge.

Briefly, situated evaluation requires an evaluator's sustained, extensive, and self-reflexive engagement. That effort is worthwhile if one wants to understand diverse cultural adaptations of technology and the process of technology design and use *in situ*.

a stud Y o F electron Ic Qu Ill In use

Quill (Bruce, Michaels, & Watson-Gegeo, 1985; Bruce & Rubin, 1984; Liebling, 1984; Rubin & Bruce, 1985, 1986) was an approach to the teaching and learning of writing built around a software system that included both tools and environments for writing. From 1983 to 1987, it was used throughout the U.S. and Canada, primarily in upper-elementary and middle-school grades. Quill is no longer commercially available, but the Quill studies show extensive classroom data on its use. The studies examined how Quill was realized in different ways in diverse settings. They also looked at the details of the implementation processes to understand how the realization reflected the unique characteristics of Quill, as well as the particular classrooms in which Quill was used.

One of the Quill studies is described here in order to demonstrate how a situated evaluation can be conducted in a specific case. This study focused on the various ways that Quill's goal of purposeful writing was realized through the use of Mailbag, one component of the Quill software. Mailbag was a version of email used by the Quill students, years before many people became aware of it. The goal of the study was to understand how realizations of an innovation were created, and to use real classroom examples for insight into the process of integrating new technologies into teaching.

The following presents the findings in two major sections: the idealization of Quill and realizations of Quill. The latter describes alternate implementations of Mailbag and how the integration of students' and teachers' purposes and habits with the innovation produced different realizations. The data gathered include writing by the teachers about their own classrooms, student writing, electronic mail (both from Mailbag and from a network for teachers), and field notes from classroom observations.

t he Idealization of Quill

Quill's design was based on research on composition, and encompassed prewriting, composing, revising, and publishing aspects of the writing process (Bruce, Collins, Rubin, & Gentner, 1982; Flower, 1981; Flower & Hayes, 1981; Graves, 1978, 1982; Newkirk & Atwell, 1982). It included a text storage and retrieval program (Library), a note-taking and planning program (Planner), and an electronic mail program (Mailbag), all supported by a text editor (*Writer's Assistant*; Levin, Boruta, & Vasconcellos, 1983).

In its software, accompanying curriculum (Quill *Teacher's Guide*; Bruce, Rubin, & Loucks-Horseley, 1984) and teacher workshops, Quill embodied a philosophy for teaching writing. Quill emphasized the process of writing, including the importance of both planning and revision. The contrast between Quill classrooms and traditional classrooms is highlighted in Table 3. On the left is a gloss of what we call the idealization of Quill, that is, the view of what Quill was supposed to become in classroom use. On the right are parallel descriptions of a more traditional writing class. Many teachers tried to integrate Quill with some of these discrepant practices. Although major changes in the teaching of writing have occurred since then, many classrooms still approach writing in the "traditional" way. Moreover, the issue of how classroom technology adoption is inseparable from pedagogy is still relevant (Mishra & Koehler, 2006)

A central element within the idealization of Quill was an emphasis on real audiences and purposes, which was expressed in the software, teacher's guide, and training. In the software, Mailbag, in particular, reified this emphasis on audience and purpose. Combining features of the post office, the telephone, and a bulletin board, it facilitated direct communication among students, groups of students, and teachers. With activities suggested in the Quill *Teacher's Guide*, it encouraged a variety of purposes for writing that students seldom experienced in school: "chatting," persuading, informing, instructing, and entertaining. It also motivated students to write more by introducing a personal element into the experience.

Many teachers introduced "writing as communication" to their students through Mailbag. Since they had used Mailbag extensively during training, teachers appreciated the differences between sending Mailbag messages and standard classroom writing assignments. They saw Mailbag as a way to help students understand writing as a communicative act through participation in writing activities that demanded a real audience and purpose.

r ealizations of Quill

The realization of Quill in any real classroom was a re-creation that drew upon the idealization, but was usually more dependent upon characteristics of the situation of use, institutional forces, the teacher's goals and teaching style, the students, and idiosyncratic technical details, such as the number of computers or room layout. Thus, the many forms of Quill-In-Use differed markedly from the original conception.

Of course, each teacher understood the idealization of purposeful writing in Quill in his or her own way, and the variety of realizations were due in part to different teachers' interpretations of our message. What mattered was not just Quill's conception of purpose, but that of the people who used it: What did teachers and students think writing was useful for? How did they use writing to accomplish personal goals? What did teachers think students should learn about writing in school? What natural goals for writing existed in classrooms or community contexts?

In most classrooms, Mailbag use *did* lead to more purposeful writing. Students saw Mailbag as an unconstrained writing environment and were thus able to use it for their own purposes. But the specifics of this use took many different forms, often surprising both us and the teachers involved. A few teachers regarded the openness of the Mailbag environment as a pedagogical problem, and in these cases, little purposeful writing with Mailbag occurred.

Table 3. Contrasts between QUILL and traditional classrooms

QUILL Classroom	Traditional Classroom
Prewriting	Sit and write
Topic choice	Designed topic
Multiple genres	Mostly narrative
Multiple real audiences	Teacher as audience
Real purposes	Writing for a grade
Conferencing	Red marks as response
Revision	Editing
Collaboration	Hidden papers
Sharing writing	Isolated writers
Writing across the curriculum	Writing in English class

For several teachers, Mailbag and its built-in assumptions were completely consistent with their current classroom practices and their attitudes toward teaching writing. These teachers firmly believed in "student-centered education" and in students' feeling ownership of the process and product of their work in school. They saw Mailbag as a welcome extension of the way they already taught writing. They were comfortable with students' deciding when, where, why, and on what topics to write. For instance, Bonnie's multigrade, village-school classroom reflects this symbiotic use of Mailbag. Students used the program frequently and enthusiastically from the beginning of the year. Bonnie offered the following comments about her class' early use of Mailbag:

Probably the best thing about Mailbag is communicating. The person at the keyboard is in complete control. I never made any Mailbag assignments. Students could use it or not, decide what they would say, to whom, when, how often, and why.

The Mailbag messages written in this class show their oral-language character. Students seemed to regard Mailbag as an environment in which they could carry out the same communicative functions for which they used oral language. Although many messages contained nonstandard grammar or spelling, Bonnie never corrected any student message. She considered Mailbag to be in the students' domain, where spelling and punctuation were secondary to just plain communicating.

In Bonnie's classroom, students expressed their control over Mailbag by deciding both when to use Mailbag and when to stop using it. Several other teachers also found that students' enthusiasm for Mailbag diminished as the year went on, but Bonnie's comment about this shift reflects again how her educational views easily encompassed such as change:

By springtime the Mailbag was hardly used at all. At first I was disappointed, then pleased. The students had learned that there were appropriate forms of communication for specific needs.

Especially in small classes where students knew each other well and saw one another frequently outside of school, the kind of communication Mailbag facilitated was mostly redundant. As Bonnie implies, students had become more sophisticated about audience and purpose and were not satisfied with a communicative situation that did not increase their access to real audiences.

In one class, however, interest in Mailbag remained strong during the entire year. Hans taught high school in Bonnie's village and used Mailbag with his class after learning about it from Bonnie. He designated one disk as the students' private Mailbag disk and promised the class that he would never read it. The students continued to send messages on the disk all year, and Mailbag remained the most popular Quill activity. As the year went on, Hans actually had to ration Mailbag's use because he wanted students to use the computer for other kinds of writing as well. Why did Mailbag remain so popular in this class? Certainly at least one influence was the unique audience Hans defined for Mailbag messages. It appears that the secrecy of the disk made the communication environment unusual enough that students did not consider it redundant with face-to-face communication.

Since many Quill classrooms had only a single computer, using Quill required some teachers to rethink their classroom management practices. How were they to integrate a free-form activity like Mailbag into a more structured day? Wilma, a fifth-grade teacher, invented a procedure to deal with the changes in her classroom structure. Wilma's students' excitement over Mailbag was particularly significant to her, since one of her goals for the year was to help her students learn to enjoy writing. While she was enthusiastic about Mailbag's effect on her students, she was troubled by its classroom management consequences:

When we started using Mailbag, I had a problem with my students wanting to be back at the computer constantly checking to see if they had any mail or not. We decided we needed to devise a system that would solve the problem. We talked about what we could do, and soon came up with a mailbox poster, which worked quite well. We each wrote our computer code name on a Library book card pocket, and glued the pockets to a piece of poster board. The poster board was then hung on the wall behind the computers. Another pocket was added to hold slips of red paper. When a student left a message on Mailbag for White Knight, he or she would put a red slip into White Knight's pocket. After While Knight read his messages, he returned the red slips to the extra pocket.

The classroom management issues were so central to teaching with Quill that Wilma's idea spread around the community via our technical assistance visits and the teachers' electronic mail network. The classroom management problem turned out to be a common one, and many teachers adopted Wilma's solution.

Not all integrations of purposeful writing with Mailbag into the classroom grew out of a symbiosis between Quill and a teacher's purposes. In one case, a teacher completely rejected Mailbag because it conflicted with her views of the appropriate way to teach writing. This teacher started out using Mailbag in the usual way, and students began sending messages according to their own purposes, such as love letters to one another. When the teacher discovered this, she immediately made Mailbag unavailable since she felt that the messages students had been exchanging were not appropriate classroom writing. The gap between her pedagogical assumptions and those underlying Quill was too great.

In a slightly different attempt at integration, a fourth-grade teacher tried to combine a fairly traditional writing assignment with Mailbag. The idea for her assignment came from the Quill *Teacher's Guide*, where we had described a "Classroom Chat" activity, based on a popular newspaper column called "Confidential Chat." In the newspaper prototype, writers send anonymous letters describing their personal problems; they usually adopt a pseudonym that refers to their situation (e.g., Hassled Mom or Concerned Commuter). Quill's variation had students sending anonymous messages to the Mailbag's Bulletin Board in order to discuss personal problems anonymously with others students in the class. Mixing the pseudonymous personal consultation idea of Classroom Chat with a more traditional teacher-directed writing assignment, the teacher sent the following message, complete with pseudonym:

Dear Classy Computer Kids,

There are five members in my family and only one shower. Because I'm the youngest member of our family, I'm the last one in line to take a shower. By then, there's usually no more hot water and not too much time for me to wash behind my ears! It's a horrible way to start a day. What can I do to solve this problem?

Cold, late, and dirty,

I. Needabath

The following tongue-in-cheek student response hovers between reality and fantasy, much as the original letter did:

Dear I. Needabath,

I think you should tell the first person that takes a shower you have to go to the bathroom. Then they should let you go before they take a shower. Quickly lock the door and take your shower. You will have enough of time to wash behind your ears.

Sneaky and Desperate,

Kerry N. and Jenny B.

An interesting problem emerged in this activity because of the conflict between the teacher's goals and the presuppositions of Mailbag. The form of the teacher's message mimicked that of the standard confidential chat letter, but the students in the class all knew who had sent the letter and, even more important, that it posed a fake problem. Thus, their assignment was to pretend they were answering a real letter from a needy person, while knowing it was an imaginary letter from their teacher. While students produced imaginative replies, we observed that students were confused about their audience (their teacher or I. Needabath) and their purpose (real or fantasy) while they were writing. This lack of clarity was most obvious when they were signing their names; many were not sure whether to use their own names or to make up clever pseudonyms. In this situation, the teacher's assignment worked only weakly as an attempt to integrate two inconsistent pedagogical goals.

Teachers were not the only ones for whom Mailbag offered new opportunities for integrating technology with personal goals. In several classrooms, students found in Mailbag, a new and unexpected way to pursue their own purposes in school. Students in Syd's fifth-grade class in Juneau discovered that Mailbag could serve an unexpected purpose in their relationships with others in the classroom. One of Syd's students "saw himself without friends"; Syd worried about both his academic and social development:

He chose late Friday for his time [on the computer] *so he could miss it, not realizing that more often than not, late Friday was the easiest time for me to be his partner. The other children, in spite of their ugliness to one another, were able to sense his feelings and began writing* [Mailbag] *letters telling how much they liked him and that they wanted to be his friends. There is no way to describe the face of this handsome, brown-eyed boy as he read these notes, frequently slipped into his desk anonymously. He sat near me for obvious reasons and I would watch him remove one and literally clutch it to his chest.*

Syd's students, having learned the power of writing, chose to use it to be kind to a troubled student with whom face-to-face communication was difficult.

Many students in field-test sites in Alaska used Quill to answer a pressing communicative need; they were unable to be in touch easily with people outside of their own villages and they had no way of meeting new people. Partly in response to their needs, the Quill project in Alaska instituted a long-distance network, implemented through a combination of human travel and U.S. mail (Barnhardt, 1984).

On one of our trips through Alaska to visit classrooms, we carried a disk called "Supermail." This was a very slow, but still effective, way to carry electronic messages from one village to the next, when even dialup connections were rare and unreliable. The Supermail disk facilitated communication for some students in Nikolai, as Don, their teacher, explains:

What made this activity fun for my class was the fact that Chip had just come from Telida and the most recent messages on the disk were from cousins and playmates upriver. This connection made the notion of sending hellos to strangers Outside seem less threatening.

Don reflects his students' view of the world by referring to the rest of the United States outside Alaska as Outside, to them a vast and little-known area. The Supermail disk provided an opportunity for the students to be in touch with the outside world;

it made the transition gradual by allowing them to expand their understanding of communication from a familiar audience to a larger and unfamiliar audience Outside.

The crucial point for us here is that Supermail was nowhere envisioned in the original Quill design, or idealization. It didn't exist at all for most Quill classrooms and users. Instead, it emerged from the unique social and geographical situation of Alaskan village schools, and was thus as much a new technology as any other Quill component, although one created through use. For some in Alaska, Supermail became a salient part of the Quill experience. In a standard evaluation approach, we might footnote it as a user adaptation of the pre-existing program; with situated evaluation we describe it as an innovation created through practice.

It may be helpful to refer to Dewey's (1922) critique of the dualism of means and ends. He discusses how "means and ends are two names for the same reality"; that they are convertible, one into the other:

Only as the end is converted into means is it definitely conceived, or intellectually defined, to say nothing of being executable. Just as end, it is vague, cloudy, impressionistic. We do not know what we are really after until a course of action is mentally worked out. (p. 29)

Standard evaluations tend to assume a separation of means and ends: The program is a known, fairly well-defined means and the desired outcome is a known and somewhat fixed end. Situated evaluation, in contrast, assumes that means are created as much through use in a community or classroom as they are through development in the lab. Ends emerge as well, reflecting those new means. Supermail was an innovation created through use, because of ends that were unknown during development, or at best "vague, cloudy, impressionistic." Its creation defined new ends for the participants.

conclus Ion

In the Quill study, the use of Mailbag for purposeful writing is only one area in which alternate realizations of Quill arose. In every case in which Quill raised significant pedagogical issues, teachers had to confront the relationship of their past practices to those implied by Quill. This resulted in a variety of solutions to the need to integrate Quill with sometimes disparate goals, values, and practices.

Our analysis views these as creative solutions to the complex and ill-defined problems teachers or, for that matter, anyone, must solve when presented with an opportunity to change. As we see through this study of Quill in use, an innovation is not an object that can be packed inside a box, but rather a set of practices that emerges from the social setting of its use. Thus, in a sense, the user does not accept or reject an innovation but instead creates it through action in the world.

The key notion about situated evaluation, as also shown in the Quill study, is that it does not postulate an *a priori* innovation to be used in various settings. Rather than investigating the practices or impact based on such an innovation (as formative or summative evaluation would do), it seeks to discover what innovation comes into being through practice.

Accordingly, situated evaluation highlights the power of the social context to affect the use of a new technology. How the features of the technology interact with human needs, expectations, beliefs, prior practices, and alternative tools far outweighs the properties of the technology itself. This does not mean that we ignore the influences of developers' visions and technical designs. Instead, we seek to develop a holistic understanding of an innovation as a mutual adaptation between technology and its situated social settings. This understanding of the idealization and various realizations of an innovation can help improve further re-creations of a socio-technical system.

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ke Y ter Ms

Situated evaluation: An approach to uncovering or articulating the emergence of innovations through practice, assuming that innovations are mutually constituted by social practice and some external input.

The innovation-in-use: Different ways in which the innovation is realized and thus created by diverse users. Situated evaluation, which is open to new variables and sensitive to alternate uses and interpretations, focuses on understanding *innovation-in-use.*

Idealization: The elements of the innovation as intended by developers.

Realization: The ways the innovation was used, modified, and re-created by users *in situ*.

Appropriating technologies: Users actively rethinking the meaning and use of a technology and reinventing its practices within their situated, cultural contexts.

Technocentrism: The tendency to focus on technological artifacts or mechanisms to the exclusion of social, cultural or historical perspectives.

e ndnote

1 This chapter adapts portions of *Electronic* Quills*: A Situated Evaluation of Using Computers for Writing in Classrooms* (1993) by Bertram C. Bruce and Andee Rubin.

Chapter XLVI
Cultural Appropriation of Software Design and Evaluation

Heike Winschiers-Theophilus
Polytechnic of Namibia, Namibia

a bstract

Communities all over the world have established their own value systems which do not necessarily correlate with the intrinsic values of technology. The account of internationalization and localization of information technology reveals that an abstraction of the receiving societies' culture leads to the design of unusable and unwanted socio-technical systems. Cross-cultural research extrapolates major challenges of current development practices. Longtime established methods, understandings of quality concepts, and metrics of socio-technical systems can no longer be assumed to be universals. Thus the author argues that as much as the design of socio-technical systems has to be synchronized with the target community so does the design and evaluation process itself as well as the underlying quality concepts. Empirical research in the design of information and decision support systems in the Namibian context demonstrates the need for a change of paradigm in socio-technical system design and supports the presented culture-driven design framework.

Introduct Ion

Technological innovation has progressed with breathtaking speed during the last decade. Especially in the field of information technology where people are under constant pressure to keep abreast of development be it at work or in their private space. Although technology is intended to be used by every citizen, not all can manage. Societies are divided in "technological know and know nots". The socio-technical gap is widening by the day as the technologically skilled are the one's continuously driving technology further. However in socio-economical terms, all communities are targeted to use technology. Researchers and practitioners worldwide are facing numerous challenges in developing usable systems for specific socio-cultural contexts. Crossing disciplinary or cultural boundaries implies that one should reconsider conventional assumptions, concepts and methods (Winschiers, 2006). As much as artifacts are cultural so are processes, thus software as well as their development method-

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ology are not universally applicable. The invalidity of established design methods and concepts is best explicated with case studies from a society where the value system is highly distinct from a technological society. Our experience is based on the design and evaluation of information and decision support systems in Namibia, a southern African country. From these case studies, similar evidences from the literature and theoretical models, lessons can be learned informing appropriate socio-technical system development.

Culture in this chapter shall be seen as an orientation system including values, beliefs, and behaviors of a group sharing genuine or virtual reality. An important aspect of our debate is to consider culture as much as a structure and a process as defined by cross-cultural psychologist Boesch (in Eckensberger, 1997): Culture represents the field of action which it induces and controls and is also continuously transformed by it. Thus considering culture in relation to the action of software development implies that culture induces and controls the development but is at the same time transformed by it. The dynamic and mutual interdependence of culture and information technology has become apparent through manifold experiences of technology transfer, internationalization and localization efforts and cross-cultural design.

t he Intrinsic c ulture of t echnology

It has been acknowledged widely that Information Technology represents the culture and worldviews of its creators. Functionality as well as user interfaces of the world-wide-web and other IT applications being determined mostly by western, male, middle-class representatives are highly cultured and gendered.

Luis Hestres (2003) has identified features reflecting the American culture, such as individuality, low-context communications, competition and cooperation, business, tight time management, and high work ethic in Microsoft Outlook. Information and knowledge architectures in web-applications match with the predominant western classification scheme (Winschiers and Paterson, 2004). The worship of values, such as rationality, instrumentalism, effectiveness, efficiency, and competence in technologically driven societies promotes continuous transformation of technology and society in line with the professed objectives. Software products preserve those values through explicit quality formulation as part of the software development process. A typical software specification comprises functional requirements as well as software quality attributes. The software is designed and evaluated in accordance with specified quality criteria. Major architectural and interface decisions are guided by the quality attributes specified thereby fully incorporating those values. Common software quality attributes are Safety, Understandability, Portability, Security, Testability, Usability, Reliability, Adaptability, Reusability, Resilience, Modularity, Efficiency, Robustness, Complexity, and Learnability (Sommerville, 2004). The definition of "*usability*", (or user-friendly) furthermore, incorporates its origin from a modernist or enlightenment tradition. It is commonly described in terms of time to learn, speed of performance, error rate, retention over time and subjective satisfaction (Shneiderman and Plaisant, 2005). Consequently, industry-recognized methods for evaluating a system's usability focus on efficient and accurate performance (Badre, 2002).

However empirical research with Namibian user groups has demonstrated a deviating understanding of a "usable" socio-technical system. It was associated with terms such as *trust, communicative, easy, comfortable, conducive* (Winschiers and Fendler, 2007). Allen and Buie (2000) have further examined how different frequently used terms in Usability Engineering, such as "intuitive", "user-friendly", "logical" could be compromised. They conclude that if a common meaning is not ensured among the concerned group a software solution is created that is different from the one intended.

Cultural Synchronization of Technology and User Community

A number of western non- mainstream sub-communities, such as elders, unemployed youth, as well as other nations, sustain different values from those currently incorporated in technology. A successful implementation of Information Technology is often declared to be dependant on the receivers' cultural ability to assimilate the technology.

The contrasting success of Information Technology conformity is best exemplified by the Asian versus African culture. Considering the development of the new industrial countries in East Asia, the dominating value system of Confucius, with an emphasis on high productivity and self-discipline, favors the introduction and assimilation of technology. This is sufficiently illustrated by the present Information Technology status of those countries. On the other hand many systems are reported to be failures in Africa as a result of the cultural mismatch between the imported and indigenous culture. African communities attach importance to tradition, respect especially for elders' wisdom and experience (Kopytoff, 1968) as opposed to technological values of progress, rational and instrumental thinking. Tradition represents an essential part of contemporary Namibian culture as guarded by the elders thereby preserving their authority. (Winterfeldt, 2002) These facts are essential parameters to be considered in software design and evaluation as we will demonstrate later in the chapter.

Attributing software project failures to the receivers' culture however disregards the mutual dependency and possible dynamic of receivers' cultural influence on Information Technology. Culture, as well as Information Technology is both in an interdependent transitional evolutionary state. It has to be recognized that for any socio-technical system to be workable and sustainable the culture of the technology and the community must be synchronized.

Cultural Adaptation of Software Development

Many researchers and practitioners are concerned with the design of socio-culturally valid and acceptable systems. Two different approaches are mainly followed: Either, exploring cultural models for product adaptation and development or, local software development with user involvement. However, both approaches still face numerous challenges which will be elaborated in the following parts.

Cultural Models in Internationalization and Localization

Localization of software products is often no more than national customization, comprising translation of user interface languages and adaptation of display and layout, such as currency, measurements, icon symbols and color schemes. To minimize re-engineering time and cost, internationalized software incorporates the distinct localization options in the software design (Hogan et al. 2004).

The focus of internationalization and localization is on fast and superficial product adaptation. Developers unfamiliar with most target cultures have no choice but to rely on design guidelines and cultural models. For example Trillo (1999) refers to Fernandes' nine design rules for international user interface design which lists issues of language, visual communication, appropriateness of features and aesthetics to consider which are specific for different countries. These guidelines however only refer to superficial aspects of the user interface. In the mid-nineties, Del Galdo and Nielson (1996) already suggested an addition of two more levels to internationalization of software, namely the adaptation of usability methods to specific countries and the design of user interfaces to fit cultural models of how people work and communicate. Many researchers launched into the investigation of the viability of cultural models for software design. Among the most known cultural models quoted in Human Computer Interaction literature are Hall's, Victor's, Hofstede's and Trompenaar's (Shen, 2000, Hoft 1996). Hofstede's cultural model (Hofstede, 1997) distinguishes the following dimensions: Power-distance, Collectivism vs. Individualism, Femininity vs. Masculinity, Uncertainty avoidance, and Long vs. Short-term orientation. Among others, Marcus and Gould (2000) derived guidelines for user interface and web design, such as the information structure, hierarchies, and security features should be aligned to the level of the power distance. On the other hand, Ford and Gelderblom (2003) found no correlations between the use of websites displaying cultural dimension specific characteristics and South African users' performance. Thus derivations of cultural dimensions into specific user interface design rules often lead to inadequate generalizations (Winschiers and Fendler, 2007). Fitzgerald (2004) concludes that cultural dimension models are aimed at a description of culture rather than as a directive for user interface design. Cultural models can be seen as national user models, which are highly abstract thereby omitting important local nuances. Besides the design being based on abstract user models, evaluation is also often done with country representatives only rather than the real end-users. Internationalization and localization can no longer take shortcuts if the implementation of usable and sustainable software is intended. Hence cultural models and their use have to be further refined to support the implementation of culturally synchronized socio-technical systems.

Local Software Development and User Involvement

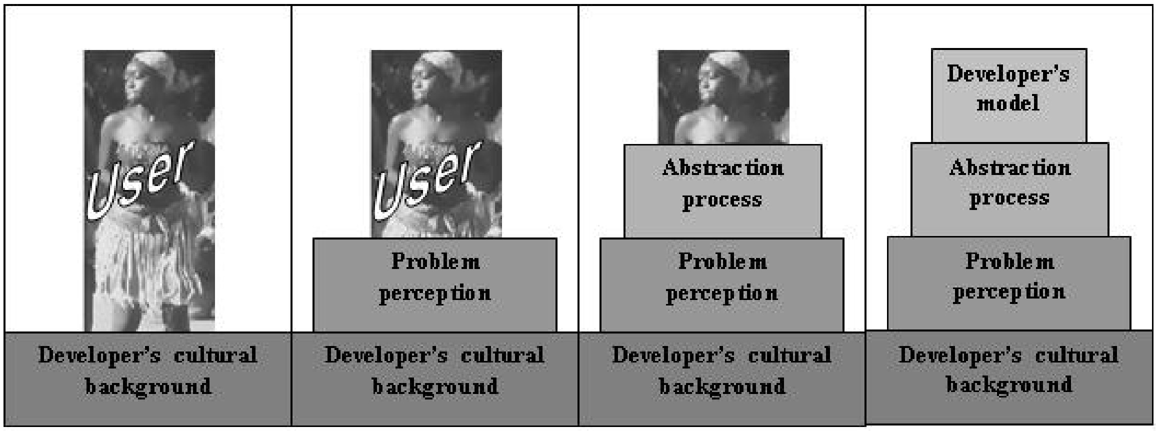
The field of software engineering is constantly evolving in line with new demands. In an attempt to design usable and acceptable systems, methods such as extreme programming and agile development, user-centered, interaction and participatory design were embraced. A general consensus on the importance of user involvement among software engineering practitioners and researchers has been reached. However the concept of user involvement is only loosely defined and therefore varies greatly from one development context to the other. Moreover, the contribution of user involvement is not systematically evaluated as part of a common software development process. Hence although software developers have involved end users, the latter judge the implemented system to be non acceptable and non usable. An investigating into cross-cultural software development reveals the impact of a developer on the design of a socio-technical system.

Developers' Model Monopoly

The developer takes the role of a facilitator as well as a change agent in user-involved software engineering processes. In participatory action research and critical design ethnography this double role has been experienced to be problematic. Conversely in common software engineering the developer creates a system model based on the merged viewpoints of the stakeholders. However modeling uses decontextualization followed by embedding as re-contextualization: whatever is considered important for a specific purpose is abstracted and represented (Floyd, 1997). Thus the model always epitomizes a subjective world, which depends on the judgment of the modeler of what is perceived as important. According to findings in developmental psychology, the maturing perception may be seen as an active interpretation process of reality depending on one's cultural background (Mueller, 1991). This has serious consequences on the belief of objectivity in system modeling as part of the design process. As pictured in figure 1, the developer although involving the users, considering their viewpoints, perceives the problem at hand depending on his/her cultural background. The system model is then based on the abstraction of what the developer perceives to be the problem. Thus the model is a recreation of the developer's reality in which the perspective of the user is swallowed. Moreover, the monopoly of the model is preserved through a symbolic representation thereby maintaining an asymmetric design (Bråten, 1983).

Consequently the design of the system once more reflects the values of the designer rather than of the target society. The developer's influence can

Figure 1. Developers' model monopoly



only be minimized through an increasing true user involvement.

Cross-Cultural User Involved System Design and Evaluation

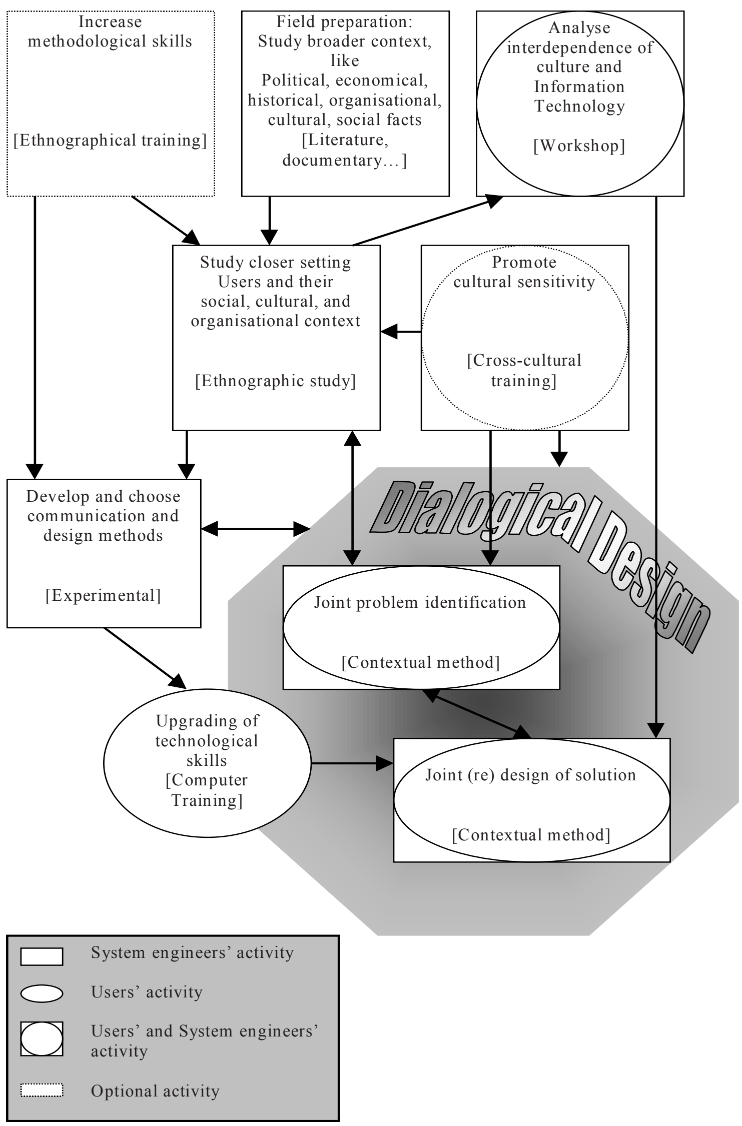
A great number of successful participatory design practices, principles, methods and tools have evolved mainly in the northern hemisphere. For example, one effective method to obtain user requirements and feedback is prototyping, which is used in different developmental stages and variations. This however assumes users being willing and able to express their criticism, suggestions and needs. Yet in our experience in Namibia, prototyping was rather counterproductive in the sense that users did immediately approve the prototype to be the end product no matter in what state the prototype was. Analyzing the cultural context provides ample explanations: among others, the traditional respect for seniors (in this case the system developer) who should not be criticized no matter what. Moreover, a common Namibian custom of taking what one is offered contributes to the acceptance. Likewise the use of questionnaires, which is a highly effective, quantitative method in a western context embodying the predominant values of time-saving and in line with the tradition of writing and data integrity. Yet in our studies, most Namibian users filled out questionnaires with the assumed expected answers irrespective of reality. This phenomenon is in line with the observed communication convention of "listener satisfaction" and conflict avoidance. (Winschiers, 2001) Similar accounts on the unsuitability of common participatory design methods can be found in the literature. Trillo (1999) reports on the usability expert from New York who does not understand why the females in his focus group in Tokyo did not participate. Vatrapu and Pĕrez-Quiñones (2006) experienced that usability problems are masked rather than uncovered within structured interview sessions when the usability expert and the user are from different cultures. Based on further case studies in developing countries, Puri et. al (2004) argue that participatory design and the implementation of ICT in developing countries bring in new challenges to fostering and nurturing participation. Thus participatory design in a cross-cultural context goes beyond the involvement of users in the design of the product but should include an appropriation of the design process itself (Winschiers, 2006) to be truly participatory. Similarly, standard usability evaluation comprises a dual bias through the technocratic definition of usability fostered by the choice of related methods (Winschiers and Paterson 2004). Thus in software development the success of the methods depend on their compatibility with the cultural context.

A Culture-Driven Design Framework

Each socio-technical system development unfolds within its own unique socio-cultural design context, where concepts need to be redefined, adequate methods to be determined or created, best practices established and applied, and process evaluation mechanisms put in place.

A dialogical approach encompassing all stakeholders promises to be most successful. Software development should no longer be a "solution matching problem" procedure but rather a mutual learning one and an exploration towards a creative design process. However to enable such a development to take place an inclusive structure has to be established. Figure 2 presents a usable framework to ensure culture-sensitive development of socio-technical systems. Before plunging into the software design itself, a common understanding of the development context has to be established. Thus the users should upgrade their technical knowledge. Software engineers are to develop cultural

Figure 2. Culture-driven framework for dialogical design (Winschiers 2001)



sensitivity by reflecting on their own ethnocentric perspectives as well as those of others in order to acquire a polycentric or ethno-relative viewpoint. This enables software engineers to understand, accept and integrate differing user perspectives into processes of system development. Development of cultural sensitivity and intercultural communication competency to guide the dialogue ought to be formally promoted through cross-cultural training programmes. Ideally, users should participate in such training to facilitate symmetric exchange of viewpoints within such a dialogue. Based on the knowledge of a cultural context and experimental evaluations of methods, adequate methods for the software design and evaluation can be determined. A joint problem identification and design contributes to the locally adequate conceptualization of technology. (Winschiers 2001)

A contextual realization of the culture-driven framework will be demonstrated through the Namibian case studies in the next section.

Culture-Driven Software Design and Evaluation in Namibia

This section presents the results of empirical research on a cultural adaptation of software concepts and methods in the Namibian context. The different activities comprised in the culture-driven framework have been carried out at different occasions and been considered in the design and evaluation phase. Experimenting and evaluating participatory design and usability engineering reveals a number of good practices as well as locally inadequate methods. We first set the scene with a short description of the Namibian context relevant to software development followed by specific design and evaluation scenarios.

Namibian Cultural Context

Namibia, a low-populated southern African country, is home to many different ethnic groups and has a high disparity in socio-economic terms. English is the national language although it is the home language of only three percent of the population. As part of its national development goals Namibia is striving to become a knowledge-based and technology driven nation. However major constraints are the lack of adequate numbers of qualified personnel, too low disposable household income and lack of access to electricity in rural areas, which limits access to ICT services. Another aspect is the lack of a reading culture, which is the result of a low literacy rate. Also lacking is an enabling policy and enabling environment that allows private initiatives and entrepreneurs to deliver technology solutions that suit low-income groups. (Namibian Third National Development Plan, 2007)

In terms of cultural dimensions as outlined in Hofstede's (1997) cultural model, Namibia has a high power distance and a relatively high collectivistic culture. Authoritarian societal structures have been shaped by the African tradition and over 100 years of colonialism. Respect and obedience is expected towards elders, parents, teachers, chiefs and superiors. A consequent "culture of silence" displays an absence of criticism and expression of individual opinions towards authoritative figures (Winschiers, 2001). On the other hand there is a strong sense of community manifested in the extended family structures. For all major household decisions family meetings are held. Participation is the keystone of traditional African society (Taylor, 1963; Setiloane, 1986; Shutte, 1993).

Most of the local software is developed by foreign consultants or by some of the few previously advantaged Namibians. The end-users are mainly from previously disadvantaged groups from a different cultural background. Common attitudes of Namibian users are fear, mistrust of the (foreign) consultant, low motivation and reluctance leading to their hiding or falsifying relevant information. (Winschiers, 2001)

Figure 3. IRAS usability evaluation workshop

Contextual System Design and Evaluation

We have run a number of participatory design and usability evaluation workshops as part of different Namibian software development projects. Workshops have proven to be more successful than individual techniques of requirement elicitation (questionnaires, interviews) and usability testing. Collective methods match with the community culture and joint decision taking habits of Namibians. The user groups enthusiastically engage in discussions around their work and how to improve it with technology. For example, Figure 3, show cases one of the usability workshops in which small groups of wildlife managers determine the usability of an information system.

All our workshops are structured in a similar manner:

First, the users elaborate on their understanding of system quality, e.g. they establish their own meaning of "usability", in general and in relation to information technology.

This determines which quality attributes the system should be designed for or evaluated against.

Second, a discussion session is conducted on the content of the participants' work. In this section the developers learn what is considered to be important, how decision and information processes take place, who is involved and what the workflows are. This determines how the system should operate and be evaluated.

Third, the system is designed or evaluated using different methods depending on the context. Here, the developers obtain specific requirements for the (re)-design of the system. An evaluation of this session also contributes to the pool of good practices and invalid methods for a specific context.

In the following section we present different episodes from the various workshops illustrating the distinctive context.

Phase 1: Determining Contextual Quality Values

Usability Evaluation Experience:
In our usability evaluation of a wild-life information system for Namibian wildlife managers, the users were given a scenario task. One elderly user did not launch in the search for the complementing information on his side to answer the question but was looking for the facts that he already knows. After he could not find those he decided that he can not use the system as the system "does not even know what he knows, so how should he trust it".

Contextual explanation:
In the Namibian society, information is usually passed on by the elders, who are considered trustworthy and more knowledgeable than oneself. Naturally to evaluate the competence and trustworthiness of an unknown (human) informant one would ask a question to which one knows the answer to measure their knowledge against one's own.

Comments:
The user changed the originally planned focus of the evaluation which was intended to check whether the system supports an effective and efficient solving of the task. Yet the user given the task first checked whether the system is competent and trustworthy. This demonstrated that the user had a different understanding of what was to be evaluated in order for the system to be usable.

Lessons learned:
A clear understanding of the characteristics of a usable system has to be defined by the user group and integrated in the design. In this case the trustworthiness should have been established by including users' knowledge into the information system before evaluating it. Evaluation methods have to be culturally adapted to the user group. Moreover, in a cross-cultural setting, more than in any other context, unexpected process deviations could occur at any time and have to be catered for.

Thus all our workshops consisted of a dedicated section in which the contextual meaning of a usable socio-technical system was determined. Depending on the familiarity of the participants with English, the terms were translated, as well as the discussion took place, in their mother tongue. The conceptualization groups consisted of three to six users.

Initially the participants were asked to intuitively react on their personal associations regarding the words "usability" or "usable". All terms mentioned by the participants were immediately collected on small pieces of manila. Then they were asked to describe their ideas of a "good working environment". Once again the descriptive terms were collected and written on small pieces of manila. In the third phase, all pieces of manila were placed on the table for the participants to select the ones which apply specifically to information technology. In the last phase, a dartboard was placed on the table with the pieces of manila on which the selected terms were written. The participants ranked the terms according to importance by placing them near or far from the center. (Stanley, 2006)

Across the different user groups the terms mentioned the most frequently were easy, safe, comfortable, specific, reliable, right pace, goal-oriented, and conducive. Interestingly only one group, consisting of only white farmers, mentioned time saving. None of the other groups mentioned terms commonly associated with usability such as speed, learnability, memorability, or error rates. This confirms our hypothesis that the concept of usability is different in the Namibian context. The current data set is insufficient to make a statement as to whether there is a Namibian connotation or whether it is user group specific. Further research should be done also in other countries to discover patterns.

Phase 2 Work Related Session

The participants are given different work-related scenarios preferably controversial so as to engage them in a discussion. On the one side, the flow of thought and discussion can be observed. On the other side, design decisions such as features, content and information architectures can be derived. Scenario techniques are suitable methods in Namibia as they mirror the local narrative culture; and furthermore scenarios create high context to successfully engage users in task design and evaluations. Embracing these techniques as part of the development process of Information and Decision Support Systems helps to assure cultural validity, thereby enhancing community acceptance and usage.

One of the most important lessons we have learned from the design and usability workshops held with farmers, extension officers and wild life mangers is that they are in no way individualists looking for scientifically proven information but are part of a geographically dispersed community ready to share their own experience and knowledge and listen to others. This fundamentally changes the design idea of information and decision support systems. Thus one of our decision support systems in the field of bush encroachment has evolved from a highly sophisticated rule-based decision system containing scientific expert knowledge to a wikipedia-like system offering the user community a platform to create and exchange local knowledge.

Phase 3: System Design and Evaluation

In the last phase the users are no longer intimidated by the developers in comparison to the previous sections of the workshop which were dominated by the area of expertise of the user group. Different methods have been tried in the design phase such as paper prototyping, card sorting, game development, scenario development in writing, drawing or as a role-play. Besides game development all techniques lead to successful though incomplete designs. Using game development for participatory design has become popular recently. However, even in the teaching context Namibian students have been complaining about the seeming non-seriousness of the method.

For system usability evaluation we let the user play around with the system, ask questions if needed and let the user attempt to solve a real problem. We have one observer per user, screen and user recording software. We then interview the user so as to find out about the perceived usability of the system. The first few workshops included a user satisfaction questionnaire. However we have identified the invalidity of the data through triangulation with the observation and the interview data. We therefore abstain from using questionnaires. It was interesting to note that the commonly assumed correlation between user satisfaction and efficient and effective task completion does not hold in the Namibian context, as users did not complete their tasks but were still satisfied and believed they had mastered the system (Winschiers and Paterson, 2004). Furthermore we confirmed results of an observation from the literature (Vatrapu and Pĕrez-Quiñones, 2006) about the relationship between the user and the observer/tester/interviewer that is if they are from the same ethnical group the results are better. Also the given pair choice indicated that ethnicity in Namibia seems to have priority over gender association.

c onclus Ion

Theoretical as well as empirical research has demonstrated the mutual interdependence of culture and technology as well as the impact of culture on software development. Technology as well as the development process incorporates the value system of the developers. E.g. standard usability evaluation methods encompass a twofold bias. Firstly, through the definition of usability according to western standards and secondly, through methods which aim to test an already biased objective. User models and cultural models being abstract representations of reality cannot replace user involvement. Socio-technical design requires a contextual re-definition of quality criteria and a determination of valid development methods. Cultural models can inform local appropriation of design and evaluation methods. Besides, it has to be recognized that user involvement should go beyond the participation in the design of a product to a decision on the process. We have developed a culture-driven design framework which can inform socio-technical design aiming for usability and acceptance. Case studies from Namibia have demonstrated the need to adapt software design and evaluation methods. Yet we are only at the beginning of a new era of contextual socio-technical development. Much more research needs to be done in exploring methods and their evaluation within the software development process. Only through enhanced cross-cultural and cross-disciplinary dialogue can new knowledge and practices be created at the frontiers enriching rather than standardizing the design of socio-technical systems.

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KEY TERMS

Cultural Model: A model consisting of cultural determinants/ variables which can describe and distinguish different societies.

Internationalization: Designing Software for easy local adaptation

Localization: Local adaptation of software products

Participatory Design: Users are actively involved in the design process. It is rooted in trade unionist movements of cooperative workplace design. Thus in some instances it has a political dimension of user empowerment and democratizations.

Section VII
The Future of Socio-Technical Systems

How will socio-technical systems evolve in the future?

This section takes the next step beyond socio-technical systems today to consider socio-technical systems tomorrow. Much of what happened in computing in the last decade took us by surprise—can we do any better for the next decade? This section addresses questions like:

1. Are there visible trends in socio-technical system development?
2. What are the barriers against and supports for socio-technical evolution?
3. What are the choices we face in a socio-technical future?
4. What socio-technical goals should we seek to achieve in the future?
5. What is the role of socio-technical systems in the development of computing?
6. What should we as individuals do to help things along?

Prologue
The Future of Socio-Technical Systems

Charles Steinfield
Michigan State University, East Lansing, USA

Like it or not, we live in interesting times. They are times of danger and uncertainty; but they are also the most creative of any time in the history of mankind.

—Robert F. Kennedy

This is an interesting time to be studying ICTs from a socio-technical systems (STS) perspective for many reasons; in this introduction I will focus on two that have implications for the future of STS research. The first reason has to do with the notion of *context* - a core aspect of STS theory. Much of the early STS research emphasizes work settings as the context for technology design and use, derived from such foundational work as Emery and Trist's (1960) studies at the Tavistock Institute for Human Relations. Even in the intervening years, as STS theories were applied to computers and information systems (e.g. Mumford, 1983), the focus remained on the workplace since that is where these systems were concentrated. Even recent articulations of STS theory and research have an organizational orientation, albeit expanded to include the complex interactions between computer systems and society at large (e.g. Kling's (2007) efforts to define a field of *social informatics*).

This work and organizational focus is no longer adequate today. ICTs have permeated all walks of life—in and outside of the workplace, for productive activity, for socializing, and for pure entertainment. Indeed, some of the most interesting new trends in the use of ICTs are emerging outside the workplace (e.g. consider young people playing a location-based game via mobile devices). Support for socializing and entertainment are core aspects of many new media such as online social network sites, games, and mobile content and services. A number of the chapters in this section recognize that ICTs are used in all aspects of everyday life, which creates challenges for how STS researchers define the context in which technologies are designed and used. In large-scale online social network sites like Myspace and Facebook, for example, it is difficult to define the social context of use. Not only are the lines between online and offline activity blurred, but

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these services have become so large they transcend any semblance of organizational, geographical, or national boundaries. One problem this creates is that people operate in many distinct communities with sometimes overlapping network membership, but the information they wish to share with others differs depending on the situation. A Facebook profile element about ones' relationship status may not be appropriate for work colleagues, and we may wish to share some photos with close friends that we do not share with co-workers.

The authors in this section recognize that this more expansive set of context domains is both a challenge to efforts to improve design through a greater understanding of the social context of use as well as an opportunity to find new ways to explore the evolution of social rules and norms in these new media. Just because usage is occurring in other places besides the workplace does not make it any less important. And, if we extend this issue to include the design of ICTs by large, distributed, and loose-knit communities of developers such as open-source communities, we can easily see the challenges for STS research. There are crucial social, psychological, and economic payoffs to improved design of these services that can come from a STS perspective - from improving designs, to enhancing peoples' abilities to form and maintain social capital, to improving services to consumers through better e-commerce mechanisms, as chapters in this section illustrate.

The second issue that will influence future STS research derives from the fact that ICTs increasingly are infused with traces of human activity that can be captured and leveraged in the production of services. This, in itself, is not a new idea. Zuboff (1988) observed that modern information technologies do more than automate—they "informate" by capturing informational byproducts of transactions. However, as with other contemporary work, Zuboff's emphasis was on organizational contexts, with the information byproducts viewed as something useful for management decision-making. Today, these traces of human activity are often essential features of so-called Web 2.0 services, supporting what has been termed *social navigation* (Dieberger et al, 2000). Services such as the newsfeeds on Facebook, recommendation systems for e-commerce, and Geo-tagged photos for tourism services, are examples of applying information collected unobtrusively to create new value for users of ICT-based systems.

The future of STS research will be intertwined with this emerging philosophy of Internet-based service design. These traces of activity not only provide useful information to other users, they also provide data for researchers that can help them deal with the many ambiguities raised by the first issue - the broader contexts in which ICTs are used. These information trappings give rise to new tools to better understand social structures and behaviors in online contexts (Smith, 1999). And this data is certainly of use to designers, enabling an almost real-time feedback loop between users and designers. Indeed, as the information contributed from users becomes a more explicit component of the service, the lines between user and designer become blurred, which is itself a fascinating topic to explore in STS research.

The expansion of ICTs into all walks of life, and the growing ability to capture and re-use information are, of course, double-edged swords, opening up unprecedented opportunities for innovation in service design on the one hand, as well as ever-more intrusive windows into the private lives of people on the other. STS researchers do indeed live in interesting times.

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Chapter XLVII
Resolving Wicked Problems through Collaboration

Peter J. Denning
Naval Postgraduate School, USA

a bstract

Wicked problems (messes) are tangled social situations that are too costly to stay in and too intransigent to get out of. Collaboration is essential to resolving them. This chapter examines five main ideas: (1) Messes and wicked problems are the most difficult in a hierarchy of difficult problems.(2) Why mess resolution usually involves disruptive innovation. (3) Why collaboration is essential and hard to achieve. (4) Collaboration is a practice generated in six kinds of conversations. (5) Someone who understands the practice of collaboration will find many information technology tools to help with the process: exchangers, coordinators, and games, and can design better tools.

Every revolutionary idea seems to evoke three stages of reaction: It's completely impossible. It's possible, but it's not worth doing. I said it was a good idea all along.

—Arthur C. Clark

The Americans can be counted on to do the right thing, after they have exhausted all the alternatives.

—Winston Churchill

Introduct Ion

The question is simple enough: "How can we resolve a mess, a tangled social situation that is too costly to stay in and has no obvious way out?" Messes are also called wicked problems. The various players cannot agree on the nature of the problem or on solution approaches. Their search for solutions

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produces few results and seems open-ended amidst constantly shifting constraints (Denning 2007, Roberts 2000, 2001). The end state is a moving target (Reeves 1991). The purpose of this chapter is to shed light on effective strategies for resolving messes and the technologies available to support those strategies.

We will investigate four main ideas: the nature of messes, why mess resolution is likely to involve disruptive innovation needs collaboration, strategies for organizing collaboration to confront a mess, and technology tools to support collaboration. Most existing "collaboration technologies" are good for information sharing but not true collaboration. However, someone who understands the practice of collaboration will find many tools to help with the process.

sol VIn G hard Proble Ms In soc Ial s Yste Ms

Let us begin by considering messes as a category within a hierarchy of difficult problems. We use the word "system" to mean either a social or natural system.

Problems come in four categories of difficulty (Table 1). The simplest are the ones where the solution knowledge already exists, either in one's own domain (Category I) or in another (Category II). The more difficult require the construction of new knowledge. When the system of interest is complex and governed by fixed (but unknown) laws, its reproducible behaviors can be discovered through experiments (Category III). When the system of interest is complex and adaptive, it tends not to have reproducible behaviors; it adjusts its responses and neutralizes repeated probes (Category IV). The last category is the abode of messes and wicked problems.

These categories blend together ideas from Kurtz and Snowden (2003) and Roberts (2001). Kurtz and Snowden discuss the notions that Category III problems may be complex natural systems governed by unknown laws waiting to be discovered, and that Category IV problems are complex social systems. Roberts lumps our Categories I and II into a single class ("simple problems") and uses the terms "complex problems" for our Category III and "wicked problems" for our Category IV. These categories represent the degree of agreement among the social power centers about the problem and its possible solutions. The simple problems are those in which everyone agrees on the problem definition and there is a power center that can implement the change. The complex problems are those in which everyone agrees on the problem definition, but there is no consensus among power centers on how to proceed. The wicked problems are those for which there is no consensus on the problem definition or on the solution approach, and partisan interests block collaboration.

These categories suggest a strategy for solving a problem of unknown difficulty. We start with the hypothesis that our problem is of Category I, and then work our way upwards through the categories until we find a solution or know that we confront a mess. If our problem is Category I or II, we will

Table 1. Categories of problem difficulty

Name	Category	Characteristics	Actions
Simple Problems	I	Solution knowledge exists in your own domain	Redirect attention.
	II	Solution knowledge exists in another domain	Find an expert. Become an expert and design own solution.
Complex Problems	III	No solution exists in any domain; system is very complex but responds the same way to repeated stimuli	Explore for recurrent patterns by probes and experiments, design resolution around recurrences discovered.
Wicked Problems (messes)	IV	No solution exists in any domain; system is chaotic and adaptive, does not repeat patterns under the same probes	Organize collaboration in a local part of system, then spread the new organization to the whole.

discover an expert to help us. If our problem is Category III, there is no expert, but we will discover and exploit the system's recurrences for a solution. If our problem is Category IV, we will find no recurrences; we can employ the strategies discussed shortly for resolving messes.

Category III problems tend to appear around undiscovered aspects of natural systems. They demand a level of skill comparable to a cutting-edge scientist who is capable of inventing new hypotheses and validating them with experiments. Sometimes current methods and instruments are not powerful enough to discern the patterns needed to solve the problem; the solution may have to wait for a later age with finer instruments. Throughout most of the 1800s, for example, physicists hypothesized that light traveled in a medium called "ether". They could not verify this because they lacked the instruments to measure ether. In 1887 the Michelson-Morley experiment provided the instrument. That instrument's failure to detect any ether influenced Einstein's 1905 inspiration for relativity: he postulated there is no ether and light travels at the same speed in all frames (Einstein 1916).

Category IV problems tend to appear in conflicted social systems. Nancy Roberts refers to them as wicked problems:

Government officials and public managers are encountering a class of problems that defy solution, even with out most sophisticated analytical tools. These problems are called "wicked" because they have the following characteristics: (1) There is no definitive statement of the problem; in fact, there is broad disagreement on what "the problem" is. (2) The search for solutions is open ended. Stakeholders champion alternative solutions and compete to frame "the problem" in ways that directly connect their preferred solution and their preferred problem definition. (3) Resources and political ramifications are constantly changing. (4) Constraints constantly change as interested parties come and go. (Roberts, 2001, p353)

The systems embodying wicked problems tend to resist and defy attempts at change. Change occurs only when leaders achieve consensus among power centers to enact new social agreements and new organization within the system. The leaders look for ways to bring about local solutions that can be propagated to the whole.

Candace Lightner founded Mothers Against Drunk Driving in 1980 as a response to a wicked problem: the widespread tolerance of drunk drivers and their annual carnage. Lightner and her colleagues showed great skill in attracting media attention and in gaining the support of politicians for new laws. (See www.madd.org.)

Messes as soc lal t an Gles

Here are fifteen contemporary examples of messes:

- Spam
- Identity theft
- Information overload
- Sustainable versus secure infrastructures
- Getting dependable, reliable, useful, safe, and secure software
- Drug resistant bacteria
- Preventing a pandemic
- Global warming
- Quality education in public schools
- Planning for affordable housing
- Obesity epidemic
- Health care cost crisis
- Poverty
- Thwarting terrorist plots
- Reconstructing society after war or disaster

The first eight of these seem like technology problems and the last seven like social problems. However, they are all social problems. The first eight are the social consequences of pushing technology beyond its limits; their resolutions lie in the social domain. Messes cannot be resolved without untangling the social situation. The signature signs

Table 2. Signs of a mess

Threat	Something of great value is threatened in a large community; many stakeholders are involved.
No progress	Little or no progress despite huge effort; improvements haven't worked; existing solutions are ad hoc, incompatible, and ineffective.
Social paralysis	No agreement on problem statement, causal relationships, or solution strategies.
Active resistance	Multiple stakeholders have social and political means to block actions that do not support their agendas. They distrust or resent one another.
Negative moods	Frustration over disordered conditions, feeling of being stuck, confusion, discord, conflict, turmoil, controversy, distrust, resentment.

of a mess—all social—are summarized in Table 2 (Denning 2007).

We prefer the term "mess" for these exceptionally difficult situations because the word "problem" (as in wicked problem) carries a connotation that we can articulate the nature of the concerns and conflicts sufficiently well to anticipate an "answer". Messes don't have answers. With a mess, the problem is that we don't know how to characterize it as a problem. We may even disagree about whether there is a mess at all.

Messes and Inno Vat Ion

History tells us that solutions to messes are likely to require disruptive innovations (Christenson 1997). The reason is that the paradigm (belief system) of the mess dwellers has already proved itself incapable of resolving their difficult situation. Only a belief-changing innovation will succeed. This is why many in the mess feel threatened about the prospect of a solution. The solution may challenge everything connected with the mess, including social power structures and deep beliefs.

Figure 1 depicts a temporal structure to a mess. The horizontal line represents time. The mess condition builds in the social system and exists for a period of time. A transformational event provides the key to a resolution. The social system integrates the resolutions and settles down with the mess gone. Smaller social systems resolve more quickly than bigger ones. Highly uncomfortable messes resolve more quickly than less uncomfortable ones. James Burke showed that the messes and settlement periods accompanying great scientific revolutions lasted 50-100 years each (Burke 1995).

There are three main observers in this structure. Alice (A) is embedded in the mess and lives under its mindset and rules. To Alice, the mess looks normal and impossible to change. Bob (B) is embedded in the settlement and its mindset and rules. To Bob, the settlement looks normal and the ways of the mess archaic. Chris (C) straddles the transformation and sees both the mess and the possibility of resolution. We will design a strategy for C shortly.

These three observers personify the stages in Arthur Clark's quip about revolutions. Alice says, "Change is impossible." If Alice meets Chris, she will say, "Your proposed change is not worth doing." If Alice survives and becomes like Bob, she will look back and say, "It was a good idea all along."

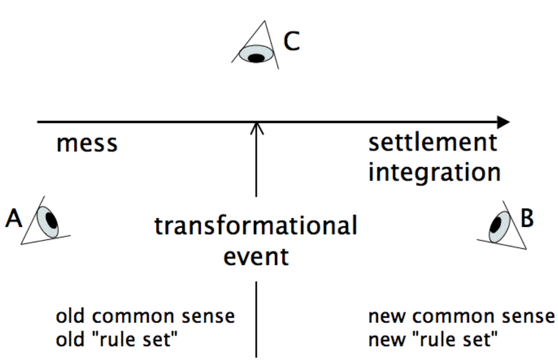
Sometimes a chain of sustaining innovations will collectively create sufficient disruption to alter the mess. Computational science gives an example. In the 1970s, scientists and engineers articulated many grand challenge problems—such as designing aircraft with computer simulation of flight instead of with wind tunnel tests. These problems were insolvable with the supercomputers of the day, which performed around 1 million operations per second. Scientists estimated those problems would yield to supercomputers of 1 billion operations per second—a thousand times faster—but such supercomputers were dauntingly expensive. Twenty years later, Moore's Law had given us 10 doublings of computing power—the required thousand gain—enabling solutions to those grand challenge problems. The Boeing 777 aircraft was a product of this advance.

It is worth noting that a mess is not a necessary precondition for disruptive innovation. Many disruptive innovations arise from other conditions and motives. For example: (1) Someone serendipitously stumbles on something wonderful (e.g., penicillin). (2) Someone envisions a whole new potential (e.g., Alan Kay's Dynabook led to laptop computers). (3) Someone creates a new social entity that unleashes creativity and new values (e.g., MySpace). (4) Someone seeks a cheap way to give to the many what only the well-to-do can afford (e.g., Unix, Internet telephony, low-cost inkjet printers); according to Clayton Christenson (1997), many disruptive innovations arise from this source.

Collaboration Is Not Our First Choice

Given the discordant nature of a mess, it would seem obvious that collaboration is essential to make progress. Otherwise the different groups will continue the stalemate of mutual opposition. Yet, when faced with a messy problem, most people do not automatically fall into a mode of collaboration. Our colleague, Nancy Roberts, has confirmed this from her work and uses it to teach a class on "coping with wicked problems"(Roberts 2001).

Figure 1. The mess and its observers. The transformational event marks the beginning of adoption of new practices that eventually resolve the mess



Roberts begins the class by posing a wicked problem and asking everyone to come up with a solution to it. When they come together and report their proposals, the group judges no solution satisfactory. Their proposals typically involve getting an appropriately high authority to make and enforce key declarations. For example, a green infrastructure is best achieved by establishing a new cabinet-level "infrastructure czar" who can set sustainability goals, create timetables for their completion, and inflict punishments on those who do not comply.

After this failure, Roberts asks the students to try again. Once again, when they come together and report their proposals, the group judges no solution satisfactory. This time their proposals involve various forms of competition: the best prevails in some sort of contest. For example, the green and anti-green advocates both present their cases to the public, who vote on referenda to adopt one scheme after a period of debates and campaigning.

Roberts sends the students back to try a third time. In their frustration over their recalcitrant instructor they start meeting as a group. They discover they can invent solutions that take care of multiple concerns. Together they find a solution to the wicked problem.

Roberts notes that they eventually got to collaboration, but not before they had exhausted the alternatives of authoritarianism and competition. These two approaches do not work because they do not show how individual concerns will be taken care of. Roberts observes, as did Winston Churchill, "People fail into collaboration."

The situation in the US after Hurricane Katrina in August 2005 followed this pattern. The wicked problem was to restore infrastructure in a region where most of the residents had permanently fled after the storm knocked out all power, communications, water, transportation, food distribution, sewage, and waste removal. The President's first proposal (FEMA takeover) was authoritarian. Local authorities asserting regional rights rebuffed that approach. Thereafter, the situation devolved into numerous competitions (including disputes and finger-pointing) between federal and local jurisdictions.

Two years after the disaster, the region remained gridlocked by local rivalries, fewer than half the residents had returned, disaster reimbursements were held up by enormous tangles of red tape, and very little rebuilding had even started. Most of the progress that was made came from the grass-roots level, such as businesses, churches, voluntary associations, and neighbors.

So the political system tried and failed at authoritarianism and competition and got stuck, while the grass roots fell into collaboration and made progress. The political system, in its desire to manage everything, did little to empower the grass roots. The Katrina mess is one of many where grass-roots movements have outperformed governments. There is a worldwide movement to empower local grass roots groups for humanitarian assistance (Hawken, 2008).

We are not saying that authoritarian solutions or competitive solutions never work. Of course they do. They tend not to work for wicked problems because authoritarian solutions provoke resistance and competition produces local winners at the expense of the whole. Our familiarity with these two approaches draws us to them first. Roberts is saying that when we encounter a wicked problem, we are most likely to find a solution by going straight to collaboration.

Clearly it will take some work and practice on our part to understand how collaboration works and how to achieve it.

Practices For Resolving the Mess

What form shall the collaboration to resolve a mess take? It will be shaped around six themes running through all the examples of messes:

1. Many people in the system see the mess as normal. They are resigned to the apparent impossibility of change.
2. Few people in the system see the full complexity of the mess. Most see only their parts and think of other groups as obstructionist.
3. Messes may be intractable because many groups in the social system have enough power to block action they dislike but insufficient power to forge consensus around action they favor. Resistance from disaffected groups is a major obstacle to change.
4. Resolution requires a transformation of thinking and practice in the community.
5. Given the differences of opinion about solution approaches, no resolution will be attained without developing a sense of solidarity in the community.
6. Someone has to take the lead to promote adoption of a solution.

These six themes suggest the following six practices for resolving messes. These practices extend the eight foundational practices of all innovations (Denning and Dunham, 2006).

1. **Declare.** Begin by declaring that you see a mess and intend to do something about it. Your declaration is needed because many people find the mess to be normal and see no point in changing or fighting it. Your declaration will mobilize others who may be willing to join you in the struggle.
2. **Learn.** Few people appreciate the full complexity of the mess. Most see only their parts and think of other groups as obstructionists. Do not take sides. Instead, make yourself a student of the mess; learn everything you can about it; become an expert on the mess. Read what has been written, talk to people about what they know, and perform experiments. When you accomplish this, you will see patterns that no one else has seen, which may help you lead the stakeholders to a resolution. Becoming an expert is challenging because many people are unable to articulate all their concerns: you must listen for what is not said as well as what is said.
3. **Blend.** This is Terry Pierce's advice (Pierce 2004). Your proposed innovation to resolve the mess is certain to be resisted. Many groups in

the social system have enough power to block action they dislike but insufficient power to forge consensus around action they favor. You will probably have to use politics and media to forge healthy consensus and keep large numbers of people involved in the new game until they embody it. You want a critical mass of people to buy in to the innovation before the resistance solidifies. Think of Amazon.com and iTunes as examples; they blended with the copyright protection interests of traditional publishing by looking like an on-line version of a conventional store, but they wound up disrupting the traditional publishing houses by allowing authors to self-publish through them.

4. **Question the paradigm.** The "paradigm" is the belief system in which everyone is operating. The existence of a mess is strong evidence that the paradigm is not able to resolve the problem, and in fact may be the cause. Therefore, try to identify all the assumptions in the belief system and diagnose which are questionable in the current situation. Pay special attention to anomalies; they reveal the limitations of the paradigm. Looking outside the current paradigm is quite difficult because most stakeholders don't know what "outside" looks like; they lack the language to discuss it or even think about it. Synergistically combining their multiple perspectives is the way to overcome this blindness.
5. **Develop a "we".** Bring together representatives of all the different views and interests in the system, who are willing to talk it through together. (Nancy Roberts calls this "Getting the system into the same room".) Lead them to experience solidarity by helping them generate new observers of the mess and new possibilities for resolving it. Chances are that the group will see something together that no individual saw alone. They may find a new perspective that the various power centers can accept and move with. In other words, collaboration may find a solution where serendipity, coercion, or competition cannot.
6. **Lead.** All the declarations, learning, questioning, and thinking will come to naught unless someone steps up to lead the change. If that is not you, you had better convince someone else to do it. The primary work of the leadership is provoking people to question and learn, facilitating collaboration, and managing large-scale coordination.

These practices are not linear "steps" to be performed. They are areas of action and skill. They are performed in parallel.

Because multiple stakeholders are involved throughout, collaboration is an essential ingredient of all six practices. Collaboration is a synergistic coordination in which the collaborators create new observers, new possibilities, new futures, and new concerns (London 1995, Straus 2002). It is the only way that the stakeholders will come together, come to understand the nature of the mess, blend with the resistance, transform their thinking and practice, develop solidarity, and coordinate their resolution-generating actions.

Collaboration does not mean consensus. Consensus is the enemy of collaboration. Consensus means to make a minimally disagreeable compromise that may be unsatisfying to many but not so bad as to provoke serious opposition. It is a lowest common denominator. It appeals to a deep resignation about the mess, a feeling that the status quo is better than an attempted change. Consensus narrows possibilities; collaboration opens possibilities.

Collaboration Practice

Let us now examine how to organize a collaboration that may resolve a mess.

First, let us acknowledge that organizing groups who have been in opposition is not an easy task. Lewis Perelman cites infrastructure renewal as a messy problem involving the clash of "green" and "blue" agendas (Perelman 2008). Green represents the sustainability movement, which aims at environmental protection and resource efficiency; its main concerns include energy-neutral designs for buildings and other infrastructure. Blue represents the security movement, which aims to protect against attacks and disasters; its main concerns include critical infrastructure. The various players do not agree on the relative importance of the two perspectives. Each perspective reaches different conclusions about infrastructure renewal and best use of resources.

The struggles among the perspectives often lead the opposing groups to distrust and resent one another. Perelman notes that in the infrastructure issue, blue and green advocates tend to avoid each other. When they do make contact, their interactions often end with legal battles, such as the one in California between the Navy (wanting to test new sonar systems) and National Resources Defense Council (wanting to protect marine wildlife). The opposing groups also form political movements that try to influence public opinion in their direction and impose a solution at the ballot box. In such an atmosphere, it is difficult get the parties talking about collaborating. They fight over a choice between a “blue space” and a “green space” but do not work together to create a combined “blue-green space” (Denning, 2002).

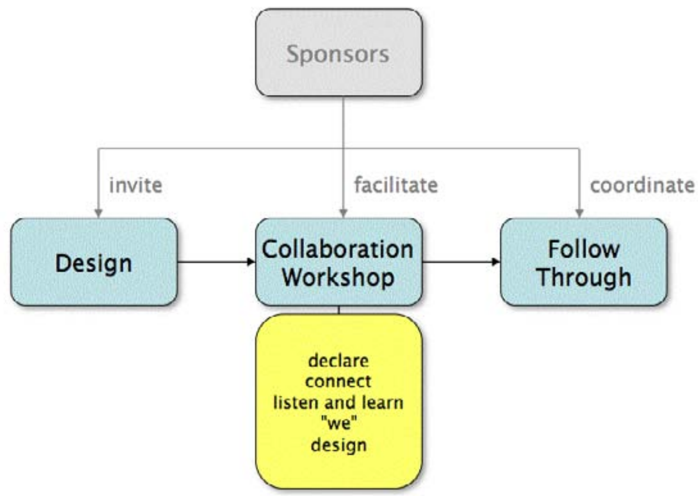
Recent experience at the grass roots is more optimistic. People are tired of failed public projects in parks, development, affordable housing, climate change, and infrastructure renewal. They are turning to facilitated processes that guide them to collaboration. Prominent examples include Appreciative Inquiry (Barrett 2005), Straus Method (Straus 2002), and Charrettes (NCI). These successful methods have a common structure, exhibited in Figure 2 (Denning 2008).

The sponsor is a credible entity who declares the mess and convenes stakeholders to engage in the six mess-coping practices. The sponsor invites the design team to propose a question for inquiry and an invitation list to a collaboration workshop. All key players, generations, and interests must be represented at the workshop. The sponsor provides a facilitator for the workshop and leads them through the mess-coping strategies. The workshop fosters a sense of community—a “we”—among its participants and designs action teams to address the mess. The sponsor coordinates the follow-through by helping the teams find people, allies, and resources.

At the workshop, the facilitator leads the group through five stages that culminate in collaboration and the design of follow-on projects. These stages implement portions of the six practices needed to bring the participants into collaboration on the design of follow-on actions.

1. **Declare:** The sponsor declares the question for the group to consider. The question emphasizes new possibilities rather than current deficits. Each group member declares acceptance of the need or desire to work together on the issue, and openness to the perspectives of the others. Without the agreement of everyone in the group to cooperate with the process, egos can get in the way and hijack the process.
2. **Connect:** The members take time to become present and engaged with each other. They say what concerns bring them to the gathering. They say their aspirations and what is at stake for each of them. They say why they see a need for collaboration. They look for and acknowledge connections such as mutual friends, business interests, or education.
3. **Listen and learn:** Now the group speaks and listens, as openly as possible, to the concerns motivating each member on the issue. The goal is to expose all the concerns and learn how and why each matters to some member. Members tell stories showing how concerns affect their worlds. For example, “Low wattage light bulbs matter to me. My company replaced a thousand incandescent bulbs and saved $5000 on our electric bill in the first year. That’s a lot of cash for our little company.” The listening must be open and inclusive—seeking to gather many different perspectives, and avoid any initial judgment that one is better than another. Conversation is for clarification—not justification or argument. Comments beginning “What if...” and “I wish...” fit, but not “That won’t work.” This

Figure 2. Structure of messy problem solving



A sponsor declares the mess and its intent to resolve it. The sponsor facilitates a three-stage practice where (1) a design team creates the agenda and broadly-representative invitation list for (2) a facilitated workshop that fosters collaboration among the representatives, and (3) follows through with action teams carrying out projects designed at the workshop. The workshop facilitator leads the group through five stages, building their collaboration

stage is complete when no one has any further ideas to express; everyone appreciates that the group has multiple concerns to consider; many may see a common core of concerns the group can work with.

4. **Promote "we":** Members of the group continue the conversation about what matters for as long as necessary until they develop the *experience* of a "we". This is the hardest part. The early signs of group identity and solidarity are members making tentative proposals that recognize, respect, and even own the interests and concerns of the other members. A later sign is reconfiguration of concerns—for example, someone favoring authoritarian, protective, anti-terrorist government might reconfigure into a concern for strong, safe, resilient community. The facilitator keeps the proposals tentative and the mood exploratory. The conversation will evolve into a shared feeling that we are all in the same mess together, and by staying together we can resolve the mess. The mess may start to unravel as the members become aware of and take care of their interlocking concerns. Occasionally, the mess will evaporate in the light of the reconfigured concerns of "we".
5. **Design:** Now the group engages with the actual work of creating projects. Some will be variations of the tentative earlier proposals, others new. Members offer to lead projects; other interested parties join the project teams. Projects addressing multiple concerns are the most likely to attract teams. The facilitator guides members with doubts about a proposed project to question in a "we" mood of exploration, clarifying objectives and exploring consequences. For example, instead of saying, "This project cannot work," the member could ask, "In my experience the resources to do this will be considerable. Can we reformulate in a less expensive way? All proposals that attract sufficient teams can move forward for action. The group's final agreement on projects to take forward cements its solidarity and service to a larger cause. The mood of this stage is ambition.

Throughout these five conversations, the facilitator maintains a background mood of appreciation and openness. Openness encourages everyone to contribute ideas and disclose concerns. Appreciativeness invites creativity. This is the hallmark of the highly successful Appreciative Inquiry process (Barrett 2005). The contrasting mood of problem-fixing tends to be narrow; it focuses on what's wrong rather than what could be; it discourages group solidarity.

The facilitator also displays all new points learned, proposed, or created on shared computers or wall posters. David Straus has found that this form of group memory helps everyone recall ideas belonging to the group as a whole (Straus 2002).

Consider what might happen if this process were applied to Lewis Perelman's blue-green clash cited earlier. Suppose that a group of green and blue infrastructure advocates decide to collaborate together despite the clash between their perspectives. Their facilitated discussion might evolve as follows. They discover that some of their members are motivated green because beloved family members succumbed to lung diseases. They discover that others are motivated toward security because their businesses have been robbed at gunpoint and because one of their companies went out of business in a blackout. They discover that all of them are hesitant to back a centralized government solution because of the government's poor track record; they do not want to risk locking in a bad solution. They start speculating about grass-roots solutions that make it cool and fashionable to be both green and secure. They agree on committees and working groups that will sponsor contests for well-designed energy-efficient products and stimulate research into personal home power plants that don't depend on the grid being operational all the time.

technolo Gles

Over the past several decades many impressive "collaboration technologies" have become available in the Internet. They can be grouped in three main categories: exchangers, coordinators, and games. We will discuss them below. We will also discuss emergent systems of practice that appear in the conversation spaces opened by these technologies, and the design considerations for technologies that support true collaboration.

Other discussions of work-supporting technologies use different categories of behavior: information sharing, coordination, cooperation, consensus, collaboration, and collective action. These categories are usually stated as various degrees of control over behaviors of people in a group. It is often difficult to classify a given technology into one of these categories. Our three categories make more explicit the kinds of conversations and practices a technology supports.

A caveat: These technologies are only able to help users who are willing to enter the conversations they support. If the opposing groups in messes try to avoid each other, these technologies will be of little help.

e xchangers

Exchangers support the sharing and transfer of information. The most common examples include:

- blog
- chat
- content streaming
- corporate directories
- database sharing
- discussion board
- document sharing
- email
- file servers
- instant messaging
- live presentation
- personal computer access
- personal info sharing
- photo sharing (e.g., Flickr)
- recording
- remote blackboard
- RSS
- screen sharing
- version control systems
- remote screen sharing

- VoIP
- VPN

c oordinators

A coordinator contains a workflow representation of the network of commitments of a group and a means to observe when participants make new commitments or move existing commitments closer to completion (Winograd and Flores, 1987). It allows only those actions that align to the workflow. It tracks workflows and can answer questions about workflow states. Examples of coordinators:

- auction system
- business process manager
- classroom manager
- collaboratory
- concurrency controller
- coordinators
- Coordina
- .00.tor email system
- creation net
- decision support system
- discussion forum
- interactive voice recognizer
- Internet protocols
- network meetings
- newsgroups
- online payment system
- operating system
- project manager
- shopping cart
- service oriented architecture (SOA)
- social network systems (MySpace, Facebook, LinkedIn, etc.)
- support center
- telescience (remote lab)
- voting systems
- wiki discussions
- Wikipedia
- workflow manager

Games

A game is a system of interactions among players seeking to achieve a specified outcome through their play together. The players are free to make individual choices as long as they abide by the game's official rules and standard strategies. Besides sports and entertainment games, many social systems in political science, social science, economics, business, biology, ecology, computer science, and psychology have been interpreted as games. Games bring the players into a set of shared practices, at which they develop skill by repeated play.

Many on-line games have been developed that allow people to assume roles in the games. The current generation of these technologies is the "massively multiplayer online role playing game" (MMORPG). A previous generation was called "multiuser virtual environment" (MUVE). Examples of these technologies include:

- America's Army
- Active Worlds
- Dungeons and Dragons
- Flight simulator
- River City
- Road simulator
- Second Life
- SimCity
- Socially beneficial games
- There
- Training games
- World of Warcraft

The list mentions "socially beneficial games", a class defined by Luis von Ahn (2006). Socially beneficial outcomes are a side effect of their regular play. In esp.com, for example, random pairs of players try to label images with keywords by guessing the keyword the other player will use. Players have fun and accumulate points and national ratings. The side effect is that the images get good keyword descriptors, which helps search engines find them. Von Ahn says that these games mobilize brains to do computations that we do not yet know how to program into computers.

Game theorists study the same kinds of games analytically. They introduce payoff matrices that award points to pairs of players according to the kinds of decisions they make in encounters during the game. They seek to discover, through analysis and simulation, which strategies produce the highest long-term payoffs for the players. Robert Axelrod, for example, learned that large-scale cooperation is likely to evolve in a social system if the players use a "tit for tat" strategy when they interact (Axelrod 1984); tit-for-tat means that, in your next encounter with a person, match that person's last move of cooperation or non-cooperation.

Two aspects of these games make them very interesting for innovators. First, when people join these games, they quickly become immersed in the practices of the game. The virtual world of the game becomes "reality" and they often forget they are playing in a game. This aspect of games makes them very useful for training. The players learn how to perform in the real world by developing their skill in a simulation of that world.

The second interesting aspect for innovators is that people tend to develop trust for their fellow community members in the game. This happens because they share in the same practices, giving them a strong connection.

Many innovators work with a game interpretation. They begin by interpreting the mess as the result of a game. Through careful examination of the history of attempted innovations, they find the rules and strategies of the game. Then, in the question-paradigm practice, they speculate about how they might change the game so that the mess will disappear. The multiuser role-playing game may be a useful tool to develop the new practice in a virtual world and then propagate it to the real world.

Emergent Systems of Practice

Each category of technology explicitly supports certain practices. Exchangers support practices for sharing and exchanging information, coordinators support the practices of a community in doing their work, and games support people in learning new practices in a virtual world, that can be taken later into the real world.

Impressive systems of practice often arise around the simplest technologies. The Faulkes Telescope (www.faulkes-telescope.com) is a facility that provides free access to robotic telescopes and an education program to encourage teachers and students to engage in research-based science education. John Hagel and John Seely Brown (2006) see this as a fine example of a creation net, a (possibly collaborative) community that learns and invents together. Clay Shirky (2008) gives numerous examples of groups coming together spontaneously in a cause or movement using the simplest of information sharing tools. Thus, a community practice can flourish even if no technology has been specifically designed to support it.

Sometimes these impressive systems are captured into a new technology. Technologies that support the work of organizations illustrate this. Initially, organizations used simple information sharing tools such as email and online records to support their work. Workflow management systems were invented later to support standard practices, such as mapping interactions among roles and tracking the commitments made by persons in those roles. More recently, multiplayer role-playing games have been invented to enable users to practice the dynamic creation of workflows and roles.

Designing to Support Collaboration

Collaboration is an emergent practice. There is as yet no category of technology that fully supports the collaboration practice we described earlier. People learn the collaboration practice in various ways including coaching and immersion in an already-collaborating community. Once they know the practice, they carry it out with the help of exchangers, coordinators, and games.

Designers of systems to support collaboration use a three-part strategy:

1. Declare the unifying principle or theme for the collaboration,

2. Interpret the social system as a network of conversations, commitments, and practices,
3. Assemble a suite of tools that enable conversations, enact commitments, and support individual practices in the network.

The users can then use the tools to participate in the process and achieve the unifying purpose.

The collaboratory is a social process designed in this way. A collaboratory is a virtual center that supports collaborative scientific research among geographically distributed researchers (Wulf 1989, 1993). The collaboratory is envisioned as a means to solve complex natural system (Category III) problems, but not wicked problems (Category IV). Wikipedia reports at least nine collaboratories in various fields. Some have been successful, others not. They each have a social model for their community and have selected tools to facilitate research in that community. Despite their differences of purpose, all the collaboratories employ similar technologies (Bly 1998):

- repositories (technical papers, preprints)
- digital libraries (access to ACM, IEEE, wikipedia, etc.)
- real time communication such as teleconference
- Internet connected blackboards
- community discussion boards, RSS feeds, blogs, and wikis
- distance learning systems
- remote instruments
- remote data collection and analysis
- integration with supercomputers and grid computing

With our model of the social collaboration process for a mess (Figure 2), we can infer the kinds of tools that would have to be assembled into a mess-resolving center. The National Charrette Institute, which has developed a suite of web-based technology to help their clients with architectural design and infrastructure issues, perhaps comes the closest to this goal. The most useful tools are:

- repositories (articles, case studies, preprints)
- digital libraries (access to ACM, IEEE, wikipedia, etc.)
- real time communication such as teleconference
- internet connected blackboards
- community discussion boards, RSS feeds, blogs, and wikis
- distance learning systems
- systems to record group results at collaboration workshops (charrettes)
- coordinator systems to track follow-on projects after the summit workshop

The overlap with collaboratory systems is striking.

Chauncey Bell (2005) describes a coordinator system for financial management that could be adapted for supporting follow-on projects. His system recognizes three roles: proposer, investor, and manager. It provides tools that support the main actions of each role. It enables sophisticated reporting on the status of investments and the expected returns.

In time, we will be able to design additional tools that will help facilitate collaboration and extend its reach into larger communities.

LIMITATIONS OF THIS STRUCTURE

It is doubtful that the process of Figure 2 could ever be fully automated and the facilitators sent home. The facilitator's main job is to manage the mood of the group, maintaining a sense of appreciation and moving toward the experience of solidarity (the "we"). Building computer systems that monitor and manage moods is hard. Chauncey Bell (2005) points out that financial management systems, which record every commitment and every action leading to its fulfillment, enable auditors to make powerful inferences about participant moods and probable wrongdoing.

How far does the messy problem collaboration process scale? We know that it works for workshop-size groups (say 50-200 people). It extends to larger communities if the workshop represents them well and if the sponsors can support the follow-through teams created by the collaborating group (London 1995). What about messy problems that affect millions of people? How do we bring about enough collaboration to influence so many?

This of course is the central question in efforts to deal with large-scale wicked problems such as sustainable infrastructure, global warming, or health care. We don't yet know how to make the collaboration process scale up to enlist millions of people in a solution. Currently, problems of such scale tend to be resolved by strong leaders who combine technology with political and media savvy to inspire collaboration. For example, Candy Lightner and Cindy Lamb established Mothers Against Drunk Driving (MADD) as an international movement. US Senator George Mitchell established the "Mitchell Principles" that created a workable framework for dialog that ultimately led to the peace agreement in Northern Ireland. Amory Lovins, who focuses on technical facts and avoids moral judgments, has helped clients as diverse as Wal-Mart and the Department of Defense deal with energy issues.

coPInG wIth FaIlures

The social process depicted in Figure 2 does not always lead to a solution of the mess. There are five common failures that the participants must cope with as the process unfolds. Professional facilitators, who are trained to cope with these failures, significantly improve the odds of success. The five failures are:

1. **Not developing a shared interpretation of the problem.** It is easy to blame the obvious lack of consensus on obstructionists giving preference to their own interests over the common good. But the lack of consensus on problem definition or approach is the central issue. There is no sense of a "we" to work together on the issue. It must be developed through collaboration.
2. **Falling into authoritarian or competitive approaches.** Authoritarian and competitive strategies often fail with messy problems. Without everyone's coming to a mutual understanding of all the other concerns and interests, and learning together, it is unlikely that a design will be found that wins enough acceptance to resolve the mess.
3. **Trying to do it alone.** Messes cannot be resolved without collaboration. Moreover, the action teams will require experts in various areas including technology, media, social issues, and politics.
4. **Technology-only solutions that do not address the social issues.** The mess is a social issue even if originates with technologies. Considerable collaboration-building is needed to bring about social agreement.
5. **Being unprepared for resistance.** It is a mistake to discount the resistance that will surely come from stakeholders who see no benefit in the proposed solution.

conclusIon

Messes are intransigent social situations that people want to exit but feel stuck in. While some messes may be irresolvable, we can often find ways out of messes through six basic practices. Collaboration is at their core.

Collaboration is a practice of creating new observers and new possible actions together. Through collaboration, a community creates a solution to a messy problem that takes care of all their concerns at the same time. Collaboration does not mean that community members give up or comprise their dearest concerns. It means they design a solution that recognizes their concerns. The process often leads to a reconfiguration of everyone's concerns. The hallmark of successful collaboration is the experience of solidarity and new energy: a "we".

Collaboration is an ideal achieved far less often than it is invoked. Many people are drawn to more familiar authoritarianism or competitive strategies—which generally do not work for messy problems. Collaboration is often confused with information sharing, consensus, cooperation, coordination, or collective action. Most "collaboration technologies" are actually tools for information sharing. The design strategy for tools is, first, understand the social process and, second, assemble a suite of tools to support the process.

As we learn more about collaboration practice and tools to support the collective actions of collaborating communities, we will be able to extend the known collaboration processes to much larger scales, perhaps even to country or world sizes. Their designs will be based on deep knowledge of the practices now used by the human facilitators of today's processes.

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ke Y ter Ms

Consensus: people reaching an agreement for action that is unsatisfying to many in the group but not so bad as to provoke serious opposition.

Cooperation: people working together to achieve a common purpose.

Coordinator: information technology that helps people move within a network of commitments, by recording when they make commitments and tracking their progress toward completion.

Collaboration: a practice of working together with others to produce new observers and new possibilities that no one could produce alone.

Collaboration Technology: information technology that supports the practice of collaboration. See collaboration.

Collective Action: people coordinating together inside a game, producing some result in the sum total of their actions that cannot be seen from any individual's action.

Disruptive Innovation: a change of practice in a social system that requires new thinking, new beliefs, an alteration of the roles and their connections in the social network, and shifts of power among groups in the social system. Contrast with sustaining innovation, which means an improvement of performance in existing practices of a social system.

Exchanger: information technology that shares or transfers information among members of a group; supports collaboration.

Game: a set of rules by which members of a social system interact to achieve some purpose together.

Mess: a tangled social situation that is too costly to stay in and too intransigent to get out of. See also wicked problem.

Wicked Problem: a tangled social situation that is too costly to stay in and too intransigent to get out of. See also mess.

Chapter XLVIII
The Myth of the E-Commerce Serf to Sovereign Powershift

Rachel McLean
Manchester Metropolitan University Business School, UK

a bstract

As a social activity, the shopping experience can not be recreated or improved through technical design alone. This chapter proposes that there is incongruence in online retail provision and the needs or requirements of customers. It argues that a greater social awareness or sense of "audience" is required by retailers who adopt E-Commerce. Web sites and service provision need to be more closely related to social requirements to reduce the socio-technical gap. This chapter will attempt to deconstruct the belief that E-Commerce in its current format is bringing about a power shift. It focuses on five of the most prevalent strands of the myth that E-Commerce empowers customers. A critical social theory (CST) epistemology is adopted. Through a series of semi-structured interviews with consumers and consideration of the wider empirical evidence the myths are deconstructed. The chapter raises the question "how far can commercial enterprises afford to empower consumers" and reflects that rather than a "power shift" there has been a "responsibility shift".

If Web 2.0 for you is blogs and wikis, then that is people to people. But that was what the Web was supposed to be all along.

—Tim Berners-Lee, 2006

Introduct Ion

It is frequently suggested that e-commerce facilitates a new consumer experience, and brings about "true" consumer empowerment. Levine et al. (2000) state that "the Internet invites participation. It is genuinely empowering". The idea that technology in general, and more specifically the Internet will

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bring about a social revolution is not new (Howcroft, 1998). It is particularly prevalent in both academic and journalistic writings on consumers and the Internet. Professional literature suggests that customers empowered through the Internet bring benefits to the organization (Stewart, 1997). While academic literature (Wathieu et al. 2002) and consumer rights groups welcome the power that the Internet bestows upon consumers (Pitt et al. 2002; Office of Fair Trading, 2003). With few exceptions, conceptual and empirical literature in the field is normative, presenting e-commerce as beneficial to business and empowering to customers. For example, the proliferation of literature on creating and building trust in e-commerce stands in stark contrast to the neglect of its counterparts of fraud and deception (Wareham et al 2005). The majority of existing literature fails to explore the 'real' experience of customers interacting in this new electronic channel in any depth.

Despite a growing body of 'sociology of technology' literature highlighting the *evolutionary* rather than *revolutionary* effect of technology and its adoption (Bijker, 1999), the utopian / dystopian duality of technology (Kling, 1996; Howcroft and Fitzgerald, 1998) and the recognition of people's natural resistance to technology (Venkatesh et al, 2003; Markus, 1983), each new application that emerges is heralded from a discourse of technological rationality. Through hyperbole and the creation of myths (Barthes, 1973) surrounding the revolutionary, transformative effect of the technology under study an illusion or *promise*, which falls short of the practice, is created and maintained. In academic and popular literature, news reports, and government rhetoric e-commerce has been hailed as the emancipator of customers from the power of commercial enterprises. The 'reality' suggests that e-commerce in its current form is unable to deliver on this promise, or to live up to the myth which enshrouds it.

This chapter will attempt to critically analyse (or deconstruct) five of the most prevalent myths surrounding e-commerce and the benefits it is claimed to bring, namely; e-commerce will revolutionise retailing. offers greater choice and convenience, offers greater access to information, enables better communication (C2B and C2C), brings about personalisation of services to customers.

It will show the incongruence between the myths of e-commerce and the experiences of customers, and argue that a greater sense of "audience" is required by retailers who adopt e-commerce. The deconstruction (Derrida, 1978) (taking apart of a narrative, hypothesis, or theme to reveal the underlying vested ideology) of myths is a relatively well established technique in both information systems and marketing research (Hirschheim R. and Newman, 1991; Grover and Ramanlal, 1999; Howcroft, 2001). Myths promote a consensus view of solidarity and cohesion and often perpetuate a shared misconception of the phenomena they describe (Bolman and Deal, 1984). For example, (Howcroft, 2001) explores the myths of the "dot.com share bubble" questioning why investors were drawn into financially supporting Internet start-up companies with no attempt at a traditional evaluation. This chapter will explore and deconstruct five myths that continue to perpetuate the justifications for the claim that e-commerce is empowering customers. Through this, it will highlight the socio-technical gap, or deficit between what online retailers provide and what customers need or want.

Much of the focus for the assertions that the Internet *will* bring about consumer empowerment has been on the *potential* of the Internet, and the *opportunities* for communication and social interaction. The needs, attitudes and experiences of the consumer, whom the advocates of consumer empowerment through the Internet claim it serves, have generally been neglected, if not ignored. The commonly held belief is that if information is power then through product and company information available over the Internet, consumers *must* be empowered (Pitt et al. 2002; Office of Fair Trading, 2003). Experiences recounted to the researcher in the preliminary stages of this research appeared to challenge that assumption. This challenge to what was increasingly becoming the *status quo* influenced the design of the study as it evolved and began to take a Critical Social Theory (CST) approach.

The CST themes of communication, power, and praxis are evident throughout this chapter in analysis of discourse, action and subsequent recommendations to all stakeholders. This chapter contributes to the small but growing number of CST considerations of technology, and answers the call for more empirical critical studies (Orlikowski and Baroudi, 1991; Howcroft and Trauth, 2004). Wareham et al (2005) identify the "psychology of the e-Consumer" as an area that has been "only superficially investigated" in academic and professional literature. At the same time they point to the enduring dominance of positivist approaches. This work makes a contribution both in its content and its methodology.

Methodolo GY

In the initial stages of this research, and as a response to the predominant view that the Internet was bringing many benefits and empowering customers, an interpretivist approach was selected. It is established that critical research often starts out from an Interpretivist stance (Walsham, 2001; McGrath, 2005). The researcher aimed to hold up the mirror of interpretivism and show how e-commerce was being adopted by consumers. She aimed to understand the status quo or accepted "state of affairs" (Collins, 1983); how business-to-customer and customer-to-customer communication had improved so that knowledge was shared, businesses benefited and the customer was empowered. However, the challenge to this generally accepted situation appeared to be gaining volume. A conflict of narratives was emerging. Whilst the mainstream (academic literature, broadcast media and policy makers) generally espoused and celebrated the empowerment of customers, the occasional cautionary tale of fraud or security breaches was heard. Friends and colleagues recounted stories of dissatisfaction with e-commerce services. The status quo was that the use of the Internet in commercial activity is beneficial and empowering, yet the "broader empirical evidence" (Alvesson and Skoldberg, 2000) such as friends' and colleagues' narratives and newspaper articles recounting Internet crime or simply dissatisfaction with online shopping increasingly appeared to challenge this belief. On reflection the researcher decided that the most effective lens or "magnifying glass" to investigate this phenomenon would be that of critical social theory (CST). As Howcroft (2001) states: "Proclamations to the effect that we are entering into a new age should be examined critically rather than simply accepted without question". Adopting a critical approach can be problematic for researchers, not least because there are relatively few critical empirical studies to draw upon for guidance. Each new CST study therefore has a contribution to make in reflecting upon methodology for future empirical research. The methods adopted in this study are outlined below.

In explorative research, it is important to survey relevant groups with "high experience levels of the phenomena under study" (Pettigrew, 1990). This research focuses on the individual experiences of those who have a high level of experience of the Internet in commercially related activity. Direct postings of questionnaires within two Universities in the North-West of England were initially used to contact consumers. Snowball sampling (Robson, 1993) or the encounter strategy based on principles of snowballing (Arber, 1993), (asking respondents to suggest other possible participants with a high level of relevant experience) was then adopted to build up the number of participants. Participants were members of the University community with relatively high exposure to the Internet. They ranged from students, academics, librarians, and technical staff to office administrators. Their ages ranged from twenty-one to sixty, 14 were male and 8 female.

Semi-structured interviews were carried out with twenty-two participants, each one lasting between thirty and sixty minutes (see interview schedule, appendix 1). Interviews were recorded with the permission of the participant, and verbatim transcripts were produced from the recordings. In analysis, the researcher made use of transcripts, recordings and field notes. Initial analysis of the data was through pattern coding and theme analysis (Miles and Huberman, 1994). This method of analysis is an iterative process involving data collection and analysis simultaneously, complementing the reflexive approach which is central to critical research. Opportunities for reflection are 'built in' as the data generation and data analysis phases overlap and interweave. In this process of theme analyis the conflict in the 'practice' and the 'promise', or the 'myth' and the 'reality', of e-commerce became more apparent. Discourse analysis was used to analyse the interview transcripts to greater depth. This combination of theme and discourse analysis with continuous reviews of relevant literature facilitated the identification and subsequent deconstruction of five myths of e-commerce. The research is presented in keeping with the CST approach in which the segregation of 'data collection' and 'data analysis' is not possible. Instead, collection and interpretation of 'evidence' (both primary and secondary) are simultaneous and continuous interweaving tasks. Further, critical research does not claim to be representative or generalisable, but to generate transferable theory which can be applied to other contexts.

MYths oF e-co MMerce

Through a literature review of both academic sources and "wider empirical evidence" and through theme analysis of early interviews, conflict between the *status quo* and actual experiences of e-commerce became apparent. Through comparative thematic analysis of academic literature, and the g*rand narrative* (Lyotard, 1984) in news stories and popular literature, five myths were identified:

1. e-commerce will revolutionise retailing.
2. e-commerce offers greater choice and convenience
3. e-commerce offers greater access to information
4. e-commerce enables better communication (C2B and C2C).
5. e-commerce brings about personalisation of services to customers.

The myths were then deconstructed drawing again upon wider empirical evidence and upon the experiences of the participants of the research. The following sections explore and deconstruct each of the five myths. Table one gives an illustration of the gulf between the promise of e-commerce and the practice or 'reality' uncovered in this research.

e-c ommerce will r evolutionise r etailing

Initially, it was widely believed that the Internet would revolutionise retailing: De Kare-Silver (2000). Scenarios such as smart houses with intelligent fridges that directly order replenishments, frequently recounted in the popular media perpetuate this "hyperbole surrounding the Internet" (Walsham, 2001) and fail to address the distance between the promise and the practice or actual experience. Further, they are "underpinned by an inherent determinism" Howcroft (2001). User take up of new technology is generally evolutionary, in the constructivist tradition (Bijker, 1999). A new phenomena or trend such as e-commerce does not revolutionise current behaviour as if causing a sudden break with the past tradition, but evolves out of, and builds upon current practices.

The deconstruction of the myth that the Internet will revolutionise retailing involves consideration of the determinist / constructivist dichotomy and an acknowledgement that the impact of e-commerce will be incremental and evolutionary, building on traditional commerce and retailing practices, rather than revolutionary. For example, many people currently use the Internet purely for personal communication, and many retail companies use the Internet for "brochureware" alone, adopting the www as an extra advertising channel rather than to radically change the way they do business. Significantly, sectors that show most evidence of being "revolutionised" such as the music industry have encountered numerous obstacles such as legislative issues, and consumer resistance to new formats which suggests that new technology *cannot* revolutionise as if in a cultural vacuum, but needs to evolve and build on tradi-

Table 1. Illustration of the construction and deconstruction of the five myths

Myth	Status Quo	'Reality'
Revolutionise retailing	"The electronic revolution in retail"	"We used it just to gather information really"
	"So pervasive and accessible that it can't fail to impact shopping habits" De Kare-Silver, 2000	"I wanted to actually see what it looked like"
	"Around 2030 there may be no shops at all" Saatchi, 2000	"I've done home shopping and that was a bit of a nightmare to say the least."
Greater choice and convenience	"Global Economy"	"If you order online you get not so fresh produce. 'Let's get rid of it on our Internet buyers'"
	"Level playing field"	"..stick to well known & trusted brands"
	"24/7 shopping"	"It was more stressful than going to the shop I think"
Greater access to information	"Information at the click of a mouse"	"It's a labyrinth"
	"Information is power"	"You can spend so much time trying to find the information that you want"
	"Informed consumer"	"I saw one yesterday, phoned up and it was gone because they haven't updated their website. Well why not?"
Better communication (C2B and C2C)	"A communication channel"	"Because you've got nobody directly to speak to it can be very frustrating. It's almost like dealing with a faceless bureaucracy"
	"Improved producer–customer communication removes distance between the two parties and is empowering to customers" (Gilliatt et al. 2000)	"I e-mailed them and I had to ask them by e-mail could they give me a phone number to contact them"
		"Just sits there for 5 days in an e-mail box and nobody reads it and you're just "Well what the hell's going on"?"
	"A return to the market places of the past" (Levine et al, 2000)	"a one way thing" "Spam"
Personalisation of services to customers.	"targeted marketing" "One-to-one"	"You can tell when it's not just an automatic reply"
	"Personalised, timely & relevant marketing"	"I hate being bombarded with junk e-mail. I can't stand it. It's the scourge of the Internet"
	"Whenever we give permission"	"Do I look as if I need Viagra?"

tional practices. Notably, the UK recorded a record year for album sales in 2004 (British Broadcasting Company, 2005).

Participants in this research commented that they frequently use the Internet to gather information on products, but ultimately go to the physical shop to make the purchase, suggesting assimilation of this new channel rather than a revolutionary effect. For example, two interview participants recounted how they used the Internet to gather information:

We used it just to gather information really relating to the product (male 34)

And:

I bought a little MP3 player at Christmas, I checked that it was out on line and looked at reviews and whatever, but I wanted to actually see what it looked like. Even though you get 3D diagrams you don't really get an idea of what the particular product is like. I ended up buying it not from on-line at all. (female 27)

Significantly, they resorted to more traditional channels to make the purchase, showing an assimilation of the www into conventional shopping patterns rather than revolutionary new behaviour. This is a key point for designers of online services. Assimilation or an evolutionary introduction of new technology into conventional practices brings familiarity and a more successful uptake of the service.

E-Commerce Offers Greater Choice and Convenience

The myth that through the Internet customers are offered more choice has a number of strands. Firstly, it is claimed that the Internet enables us to do business with any company wherever they are in the world. Through this ‘global economy’ we are offered a greater range of products and companies to select from. Secondly, there is the pervasive view that the Internet offers us convenience in the form of 24/7 shopping (shopping, twenty four hours and seven days a week), with no need to leave home.

In terms of the construct of the ‘global economy’, facilitated by technology, and implying a sense of the “compression of time and space” and “of the world as a whole” (Walsham, 2001) a myth is formed that a ‘level playing field’ is created. All the companies of the world regardless of size or location are proported to be competing on equal terms. However, as Howcroft (2001) notes, the Internet yields similar advantages for both large firms and small niche players, and therefore small firms remain at a disadvantage. The implication of this for customers is that larger firms have more resources to invest in establishing and running a web presence and infrastructure, effectively squeezing out, or buying up the smaller firms and continuing to dominate the market.

With this in mind, it is worth considering the importance of “brand” in the electronic marketplace. Within the context of the myth of increased choice for consumers an important contradiction can be identified. Whilst we are told that it is now as easy for us to do business with the small business on the other side of the country, if not the world, we are also advised that we should stay with “well known and trusted brands”. The UK Department of Trade and Industry (1999) state that “Consumers can improve their security by shopping with reputable merchants whose products and policies they trust”.

A plethora of academic literature and consultancy reports support this view theorising on brand power, brand and trust, and consumer confidence and brand (Brewer, 2000). Deconstruction of the myth of a greater choice of products and companies points to an increasing homogenisation of the commercial Internet, mirroring that of our high streets and shopping centres. It is arguable that a new “superbrand” dominating all channels across a number of sectors and locations has been facilitated by the Internet (McLean and Blackie, 2002) effectively narrowing down, rather than opening up, choice. A number of participants commented that they tend to return to the same sites, or only use “well known and well trusted” companies’ websites (male 24), implying *limitation* rather than increased choice.

The second strand to the myth of greater consumer choice is that the Internet offers us convenience and choice of in the form of 24/7 shopping with no need to leave home. The ‘reality’ of e-commerce falls short of its promise of ‘convenience’. Many of the interview participants recounted experiences of delays in purchases arriving, and the inconvenience of trying to contact the company to make enquiries. One in particular stated that her online shopping experience was “anything but convenient.”

I’ve done home shopping and that was a bit of a nightmare to say the least. Half the shopping was missing. Where online it had said things were out of stock were in stock and things that it had said were in stock were out of stock and some of the products were at the sell by date. It was more stressful than going to the shop I think. (female, 27)

In addition to ignoring the distance between the promise and the practice this myth is rooted in the assumption that people actually want twenty-four hour access to shops from home. Exposure to capitalist consumerism is no longer limited in time (to shop opening hours) or space (the high street or shopping centre), but literally follows us into our homes, and arguably wherever we go through the development of mCommerce (commercial activity over a mobile device such as a phone or PDA). Information and communication technologies are the vehicles through which consumerism is being spread into the homes, and private lives of individuals. (Lyon, 1993). Further, through online retail we are doing the work of the company assistant, almost subsumed into the company as boundaries begin to fade.

Deconstruction of the myth of greater convenience through the choice of when to shop, and the ability to shop from home, calls into question who this convenience actually serves. Whilst it does enable people to shop at any time of day or night from the comfort of their own homes should they wish to do so, it also allows the 'capitalistic enterprise' 24/7 access to the 'target consumer'. It could be argued that advertising *per se* has this level of access. However, traditional advertising does not actually facilitate an immediate response such as that encouraged by the discourse of advertising e-mails. Deconstruction of this myth suggests that in practice, choice is actually limited to a small number of well known brands, and that the convenience of 24/7 access arguably serves the companies and more specifically the 'capitalist enterprise' more readily than the individual. Service designers should place more significance on protection of customer choice relating to e-mail advertising. Privacy or "opt out" clauses should be given more prevalence on websites, and customer preferences adhered to.

E-Commerce Offers Greater Access to Information

The myth of greater access to information via the Internet is one of the most instrumental in the perpetuation of the myth of consumer empowerment (Pitt et al. 2002; Economist, 2004). The general belief is that access to such a volume of information on any subject at the click of a mouse *must* be empowering. However, *access* to information alone is not in itself empowering. The potential for empowerment lies in the ability to understand and evaluate the information (Harrison, 2002).

The information gathering stage of a person's decision to purchase is well established in the traditional models of buyer behaviour (Howard and Sheth, 1969; Blythe, 1997). However these models were generally developed before the 'information explosion'. An incomplete search could result in information incompleteness and asymmetry placing the consumer in a *vulnerable* rather than powerful position. The vast amounts of information available today mean that the ability to structure a search and evaluate information retrieved is an essential skill in the avoidance of information overload and the execution of a productive search. Many interview participant's remarked that they experienced information overload, "there's too much information" (female, 27), and "You can spend so much time just trying to find the information that you want" (male, 38). A further participant likened the search for information on a website to being lost in a "labyrinth":

Some websites you get a list of topics and it could be in there, it could be in there, so you click on here and that gets you to somewhere else where it might be there or it might be there. It's a labyrinth and you get fed up with it. (male, 41)

It is not insignificant that the information available on the Internet comes from a range of voices or "discourses" (expert, non expert, customer, professional). This access to multiple perspectives is regarded as contributing to the empowerment of customers through information accessability. Some participants in this research referred to the range of perspectives of information or *discourses* available through the Internet, commenting on how this confused, baffled or was too "technical". A participant who was planning to buy a camcorder commented that he gathered information from a range of Internet sources before making a purchase:

It was on company websites, and a lot of reviews were actual consumer reviews, bulletin boards as well. A lot of them were using these professionally for weddings, so they were very technical… There were some criticisms of the camera we were buying, but the group of people on the bulletin boards were all professional people who would actually notice that sort of difference. (male, 37)

Information from companies, fellow consumers and professional users was drawn upon here. However, the suggestion that the professional's reviews were "very technical" and that criticisms were of things that only experts "would actually notice" implies a conflict of interests between the expert/ non expert culture (Snowden, 1998) or "speech communities" (Saussure, 1965). This suggests that access to information from a range of perspectives or discourses is not necessarily empowering to the customer.

Pitt et al (2002) hold up Edmunds.com (www.edmunds.com) as an example of information available to inform a buyer's decision and ultimately bring empowerment. They argue that the customer can now enter the car showroom in a much more powerful position. However, not all individuals are able to effectively evaluate such information. Harrison (2002) draws the distinction between information as passive "relevant data" and advice which is "information shaped to the needs of the individual". Through the perpetuation of the myth of the informed consumer, customers could actually be experiencing a poorer service. Firstly, the responsibility for actively gathering information has been thrust on to the consumer. Terms such as the "prosumer" (Toffler, 1980) and the "responsible consumer" (Gilliatt et al. 2000) have emerged and a UK government white paper explicitly defines the "better consumer". "The better consumers are informed about what the market offers" (Department of Trade and Industry, 1999) constructing the dualism (Derrida cited in Macey, 2002) of the good consumer/ bad consumer hierarchy, with the implication that an *uninformed* customer is irresponsible. Again, this construction of the "informed consumer" as the norm is of benefit to companies. Information seeking and retrieval incur costs to the customer in terms of time, connection charges, printouts, and so on. These are charges which have been passed to the customer by the company (Bakos, 1991). The "better consumer" is doing the work of the company, cutting costs for them in terms of the need for informed staff, staff time and expensive manuals or brochures. Deconstruction of this myth is not intended to imply that information cannot empower, but that a certain level of skill is required to retrieve and evaluate relevant information. Finally, a challenge to the hierarchy of consumer types suggested in the UK Government white paper *Modern Markets, Confident Consumers*; perhaps it is the "worse consumer" rather than the "better consumer" who places greater demands upon a company and so assumes the position of power or sovereignty.

e-commerce enables better communication c2b and c2c

It is as a communication channel that individuals have most readily adopted the Internet into normal routines and practices. Ironically, here the constructivist tradition or evolutionary user approach could actually be fuelling the determinist myth; people use the Internet to communicate, the technology is available for people and companies to communicate electronically therefore e-commerce *must* be enabling better communication between companies and their customers. Further, it is suggested that improved producer - customer communication removes distance between the two parties and is empowering to customers (Gilliatt et al. 2000). This claim again ignores the gulf between the promise and the practice. The dominant discourse is that the Internet *is* facilitating customer to company communication and knowledge exchange and so empowering customers. The challenge to this is, as Walsham notes, "The communication capabilities of the Internet… (do) not eliminate the need to consider the human processes of communication." (Walsham, 2001). Further it does not eliminate the need to consider business processes and practices in relation to communication with customers. One interview participant noted that rather than bringing increased customer-to-company communication opportunities e-commerce is a "one way thing" (male 30) allowing companies to communicate *to* rather than *with* customers. In practice, the Internet appears to have opened up another channel for companies to disseminate a corporate line (Levine et al. 2000). The experiences of participants in this research suggest that companies often reply to e-mails with a stock message from a corporate script which fails to address the questions posed:

If I get something personal saying "so and so has received you order blah blah", you know, you can tell when it's not just an automatic reply (male, 38)

or simply do not reply at all. For example, one person commented how e-mail to one company:

Just sits there for 5 days in an e-mail box and nobody reads it and you're just "Well what the hell's going on? (female, 27)

E-mail is generally used by companies as a marketing tool to send out promotional marketing messages which individuals experience as 'spam', often quoted as the most annoying aspect of the Internet:

I hate it. It irritates the hell out of me. I hate being bombarded with junk e-mail. I can't stand it. It's the scourge of the Internet. I really think that it needs controlling there's no control, you know with the Internet it's unstoppable isn't it? It's going to put people off. (male, 38)

I don't like getting advertising material. I don't read it because if I want to find out about something then I will find out about it. So it just goes in the bin (female, 52)

Companies have not adopted the Internet as a means of personal B2C (business-to-consumer) communication. Few companies have adopted real time chat with customers into their day-to-day practices. Many don't even respond to e-mails, or reply with a stock message that doesn't answer the particular individual query. Current business practice means that customer communication via the Internet amounts merely to marketing messages or SPAM (notably forcing consumers to purchase anti-SPAM software) and falling short of the promise.

In contrast, the Internet does appear to facilitate customer-to-customer communication. Through consumer reviews, discussion forums, chat rooms, newsgroups and most successfully through online auction sites such as ebay.com, customers are becoming connected, discussing products, companies and services, interacting socially and sharing experiences. Consumers *can* read others' experiences of products and services and so make more informed decisions over which product to buy. They can even add their own experiences. However, an interesting question is whether we are conditioned to look for some form of validation for sources of information. Some respondents in this research noted that they would not know whether to "trust" a personal opinion and would usually look for a symbol of validity such as a brand name or logo suggesting that the information was "trustworthy". This need for validity of 'trustworthiness' effectively erases informal customer-to-customer information exchange on independent sites for those customers, and ensures that companies maintain control over customer-to-customer discourse or communication. As Foucault comments, "Discourse is created and perpetuated by those who have the power and means of communication" (Foucault, 1980). Through the perpetuation of the myth that the Internet can be harmful and deceptive, and our culturally ingrained need for authority's verification and validation of information, a limited number of large, well-known companies could maintain control. Ironically, our desire to have "trustworthy" information, validated by a recognised brand name or logo in place of the skill to personally evaluate information, restricts the potential of the Internet to bring customer empowerment.

Significantly, through companies neglecting to engage in conversations with customers via the Internet this medium allows only lateral customer-to-customer communication. It does not facilitate vertical or business-to-consumer communication, reinforcing the boundaries or barriers and maintaining the company fortress. It could be argued therefore that two worlds are operating. The establishment business-to-consumer communications from the corporate script which mirror off line interaction; and the pocket of dissenters, laterally connected through the Internet, muttering and complaining to each other, plotting a virtual revolution but in practice having limited transformative effect on the companies who choose not to listen. Interestingly, strategies suggested to companies who find that their services and products are the butt of "unfavourable hate or spoof sites" include pre-empting and buying "URLs for the firm's name preceded by "I hate" or followed by "sucks"" or "offer to host the site" thereby gaining some control over the content, and ultimately "sue the site owner" (Pitt et al, 2002). This illustrates how the economic power of the companies enables control of not only business-to-customer communication, but also customer-to-customer communication. Companies can effectively buy up the rights of customers to publicly discuss their products and services.

Deconstruction of the myth that e-commerce enables better communication C2B and C2C shows that although the Internet has the *potential* to empower customers, current business practices ensure that companies maintain a powerful fortress, controlling communication and limiting its effect.

e-commerce brings about Personalisation of services to customers

One of the key promises of the Internet for individuals was that it would enable personalised, relevant and timely marketing. No longer would we be treated as a mass of consumers addressed through broadcast media whether we were interested in the product or not. The Internet would enable tailored marketing, treating us as individuals, narrowcasting on a one-to-one basis (Peppers and Rogers, 1996) whenever we gave permission (Godin, 1999). The practice is worlds away from this promise. A most vehement attack on the indiscriminate bombarding of Internet users with advertisements was made by one interview participant:

You come off the Internet and you realise that there's three or four windows up of advertising stuff and you weren't even aware that they had come into your machine and I don't like that. They do it so that the window is slightly shifted so that you can't get to the cross. Somebody's thought all this through and it's just irritating and they should be shot. (male, 41)

The discourse of control, rebellion and revolution here is stunning, and was a feeling echoed by many other participants.

There are many strands making up the myth that the Internet brings about the personalisation of services to customers. The first is that companies send out personal marketing communications. In reality, companies send out a standard e-mail to many people with the individual's name at the top. Inserting a personal name at the top of an e-mail does not make it a "personalised communication". The second strand is that promotional e-mails are tailored to the customer's interests and needs. In practice, many people receive e-mails about products and services that they have no interest in whatsoever. This is hardly the personalised, targeted and timely marketing that we were promised. Finally, the concept of permission marketing, whereby a person gives their explicit permission for a company to send out marketing material to them, has been lost under a sea of unsolicited, or third party e-mails and pop up advertisements.

Personalisation of products and services via the Internet could be regarded as the greatest mass delusion of recent times. We have been seduced into believing that by allowing information to be gathered about us we will get a better, more personalised service. In reality the practice of gathering knowledge enables companies to market more directly to us, to follow us into our homes, and to try to convince us that we need whatever they may happen to sell. It has been argued that this knowledge gathering is a mode of surveillance. It is the gathering of knowledge about the interests, preferences, routines and movements of individuals for the benefit of the company (Lyon, 1993; Culnan and Bies, 2003). Personal consumer data has become an essential 'information commodity' within contemporary capitalism (Gandy, 2000), assisting companies in their marketing strategies, creation of our consumer identities, and ultimately in exerting power over us (Robins and Webster, 1988).

Significantly, however, the information gathered by the companies does not appear to improve marketing for customers, or to bring about a truly personalised service. Customer 'data' which is 'warehoused' is not utilised effectively. The practice of collecting information about customers is experienced by one interview participant as a mode of undetected surveillance. He commented:

I've filled in enquiry forms and that sort of thing, where they are basically gathering data on me… I just don't like the idea anyway because all they need to do is put in your postcode and your name and there you go! They've got you! And how do they link that up with other databases? You don't know do you? (male, 49)

The discourse of suspicion and uncertainty here echoes the form of oppression used in Bentham's panopticon "this model of undetected surveillance keeps those watched subordinate by means of uncertainty." (Lyon, 1993). This trade in knowledge about customers, or in 'consumer identities' created from electronic data gathered about us (Poster, 1984), happens with neither our permission nor our knowledge. Ironically, the very aspect of e-commerce that promised to bring us a more personalised tailored service and so empower us as customers is now highly instrumental in enabling companies to exert power over us. Rather than communicate with customers to create mutually beneficial knowledge, companies gather knowledge about customers, sometimes without them even realising it. Several authors have likened this "electronic surveillance" (Lyon, 1993) to the panopticon, or all seeing prison design (Boyne, 2000) which Foucault highlighted as being greatly significant to modern society (Foucault, 1995). Foucault proposed that panopticism represents a shift from power over the body, as in corporal punishment, to power over the mind as inmates knew that they could be watched by guards at any time, but they never knew *when* they were actually being watched. In Foucault's words, the inmate is "…seen but he does not see; he is the object of information, never a subject in communication" (Foucault, 1995). It could be argued that by following people into their homes, or in the case of mobile devices wherever they go, and tracking their Internet movements companies do indeed "isolate and observe" individuals. In some ways the means to observe is 'normalised' and overt through the need to register on company websites. Other methods such as cookie planting are less well understood, and more covert; surveillance without our knowledge.

Many criticisms have been levelled at the adoption of panopticism to interpret contemporary society. (Robins and Webster, 1999; Kling and Allen J., 1994). However, methods of technological surveillance have advanced since these writings, and the panopticon metaphor is now arguably more applicable. Significantly, it has been noted that one area where the panoptica metaphor has great relevance is in the commercialisation of the www (Gandy, 2000). Panopticism can be effectively adopted here to explore the myth of personalisation of commercial services through the Internet as a form of surveillance.

c onclus Ion

In order to address the incongruity between online retail provision and the needs or requirements of customers, retailers who adopt e-commerce need to develop a greater sense of 'audience' and consider the customer's requirements more fully. However, the relationship between 'producers' and 'consumers' is so culturally ingrained that a true shift in the power balance remains elusive.

The empirical material collected in the course of this research supports the deconstruction of the five myths considered here and illustrates that rather than a powershift e-commerce brings a *responsibility* shift to citizens of the e-society who do not necessarily have the skills to take on this responsibility. CST research is concerned with *praxis* (practical action), in keeping with this the conclusions of this research address a range of stakeholders who could work together to evolve online retail into a more effective experience. Firstly, it is essential that businesses and policy makers and technology designers work together to identify and address skills gaps. Companies should consider the skills of the potential market in their service design and marketing initiatives. eBay is an example of a company attempting to do this. In holding courses at centres around the UK training people in "how to buy and sell on eBay" the company is benefiting from an increased, and skilled, customer base.

Secondly, citizens of the e-society, engaging in e-commerce need to be aware of the new responsibilities facing them. As Collier states, although it is not necessary for an oppressed group to resolve their situation, it does not make sense to deny that they ought to do so (Collier, 1994). Customers need to become more active in order to redress the customer / company power imbalance. It is possible that by placing higher demands on companies and taking the time to share experiences of dealings with companies through reviews or postings on websites some small progress could be made. Equally, retail companies and website designers could use review sites as customer feedback to help to improve their customer interface. The Internet creates a social forum for customers to network and share experiences. Companies (including IS designers) should view this positively and respond to criticism in order to improve their services.

Existing power relations tend to leave customers reluctant to challenge companies. However, the Internet offers the *potential* for alienation and oppression to be replaced with collaboration and action. This could ultimately lead to improved services through a more evolved integration of technology into social experiences such as shopping. Web2.0 increases the potential for collaboration and interaction. However Web2.0 is not a change in the technology, but a change in the ways organisations, software developers and end-users *use* the technology (O'Reilly 2006). Web2.0 offers more opportunities to target and *sell to* customers as well as the possibility of *interacting with customers.* Whether the potential is realized or not still depends on how companies adapt business practices. As Tim Berners-Lee suggests "if Web 2.0 for you is blogs and wikis, then that is people to people. But that was what the Web was supposed to be all along." (Berners-Lee, 2006).

Future research

It would be interesting to repeat this study to explore whether customers are experiencing better service in the Web2.0 era or whether the media hype surrounding Web2.0 is simply creating another myth of customer empowerment.

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KEY TERMS

Critical Social Theory: A philosophy of research which focuses on power relations and creating an "ideal speech situation" where parties may communicate on equal terms.

E-Commerce: Commercial interaction through a digital channel.

Mythology: Common belief pervasive in the status quo.

Panopticon Theory: Theory based on the design of a prison building which facilitated undetected surveillance.

Praxis: Practical action encouraged by the Critical Social Theory approach.

Social implications: Effects of the phenomena under study on the wider context and actors.

APPENDIX 1. CONSUMER INTERVIEW SCHEDULE

I am researching into how people use the Internet in consumer related activities. I want to hear about your experiences, opinions, thoughts, lessons learned. So far I have looked at reports and research papers and commercial websites. Now I need some input from people who actually use the websites to gain a richer understanding of how people use the Internet in consumer related activity.

The Interview will address the following issues:

Your general views on the Internet
Significant changes (that the Internet has brought about for you)
Internet in consumer activity
Communication (business-to- consumer and consumer-to-consumer)
General conclusions

What does the Internet represent to you?

Understanding & experiences of the Internet.
Opinions about what the Internet is good / bad at.
Whether their general expectations are met.
How they think it could be improved

What has changed for you as a result of the Internet?

New things achieved / learned?
Cultural shifts
Any area of life that has changed significantly?

Tell me about your experiences of researching products online.

How would you research a product through the Internet?
    Where would you look?
    Why?
Have you learned anything new? / had a change of opinion about a product or company?

Tell me about your experiences of buying products online

Good / bad
Communication

Can you tell me about any experiences of using the Internet to communicate with or consult other consumers?

Have you ever shared your opinions of products / services online? why? / why not?
Have you ever shared your experiences of a company online?
How much value would you place on the opinions of other online consumers?

Can you tell me about any experiences of using the Internet to communicate with companies?

Are you more or less inclined to communicate with a company online?
How do you feel about companies contacting you through the Internet?

Empowerment

How far would you say the Internet "empowers" you as a consumer?
Do you feel that you have more choices available to you through the Internet? (products / companies / time / space)

General Conclusions

How effective do you feel commercial websites are?
How would you like to see businesses using the Internet for commercial purposes in the future?

This concludes the interview.

Thank you for your time.

Chapter XLIX
Teaching the Socio-Technical Practices of Tomorrow Today

Theresa Dirndorfer Anderson
University of Technology, Sydney (UTS), Australia

a bstract

This chapter explores the challenges associated with teaching the principles of socio-technical systems in the dynamic climate that characterizes work in today's—and tomorrow's—world. Avoiding a "socio-technical gap" involves preparing the designers of tomorrow in such a way that they can anticipate society's future needs and technology's future potential and prospective peril. By way of a narrative that draws on the author's own experiences teaching social informatics (SI) as part of an information studies degree program, this chapter discuss how her own research perspective in relation to socio-technical and social networking systems co-evolves with the classroom experience. The case study offers examples of tutorial activities and assessments to illustrate how the suggested approach to teaching and learning can be applied in an STS classroom.

Habits are useful but they can also be deadly. They are useful when the conditions in which they work are predictable and stable. But what happens if and when the bottom falls out of the stable social world in and for which we learn? Is it possible that learning itself—learning as we have come to enact it habitually—may no longer be particularly useful? Could it be that the very habits that have served us so well in stable times might actually become impediments to social success, even to social survival?

—McWilliam, 2005, pp 2

Introduct Ion

Our 21st century existence is highly mediated and digitised. Social responses to what seems like an ever increasing rate of technological change range from the dystopian to the utopian—with a very rich and diverse middle ground. The modern digital landscape is under constant transformation.

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Consequently the educational programs needed to equip future designers of the socio-technical systems required in such a world are undergoing a transformation of their own. Handling the complexity of social interaction and technological innovation is increasingly multidisciplinary in principle as well as in practice. Training on specific tools and applications is swiftly out of date (e.g.: Bawden et al, 2007; Hartman et al. 2005).

Understanding the social realm is equally challenging given the diversity and complexity of social engagements in this landscape. Thus navigators of this terrain need to be able to respond quickly to change. To be truly successful as a designer of such worlds, however, an individual must also be able to quickly appreciate the multiple perspectives in existence and proactively devise tools to help others make sense of it. Thus, the demands placed on educators in the field of socio-technical design move well beyond teaching about tools and applications for designing solutions to today's problems. The dynamism and complexity characterising the working world our students will enter means we need to prepare them to innovate, anticipate and imagine what might emerge.

This chapter explores the challenges associated with teaching the principles of socio-technical systems in the dynamic climate that characterises work in today's—and tomorrow's—world. Avoiding a "socio-technical gap" involves preparing the designers of tomorrow in such a way that they can anticipate society's future needs and technology's future potential and prospective peril. By way of a narrative that draws on the author's own experiences teaching social informatics (SI) as part of an information studies degree program, this chapter discuss how her own research perspective in relation to socio-technical and social networking systems co-evolves with the classroom experience. Thematically this topic relates to Social Informatics, eLearning practices and education research.

Challenges Facing Teachers of Socio-Technical Courses

Teaching practices associated with the education of students in the area of socio-technical design and social networking systems challenge both the teachers and the learners to move beyond conventional analytical/creative dichotomies. The pace of change is such that whatever we are teaching about design and socio-technical systems today is likely to be overrun by outcomes in research and practice by the time our students enter the workforce. With the rapidity of change in digital environments, graduates are increasingly called upon to devise imaginative solutions to organisational and social challenges.

Social computing and Web2.0 developments are recent illustrations of the rapidity with which the landscape is changing. Working in these industries requires analytical techniques for identifying and evaluating social consequences of design and implementation. In addition to technical know-how, it requires imaginative problem-solving. The successful professional in these industries is one capable of adapting to change because the rate of change will quicken, not slow. Thus, it is highly unlikely that students could ever hope to receive all the technical know-how that might be expected of them in these industries. A glance through job advertisements in any part of the world amplifies what is being reported in studies of the job market and university training (see for example: Bawden, 2007, Grant, 2007; Clayton-Pedersen, 2005; Kling et al, 2005; McWilliam, 2005). While an awareness of technical elements is still important, other qualities characteristic of innovators must also be valued: creativity, imagination, curiosity, networking and communication skills. These trends suggest that those who will flourish in this environment are those who don't necessarily have a mastery of particular tools or systems, but rather a capacity for lifelong learning.

Are such environments becoming the domain of the 'generalist' who possesses some adaptable 'specialist' skills (acquired while in a degree program)—but who, more importantly, has developed the techniques that will enable her to learn on the job? At the very least, it appears that a more trans-disciplinary approach is called for: one that values multiple perspectives, collaborative and imaginative approaches to problem-solving; one that appreciates the complexity of human-machine relations and the blurring of the boundaries between technical/social, public/private, old/new. Intellectual agility is increasingly in demand in the work force. In many ways, the new social computing tools of Web 2.0 environments make it even easier to find ways to think of curriculum as units to be taught as well as tools for teaching (see for example: Bawden et al, 2007). But we are not limited to these digital environments alone when devising curriculum that is relevant to preparing students for work in and with socio-technical design. Diversity and ubiquity characterise our socio-technical spaces.

For those teaching socio-technical courses, then, there is the constant challenge of devising curriculum that prepares students for the ubiquity of our socio-technical connections and the fast pace of change in digital environments. Take the following opening statement on the O'Reilly2007 ETech website (http://conferences.oreillynet.com/etech/) as an example:

… Technology is so tightly woven into our lives that at times we scarcely notice it. And yet, there are innovators, hackers, and thinkers plotting revolutions—often by simply reexamining underlying assumptions we already take for granted. From the infrastructure supporting mass-market players, the promise of mass computing, and alternative energy sources to personalized medicine, movie magic, web heresies, and talking paper, ETech 2007 explores the technological rejiggering and changes in perspective that are poised to blast off into the realm of magic.

The reference to "magic" and the wonder of things yet to be imagined suggests that in addition to being adaptive to change, a sense of adventure is also likely to become a powerful asset. This sense of wonderment was a core element of the approach to teaching and learning described in this chapter—and, as will be argued in this paper, is a worthy addition to programs aimed at teaching the socio-technical principles needed in tomorrow's world to the students we face today.

A Case Study of Teaching about Socio-Technical Issues

Trends in education generally point to the need for new pedagogies to address the demands of living and working in a highly mediated, diverse society (see for example: Clayton-Pedersen, 2005; Hartman et al, 2005). Experience in Australia, for instance, draws attention to the fact that Australian employers highly value the portability of qualifications (e.g.: Learning Futures, 2007; MyCyberTwin, 2007). We will have to assist our students to become capable of transporting their knowledge and skills from one context to another. If our degree programs are to continue to be relevant to students, we need to create imaginative and stimulating learning environments while also ensuring the employability of our graduates. Such trends have even more significance for STS education which must confront the socio-technical challenges of constant innovation and growing social and technical complexity head-on. To this already challenging mix we must also add the need to learn to work effectively in teams and to collaborate in diverse and often online environments. Engaging with the socio-technical character of our dynamic world of networked information systems and social software requires students to respond laterally and imaginatively to matters that they are likely to encounter in the context of their future work roles.

The case study described here (a unit called *Social Informatics*) is part of the core in an undergraduate degree in information and media. Collectively six core units prepare students for work in the area of socio-technical design. The aim of this case study unit is to provide an opportunity for learning first hand about the issues raised within the area broadly described as *Social Informatics* (SI) by initially introducing students to the principles of knowledge construction in various socio-technical contexts. SI places great emphasis on developing understanding of the social design of information and communication technologies (ICTs) (Kling et al, 2005; Lamb & Sawyer, 2005). The unit does not focus on tools, but rather on human practices informed by and informing the design, implementation and use of technologies.

The unit was designed to educate information professionals to be able to work in modern information environments by employing creative problem solving skills, lateral and creative responses to work tasks, and developing a range of skills and responses needed for exploratory approaches to networked environments. It sought to provide a setting for learning as a life experience based on practices which integrate creative and analytical skills as well as academic and personal experiences. The unit did not involve hands on design, but rather was created to complement the suite of design practice and theory units students take as part of their degree program. As an elective unit for students in other parts of the university, however, it attracts students from Information Technology, Engineering and Humanities & Social Sciences programs more widely. This mix of student experience is also integrated into the trans-disciplinary curriculum development of the unit, providing an opportunity to tease out the different perspectives each student brings to studying the relationships between information and communications technologies and the larger social context in which these technologies exist.

The case study described in this chapter illustrates how the principles of *social informatics* were used to inform not only the content of a unit on this theme, but also the teaching and learning strategies used to deliver that content. Social informatics (SI) is, in the words of one of the key figures associated with this approach, Robert Kling:

the interdisciplinary study of the design, uses and consequences of information technologies that takes into account their interaction with institutional and cultural context. (Kling, 1999)

Social informatics is a relatively new component of information science education, building on the activities of SI researchers in Europe, US and Australia. SI researchers are interested in questions about the future consequences of IT developments. The principles of social design associated with SI place emphasis on designing with consideration for the heterogeneity of uses, people, contexts and data. Moreover, it is an iterative process that should not end with implementation (Kling et al, 2005, esp. Chapter 3). To prepare students for such design practice, the unit in this case study centres on teaching alternative ways of working with technologies. It takes a trans-disciplinary perspective premised on a view that ideas are promoted by fluid and converging practices supported by modern technologies. Implicit in any definition of 'socio-technical' that we might use is an appreciation of the relationship between people (individually and collectively), technology and the construction of knowledge. This chapter suggests that the lessons learned in the designing of this particular unit can contribute to the curriculum developments of a range of units/subjects that might fall under the broad umbrella of educational programs in the area of 'socio-technical design'.

In addition to the field of SI (e.g.: Kling et al, 2005; Lamb & Sawyer, 2005), developments in the classroom under discussion in this paper draw on the author's own research and experimentation with the creative analytic approach of researchers like Laurel Richardson (2000) and Clandinin and Connelly (2000) and by taking this creative analytic approach further by bringing into the classroom Noel Gough's (2004) "speculative fiction" work. It also draws on research into the roles of electronic texts in the humanities, which suggests a move from an analytical academic style of writing to combinations of creative and academic styles. Some other important sources of curriculum development are found within studies of affect and emotion (Kaluzniacky, 2004) as well as the social studies of technology and scholarship of teaching and learning (e.g.: O'Sullivan, et al, 2002).

Underpinning the unit's curriculum is an interest in fostering students' creativity and lateral thinking in ways which put SI principles into practice. The aim is to foster innovative solutions to socio-technical dilemmas. Work in tutorials and assessment is designed to engage students' creativity as well as analytical skills. The curriculum makes active use of online collaboration activities as a way of getting students to experience first-hand the strengths and weaknesses of communication and information systems available to them at the time of their study. They also engage in critical examinations of technologies considered to be "emerging" at the time of their participation in the unit.

A hybrid learning environment (i.e. a combination of online and face to face activities) provides individual and collaborative opportunities for experiencing and analysing the interplay between people and technology. To encourage creative, lateral thinking in student work and to address contemporary issues on the topics taking place during the semester, the curriculum is routinely adapted to respond to the ideas emerging from classroom activities as they unfold. The next section of this chapter describes the philosophy underpinning the unit's curriculum design, two particular pieces of assessment and some online learning activities that have proven effective in meeting these goals. Evaluating the outcomes of this approach in the case study unit suggests there are benefits for STS curriculum development more generally.

SAMPLE CURRICULUM AND ASSESSMENT

Aims and Objectives

The case study unit critically examines the interplay between society and technologies to help students develop an advanced understanding of the key social issues associated with the design, uses and consequences of ICTs. It aims to make visible the social and technical choices involved in their design and use both today and in the future. In broad terms, there are three core themes in the unit: i) technologies, knowledge and social change; ii) complex knowledge systems and digital "libraries"; and iii) collaboration. The unit's objectives are to enable students to:

- Critically examine the interplay between people and technologies;
- Develop advanced understanding of issues affecting the transfer and use of information and knowledge in a variety of social & institutional contexts;
- Demonstrate proficiency in analysing social aspects of ICTs, including benefits and drawbacks of technological implementation; and
- Demonstrate awareness of unanticipated impacts of implementing ICTs on workflows and communities of practice.

Consistent with SI principles, the content takes into account human interaction with technology in a range of institutional and cultural contexts of development and deployment. The interplay of the social and technical elements is thoroughly embedded in the SI approach to ICT study, making it a useful contributor to STS education more broadly.

Teaching and learning strategies focus on interactive, constructive learning. They also support student development of the critical analysis skills and imaginative capacities required to understand and work with the dynamic nature of relationships affecting the transfer and use of knowledge and information in emerging socio-technical contexts. Tutorials are designed to promote informed discussion of key social issues associated with the design, uses and consequences of ICTs. Each session integrates formal input, personal and professional experiences, discussion, reflection and action. Collaborative activities figure prominently to enable students to develop and reflect on the work practices that they are likely to need once they enter the workforce.

Thematic Content of a Social Informatics Course

Thematically, the content can be broken into the following seven components:

- concepts and issues of social informatics (e.g. Kling, 1999; Kling et al, 2005; Lamb & Sawyer, 2006);
- exploration of the 'isms' of socio-technical systems (determinism, luddism, utopianism/dystopianism, globalism, etc.);
- ICTs and social change;
- the interactions between people and ICTs within institutional and cultural contexts;
- social issues in decision-making for implementing ICTs (including design and usability);
- ramifications of new technologies for work practices (e.g. workflows, invisible work, collaboratories, digital libraries); and
- the power, privilege and interpretation of knowledge vis à vis emerging technologies.

These SI themes foreground modes of knowledge production and the role of information in society, rather than the building of particular tools. In this way students are invited to develop new lenses for examining human-machine relations and the bidirectional influences constantly taking place.

Students examine ways that social choices and practices influence the shaping of technology and the ways the design of a particular technology can shape the choices made by people, individually as well as collectively. The theme of emerging technologies forms a "red thread" through the curriculum and the assessments prepared by the students. This decision poses a challenge to the instructor because the content of weekly lectures needs to take on issues arising at that time. It also presents challenges to the students because they are compelled to move beyond assumptions about socio-technical systems that are based on established practices and products. In doing so, they learn very quickly how to move beyond present practices to critically speculate about implications of design in future scenarios. Working with emergent and future scenarios encourages innovative thinking about STS issues.

c ore Principles for a ssessment and t utorial a ctivity

The contemporary context of working with and on sociotechnical systems outlined in the first section of this chapter calls for both imagination and analytical ability. Thus, preparing students to work with and in these digital landscapes involves teaching and learning strategies that enable them to develop a diverse suite of skills: critical thinking, research, creativity, imagination, curiosity, ethical practice, good communication skills and good networking skills (tools & people). Fostering these skills in the classroom will help students develop the innovation and imagination needed in the workplace. While this case study curriculum was designed to complement a suite of technical and theoretical subjects, the SI principles and learning strategies underpinning the design of the learning activities in this unit could be adapted to other STS courses and classroom activities.

The principles of SI described above not only inform the content of the unit, but the delivery of it as well. SI, it can be argued, is a social movement. By foregrounding issues of intention and agency in relation to socio-technical systems, more deliberate attention is given to the ethics of socio-technical design. In this way students are made mindful of the consequences of design and invited to reflect critically on alternatives. Furthermore, as the development of this case study unit also demonstrated, collaboration can be a site of study as well as a way of learning.

There were some other notable influences for this approach that warrant particular mention as contributors to the creative learning environment that is conducive to innovative thinking:

- The principle of "serious play" (e.g.: Schrage, 2000; Rieber, 2001; Wasserman, 1992);
- Noel Gough (2004) and his use of speculative fictions and fabulations;

- Erica McWilliam and her approach to the teaching of creativity (2007) and "unlearning" pedagogy (2005).

Below each will be explained in a little more detail.

Serious play is a technique often used in the schoolroom and in the workplace. Michael Schrage's (2000) book focuses on the way that experimentation with prototypes in companies like Boeing, for instance, becomes a critical condition for innovation. His book makes a strong case for introducing more serious play opportunities into work and learning settings. As Selma Wassermann (1992, pp 133) writes:

I believe that with play, we teachers can have it all: the development of knowledge, of a spirit of inquiry, of creativity, of conceptual understanding—all contributing to the true empowerment of children. Is it possible that serious play is, in fact, the primary vehicle through which serious learning occurs? If that is the case, might we consider introducing serious play at all stages of a student's learning, from kindergarten through graduate school?

Lloyd Rieber (2001) stresses a similar point when describing his efforts to draw on his experiences as an elementary school teacher once he had made the move to teaching at graduate school level. Applying serious play as a teaching technique in an STS classroom, therefore, can not only contribute to serious learning, but familiarise students with techniques that might kick-start innovative thinking in the workplace.

Similarly, imaginative fiction writing has been found to nurture critical thinking about the complexities surrounding a range of science, technology, social and political issues. Neil Gough (2004) writes about the pedagogic value of such fabulations and speculative fictions. *Fabulations* bring the unthinkable into representation, using fiction to offer a world clearly and radically discontinuous from the one we know. The invitation to speculate without constraint can unleash imaginative responses to any number of issues. In the classroom, such imaginative work is very helpful for stimulating discussion about issues in contemporary digital environments and critically examining potential consequences of implementation. Gough cites Scholes (1976) who adds that:

in works of structural fabulation the tradition of speculative fiction is modified by an awareness of the nature of the universe as a system of systems, a structure of structures, and the insights of the past century of science are accepted as fictional points of departure ... It is a fictional exploration of human situations made perceptible by the implications of recent science. (Scholes, 1976, pp 54-55 as cited by Gough, 2004, pp256)

Gough provides some examples of his own application of *fabulations* and *speculative fiction* in the classroom which worked well as classroom discussion starters in this case study curriculum.

As mentioned earlier, a sense of wonderment became part of the philosophical scaffolding for the unit because it is considered an essential ingredient for success in the area of socio-technical design. Experimenting with this approach in the classroom over the years has shown that encouraging students to ponder about the way things work helped them to better understand how the unintended or unexpected consequences of designing and developing ICTs come about in the technologies under study. Such understanding is an important component of SI curriculum so it was important to find ways to support it in this case study classroom. In a sense, such ponderings are an extension of the fascination that is characteristic of the experimentation and adventure associated with child's play. This sense of wonder connects to speculative fiction and fabulations which invite pondering about various future possibilities. Thus, students were encouraged to collect and craft such writing at various points in the unit. This approach to teaching, however, is valuable for any STS program. Devising alternative outcomes for the implementation of a prospective technology as a speculative fiction, for instance, invites students to freely examine social as well as technical consequences from a range of perspectives.

One final influence worthy of specific mention focuses more on the teacher's approach to learning—or more precisely about "unlearning" some conventional classroom teaching that Erica McWilliam (2005) suggests can hold students back from developing the creativity and imagination called for in so many work and life roles. McWilliam makes the case for unlearning in order to inform learning. It is the teacher and not the student she suggests needs to do so. Her educational research sheds light on ways that traditional assumptions about the classroom learning environment can be transformed. Her approach to teaching creativity (for example, 2007) shows how her approach to teaching and learning can support the type of learning environment this chapter suggests can enhance learning in the STS classroom. Her advice is a helpful complement to activities informed by serious play and speculative fiction.

Drawing on these influences helped craft a curriculum intended to foster critical thinking skills in the students and make them more aware of the sociotechnical complexities of ICT design and use. It led to the development of core principles for developing the case study curriculum:

- **Seeing the World Through Different Lenses:** activities in class and in assessment built on the trans-disciplinary and multiple perspectives called for in SI (see for example Lamb & Sawyer, 2005);
- **Serious Play**: critical reflection and creativity encouraged through assessment tasks;
- **Fostering Creativity and Imaginative Thinking**: students are encouraged to read and write speculative fictions and fabulations. Through the works of fantasists and fabulations, they critically examine past, present and future socio-technical possibilities;
- **Wonderment**: encouraged to foster the imaginative thinking and problem-solving required to successfully navigate the change characteristic of socio-technical environments.
- **Collaboration**: built into the serious play activities in the class room as well as the ongoing online *collaboratories* used by teams to build wikis about the emerging technologies discussed in class and then examined more critically in the final assignment.

t utorial and a ssessment e xamples

These principles are put into practice each week in class and in each assessment item. The overall intention is to encourage critical analysis and reflection alongside creativity through activities, discussions and assessment tasks. The three examples provided in this section illustrate how the approach can benefit student learning about the bidirectional relationship between social and the technical concerns associated with ICT design and use as well as help them develop the essential work skills discussed earlier in this chapter.

Imagineering and Serious Play

Early in the unit, students are introduced to a set of serious play challenges. In his discussion about serious play, Schrage (2000) uses the term *imagineering*, a term very fitting for an STS classroom that seeks to combine the analytical skill of engineering, for instance, with imagination or speculative thinking. As the case study student cohort included engineers, computer science as well as humanities and social science students, this hybrid term of two complementary skill sets was a particularly attractive way of getting students to think of ways they could harness the benefits of both. For example, after a lecture introducing students to themes of technologies, knowledge and social change, they undertake a series of serious play challenges. Through brainstorming, association games and role play they are asked to imagine the past as present, the present as future and the future as the present.

A class-wide discussion opens this particular activity with speculation about the past as the present. Students are asked to describe life in a world where a technology now considered old or obsolete was just about to be introduced to everyday life (examples used in this case study unit have included the printing press, paper, clock, wheel, car). Individually students take a few minutes to write down a couple of sentences of what impact the particular technology selected has on the way "things are done today", "today" being the period when the selected technology was invented. After they have reflected on everyday life in this imagined world, they are asked to delete these impacts from their memory (this is in itself an interesting problem dealing with the concept of knowledge) and individually describe the *world view* **before** the introduction of this technology. Class discussion then begins with imagining being alive at the time when the selected technology was just invented. Students brainstorm about life in their new present world and discuss how the introduction of the "new" technology would have shifted their world view. There is also opportunity to reflect on ways that geography and social status might influence their relation to this new technology. The class agrees on at least three key points about the impact for posting in the class blog. The class discussion often becomes a free flowing, student-generated discussion combining what students know historically about the periods in question with ways they imagine everyday life would change when a technology that we now associate with dramatic social and technical change in its time was initially introduced.

The second imagineering challenge in this particular week's tutorial gets students to imagine the present as future: they have to imagine being alive before the invention of the mobile phone and write down a couple of sentences describing what the world was like before the introduction of this technology. They describe a typical day as a student at university before mobile phones were invented. They describe their social lives during the week, weekend, day and evening. They discuss the way they communicate with friends, family, work and class colleagues. The students use this reflection to create one sentence about how the invention of the mobile telephone has shifted their world view—how the world differs for them as a result of the mobile phone. In small groups (the collaboratory teams discussed in the third example of this section), they share what they have written as a point of departure for a discussion of the themes introduced in that week's lecture. This serious play activity is very challenging for young undergraduate students, who are very active mobile phone users and cannot imagine living without their phone. It is a very effective challenge when paired with the first (past as present) task.

After these different twists on time, they are then asked to work in their collaboratory team to create a collage blending a range of artefacts and labels they have collected during the week to tell a story responding to that week's themes. In the following week, the collages are used as starting points for the construction of a fabulation each team crafts to tell a story about how they imagine their world will look 100 years into the future. The performances of each team are then used as a starting point for discussion about mobility, networking and the role that ICTs might play in supporting or confounding human communication. This manner of speculation and imaginative thinking helps students reflect on the many possible outcomes that can result when a technology is introduced in a society and the complex interplay between social and technical developments.

Reshaping Assessment

Originally, the first assessment in this unit was a literature review assignment used to introduce students in the unit to historical and contemporary debates in the field of SI and get them to read widely in the area. Exposure to the literature and key themes of the unit has always been an essential starting point for learning. Much of this material helps students complete the other two assignments, including the collaborative assessment described in the third example of this section. Earlier versions of the unit that included the traditional literature review task demonstrated students were not straying very far from the set readings. Furthermore, while they were encouraged to read widely from non-academic works (like science fiction and music lyrics) to look for evidence in their daily practices of themes covered in the unit, they appeared unable to make the creative leaps that would allow them to connect the non-academic world they experienced in between classes to the world they were reading about as they prepared the assignment. As this assignment is a keystone for the unit, it needed revising to better foster the diverse suite of skills described earlier in this chapter.

Transforming the literature review into a digital scrapbook assignment proved successful for encouraging the students to read widely, reflect critically and think creatively about the complexities of the social shaping of information and the theoretical underpinnings of the interplay between people and technology. The process of making the scrapbook allowed the class to discuss the structuring and presentation of knowledge artefacts, the impact of various technologies on the communication of ideas and to invite the students to refine and direct their already existing technical skills in ways that were personally meaningful for them. The scrapbook metaphor worked well to get students into the habit of collecting what they were encountering in early weeks of the semester. It encouraged both students and teacher to bring in samples to share and discuss on a weekly basis. In this way, the previous perception of the assignment as an onerous one involving heavy library research was removed. Students could use the content of the weekly lectures and classroom activities more effectively to incorporate scrapbook elements into the assessment. In this way the intended outcomes of the original literature review were greatly enhanced.

Converting the assessment to a digital scrapbook did not remove the need for analysis. It merely reoriented it in a manner more fitting for an STS classroom where students had technical skills that they were eager to harness for such work. Students still had to select, categorise and synthesise the significance of their growing collection in relation to themes, theories and readings introduced in class. The digital format encouraged them to be more inventive with their presentation and to collect a more diverse assortment of material from their daily encounters with the SI themes. The appeal for students in the case study unit can be attributed to the fact that these students already operated in a highly digitised and mediated environment. By connecting the medium of the assignment more to their daily practice and preference, these students became more readily engaged with socio-technical complexities they themselves encountered. The connection to first-hand experience helped them to better appreciate the concerns introduced through the SI readings introduced in class.

The revision proved a step in the right direction in terms of the core principles described earlier in this chapter. Not only were the assignments they submitted more diverse than in the former literature review task, but the students also found it a more satisfying learning experience—to the point where some students carried on building their scrapbook in the semesters after completing the unit. The results of this change suggest the task was successful in encouraging students to look at their surroundings with "new lenses." Developing such perspective is an important learning device for innovative thinking. Unlike the earlier literature review assessment (where students were not reading beyond the texts introduced in class), in most cases, students completing this new assessment created collections uniquely their own. They presented song lyrics, movies, advertisements, cartoons, conversations and even recollections of events they recognised as being connected to themes discussed in class. Through the construction of their scrapbook and analysis of its contents, students became more engaged with the complexity of ICTs in society. They grappled with the socio-technical interplay in ways that were directly linked to their existing skills and experience. In this way, the assignment succeeded in getting them to read widely and creatively construct a knowledge artefact on the themes of social informatics. Students' ability to combine traditionally separate skill sets is evidenced by their creative and academic knowledge artefacts. They were able to demonstrate creativity as well as critical reflection in relation to their examination of the complexities of the social shaping of information and ICTs. What was less than ideal, however, was the thoroughness of students' use of the academic literature on these topics—something that is discussed further in the last section of the paper.

Collaboration and the Collaboratory

The remaining two assessment items were interlinked, as both involved critical examination of the socio-technical challenges associated with six different emerging technologies. One was group based, the other an individual essay. The technologies discussed are selected at the start of the unit to include hardware and applications as appropriate. Examples from past semesters include humanoid robots, intelligent agents, immersive environments, wearable computing, mobisodes, and mashups. Both assignments examine the evolution of these technologies, the complexities associated with their adoption by various sectors of society and the interplay between people and a technology within various social contexts. Through completing these tasks students demonstrate their understanding of theories underpinning the acceptance or non-acceptance of ICTs and their evolution, the bidirectional influences of society and ICTs, and the implications for future uses of these technologies within particular contexts of use.

The group assignment ran for 10 weeks of the 14-week program and involved working as part of a *collaboratory* along the lines described by Atkins (1996) and Schleyer (2001) to construct a wiki about one of the six emerging technologies addressed by the class that semester. Each team was also responsible for leading a two-week class-wide discussion in an online forum dedicated to their particular technology. The content of each wiki and discussion forum became the starting point for the final individual assignment: a critical evaluation of one of the six emerging technologies (students had to select one other than that which was the subject of their own collaboratory's wiki).

Working with emerging technologies on these assignments gives the class a chance to speculate about a number of potential implications for future uses. Students have to find appropriate background on these recent phenomena, which is conducive to working in a team and sharing responsibilities. Because they are recent developments, they are compelled to think laterally about connections and distinctions across various technologies and contexts of use.

Developing team work and communication skills are important skills for students that have long been recognised as essential features in many classrooms. The collaboratory assignment involved both face-to-face and online collaboration, so students had to develop skills suited to both environments. Each team had a personal work zone within the unit's online learning site (e.g.: private discussion space, file exchange, wiki page) to use for group-only communication and behind-the-scenes work. Teams were also encouraged to meet in person as required. Each team was given flexibility to craft their wiki according to their collective talents, though there were some basic guidelines and scaffolding provided as a starting point. Successful wiki development called for skill sharing and utilisation of the special talents (both technical and inter-personal) of individual members of each collaboratory: some students were more comfortable and capable with back-end development of audio and visual elements, others were more effective at undertaking research for content, while others were better at project management. Students in each team were also expected to distribute the tasks associated with the two-week forum they moderated on their assigned technology. Accompanying their wiki, each student submitted a reflective report about their individual experience with collaboration and lessons learned about the conditions for effective collaboration and communication in both environments.

The wiki task was an ideal vehicle for teaching students about collaboration, group management and communication. Students in each collaboratory had to appoint moderators, weavers and coordinators for the class discussions they directed. In some groups these roles overlapped. Moderating and weaving duties were critical for encouraging wide participation, for identifying points that are valuable for discussion and encouraging a variety of responses to the points that are raised. The online moderator presides over the discussions, initiating discussion, keeping it on track, and inviting contributions from participants. Weaving describes the flow of discussion and how it can be pulled together. In reality, this is the synthesising of information. Although weaving could be done in face-to-face groups, the trace of messages in an online forum makes it far easier to draw together the various threads of a discussion. Leader, moderator and weaver styles vary from the very active to the more reflective and patient. The effort required to do the job well will vary a lot. Minimum requirements were established for the online forums associated with this assignment, but the students were given flexibility in terms of ways they guided class discussion about their assigned emerging technology.

Giving students the responsibility for managing their work in this way increases the opportunities for student-led learning that McWilliam (2005) encourages. In an STS classroom, it is particularly useful for helping students develop critical understanding about collaborative communication tools. In the case study classroom, this approach led to some very inventive and engaging wikis on these topics. The interplay between wiki construction and online discussion both within each team and across them during the semester also suggested students were learning from one another not only about the emerging technologies under discussion, but also about techniques for wiki construction, engaging presentation and the processes of collaboration and online communication. This student-generated learning is very beneficial for meeting some of McWilliam's "unlearning" suggestions. Furthermore, the agility called for in this collaboratory work, both in terms of collaboration and content development, prepares students for the dynamics of work environments that are increasingly team-based and virtual. During the semester, students find this collaboration the most challenging task but also remark that they find it one of the most rewarding. Former students now in the workforce have also reported that the task was one of the best preparations for their jobs.

Lessons Learned: Challenges Revealed in One Case Study and Future Prospects

Overall, the approach to teaching and learning described in this chapter resolved many of the challenges that prompted the changes in the first place: the need for critical engagement with SI principles; enhancing opportunities for collaborative work in dynamic online environments; supporting the development of imaginative approaches to STS issues. The unit has been able to foster imaginative approaches to STS issues by creating an atmosphere of openness to discussion and playfulness inviting different approaches to issues and tasks. Designing tutorial tasks to tap into creativity and open up different perspectives (e.g. the use of collage, fabulations, Gestalt 'games', cartoons) was also effective in this regard.

Refinements and revisions of the unit content over the past few years have transformed the unit from a traditional mode of delivery into a far less structured unit more responsive to issues arising as the semester unfolds. Given the dynamics of STS issues, this flexibility is very beneficial for teacher and student alike. While there remain challenges in terms of getting the analytical/imaginative balance right, student performance has shown the learning experience is far more effective at promoting a potentially life long process of

- combining analytical with imaginative and lateral thinking; and
- learning techniques to promote innovative approaches in individual and team work.

It has been exciting to witness the transformation of student engagement with the themes covered in the unit and the techniques used to deliver the content. The approach to teaching and learning outlined in this chapter, however, has particular merit for socio-technical design primarily because the intellectual agility called for using such pedagogy offers ideal conditions for fostering the creativity and innovative thinking we want for our students. Getting students to collaborate on building student-generated content on socio-technical issues and to think about the conditions conducive to collaboration is another effective skill well served using techniques like those illustrated in this case study.

Challenges in the curriculum design remain, particularly in relation to the digital scrapbook assignment. Despite the demonstrated value in allowing students to make the knowledge artefact they are devising personally meaningful, it is still sometimes difficult for them to appropriately organise and structure the creative elements of their scrapbook and link the imaginative "texts" they have collected to SI themes with critical analysis of the theories under study. So, while the digital scrapbook was a successful innovation in terms of encouraging students to read widely and develop imaginative collections and explore alternative perspectives, many of the assignments submitted were missing explicit links between their personal exploration and the theories introduced in class. It was as if some of these students saw the encouragement to be creative and examine non-academic texts as an indication that they should not use the readings discussed in class. These challenges will be addressed in future iterations of the unit by providing students with some assignment samples from earlier classes.

There are no recipes that STS teachers can present to students to prepare them for the dynamic work environments they will enter. The lessons learned in this one particular case study, however, suggest that the class activities and assessments discussed here could inform the development of one unit or a suite of units in any program that seeks to prepare students to work with and in complex socio-technical contexts. Regardless of how, the underlying philosophy outlined in this chapter can be flexibly applied to any STS program in order to help students prepare for tomorrow in the classrooms they sit in today.

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Collaboratory: a form of online collaboration; sometimes referred to as a "centre without walls" a collaboratory is an environment to support teams in communication and collaboration, using digital collections for access and dissemination of information and knowledge. Schleyer (2001, pp 1508) describes it as: "An information technology infrastructure that supports cooperation among individuals, groups or organizations in pursuit of a shared goal by facilitating interaction, communication, and knowledge-sharing."

Fabulation: Gough (2004) describes fabulations as bringing the unthinkable into representation; they are fictions that offer a world clearly and radically discontinuous from the one we know. He cites Scholes (1976) who adds that: "in works of structural fabulation the tradition of speculative fiction is modified by an awareness of the nature of the universe as a system of systems, a structure of structures, and the insights of the past century of science are accepted as fictional points of departure … It is a fictional exploration of human situations made perceptible by the implications of recent science." (Scholes, 1976, pp 54-55 as cited by Gough, 2004, pp256).

Serious Play: "…that special kind of intense learning experience in which both adults and children voluntarily devote enormous amounts of time, energy and commitment and at the same time derive great enjoyment from experience." (Rieber et al, 1998, pp29).

Social Informatics (SI): "the interdisciplinary study of the design, uses and consequences of information technologies that takes into account their interaction with institutional and cultural contexts."(Kling, 1999)

Speculative Fiction: can be related to a range of narrative forms that invite speculation about future possibilities and prospective responses to current situations. Writers and theorists like Donna Haraway, Ursula Le Guin and Noel Gough, for example, draw connections between a number of SF phrases: *speculative fiction, science fiction, science fantasy, speculative futures, speculative fabulation.* Gough uses the term in association with the notion of the *fabulation*.

Chapter L
Socio-Technical Communities: From Informal to Formal?

Isa Jahnke
Dortmund University of Technology, Germany

a bstract

The chapter describes an empirical study of a socio-technical community—as an extended part of an institution—with the aim of revealing its changing processes. One hypothesis is that structures of socio-technical communities evolve from being less defined and informal to being more formal structures supported by evolving social control mechanisms, regulations and rules. The focus is the new emerging forms of socio-technical relationships. It is argued that the more established a socio-technical system is on the societal level, the more regulations will be developed which are enforced first by surveillance and social sanctions, and finally by technical determination. This chapter illustrates how socio-technical networks evolve in this direction under certain conditions.

Things are not what they seem, and appearances are certainly not the whole of the story. This need to look behind appearances in careful, detailed and systematic ways is, of course, the common inspiration of all scientific and investigative work.

—Bob Anderson, 1997

Introduct Ion

The socio-technical paradigm, introduced by the Tavistock Institute, London, describes "*the study of the relationships and interrelationships between the social and technical parts of any systems*" [Coakes (2002), referring to Emery & Trist (1960)]. The approach of socio-technical systems (STS) keeps the relevant components together and attempts to improve their relationships. One object of their studies was the British Coal Mine as a new work system had to be integrated into this organisation.

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Recently, new forms of socio-technical phenomena have emerged; for instance online communities, Internet-based networks and virtual worlds (e.g., Second Life). People are getting an increasing amount of information through the Internet e.g., e-mail, web-based discussion boards, instant messaging tools, Wikis and Blogs. Social networking applications like Facebook.com and Xing.com, or Social Tagging applications (e.g., del.icio.us) enable people to come into contact, to collaborate, share knowledge and build new relationships. These new forms of socio-technical structures differ from social systems in "how" people connect: their relationships and ways of communication are technically mediated. Technical and social elements are highly interwoven, and affect each other.

O'Reilly (2005) calls the evolving Internet-based relationships "Web 2.0". This buzzword emphasises social software applications that are heavily reliant on human interactions and collaborations. To describe Web 2.0 and newer forms of its applications, it is appropriate to compare Web 1.0 and Web 2.0. For instance, personal websites are disappearing and Blogging is becoming a new favourite way of maintaining an online presence. Individual publishing is morphing into Social Tagging. Wikis are replacing pure content management systems. The role of the user is changing from reader to author, from consumer to producer ("prosumer"). To conclude, Web 1.0 is still 'information download' whereas Web 2.0 is evolving into communication about information.

Current investigations of Internet-based communication show how social structures in Web 2.0 have evolved. Forte and Bruckman (2005) as well as Wasko and Faraj (2005) investigated the motivation of people and why they contribute to Wikipedia. As a result, knowledge sharing takes places when people assume their reputation will grow through online participation. Roberts (2006) has also analysed the social presence in Web based systems. Online presence has a positive impact on a person's reputation. The more often a person is online, the higher the estimation in which she is held by the public.

Another illustration is the study of Viegas et al. (2007) about the Wikipedia community. They show an increase of coordinating activities from 2003 to 2007. In spite of the potential of chaos in Wikipedia, "*the Wikipedia community places a strong emphasis on group coordination, policy, and process*". Viegas et al. (2004) also explore the behaviour of Wikipedians in conflict situation, how Wikipedians control specific terms in Wikipedia, how they feel responsible and how they discuss new entries. According to Viegas et al., the most activity in Wikipedia is not writing new articles but controlling the quality of written articles. Such controlling activities are first, cleaning new articles from false input, and acting as mediating between two or more authors (e.g., moderating discussions about spelling, or meaning). Third, some Wikipedians provide back-office functions, and finally, some of them take the role of 'vandal hunters' (i.e., when visitors enter funny rather than correct data).

Each of the studies reveals some social effects of Web 2.0 technologies. They illustrate that at least some Internet-based communities evolve from informal, trust based forms of organisation to more formal, defined structures that are socially enforced by the members.

In this paper, we will reveal further trends of evolving structures by describing the emergence of a socio-technical community and its evolution over time. In our long-term study from 2001-2007, we explored how a group—as part of a non-profit organisation—evolved into an online community. Instead of designing a socio-technical system from scratch we just offered the conditions in which such a system, network or infrastructure could develop. Thus, the central question is how these conditions became the foundation of a successful socio-technical community. The results indicate how a human network evolves from a trust based community with few formal rules to a community with more formal rules which are socially enforced by its members. It was the social mechanisms and not the software architecture that fostered the community's evolution. This chapter illustrates how a socio-technical community evolves in this direction under certain conditions.

Social Structures in Socio-Technical Communities

How Social and Technical Systems Differ

When we talk about technical systems we mean Information Technology systems (IT). In contrast, social systems are, for instance, people in groups or companies. As Sommerville (2004) said: A socio-technical system is "*a system that includes hardware and software components that has defined operational processes that are followed by human operators and that operates within an organisation. It is therefore influenced by organisational policies (rules), procedures and structures*." Typical socio-technical systems are for example, groupware systems, knowledge management systems and applications for social networking. The challenge of such socio-technical systems is to design the interaction between social and technical parts. Whether this type of systems really contributes to knowledge sharing within organisations depends on the corporate culture and on the degree to which organisational and technical structures are adjusted to each other and how they are integrated. In other words, it depends on how efficiently and successfully the technical interacts with the social system, and vice versa.

In order to create a successful interplay of social and technical systems it is essential to understand the differences: the first one is autopoietic and constituted by contingent communication while the second one is deterministic (to its utility) and allopoietic (Luhmann, 1995). According to Eason (1988), Mumford (1995), and Cherns (1987), methods, guidelines and principles are focused on this integration. Eason emphasized: "*the specification of a new socio-technical system must include the definition of a social system which enables people in work roles to co-operate effectively in seeking organizational purposes*." According to Coakes' model (2002), the components consist of technical as well as social parts. Our focus lies on the 'web of communications', or in other words, a socio-technical system is technically mediated human interaction and communication.

Socio-Technical Communities and Social Structures

Similar to Preece et al. (2004), we use the term socio-technical communities to describe groups that have some online presence. These groups differ in the following four areas: size, primary content, lifespan and type of communication, "w*hether the community exists only virtually, or has a physical presence, or exists primarily through physical connections*" (p. 3).

In addition to these four areas, a socio-technical group also consists of social structures. Social structures are a "*relatively enduring pattern or interrelationship of social elements*" (Jary & Jary, 1991, p. 465). Social elements are for instance, expectations and social interactions that can be called "social roles" within groups of people.

According to Dahrendorf (1958), a social role is the sum of all behaviour expectations of a social group towards a concrete role actor. It is a set of descriptions defining the expected behaviour of a position (Biddle & Thomas, 1966). Roles in socio-technical communities depend primarily on technically mediated communication. Therefore, roles in online communities can be particularly observed through the written communications of their members. A role is then, a perceivable interaction pattern created through the repetition of social interaction[1]. Repeated and anticipated behaviour leads to expectations that affect a role, and vice versa. Similar to Herrmann et al. (2004), a role consists of both "structure" (including position and function) and "activity" (including role-playing based on social interaction).

Meeting on a virtual community platform does not have the same quality as participating in a "*bowling team*" (Putnam, 1995). Nevertheless, for people who are unable to find other people with the same interests in face-to-face situations, meeting in an online community is better than not meeting at all, and there are only few social duties people have to agree to. This aspect is also known as social capital: *"Social capital is the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition"* (Bourdieu & Wacquant, 1992, p. 119). Members provide immediate support for others and build more social capital than without the technical system. In other words, social capital is the access to people, their friends, and support: a person's problem can be solved with the help of others. It is a visible benefit. According to Nahapiet & Goshal (1998), social capital can be differentiated into a structural dimension that includes "*patterns of connections between actors—that is who you reach and how you reach them*" (p. 244), and a relational dimension that indicates the "*personal relationship people have developed with each other*". In summary, the more members who actively participate in a social network—with shared basic norms, values and meanings—the more social capital will be created. The building of social capital depends also on the quality of social ties. But once again, the "*development of weak ties is better than not meeting at all*" (Preece, 2000, p.24)[2].

The cultivation of social capital is particularly dependent on trust, Fukuyama (1995, p. 26). Trust is "*the positive expectation a person has for another person, organization, tool, or process that is based on past performance and truthful future guarantees made by a responsible person or organization*" (Shneiderman, 2000, p.58).

From this theoretical viewpoint, we have applied three areas for our empirical research about evolving structures in socio-technical communities. These include the activity dimension (AD), structural dimension (SD), and cognitive dimension (CD):

Structural Dimension:

- Change of social relationships?
- Change of social capital in socio-technical communities?
- Change of online presence? Technically mediated social proximity?

Activity Dimension:

- Emergence/change of behaviour and roles? (online interaction patterns)

Cognitive Dimension:

- Change of pre-trust and trust?

case stud Y

In 2001, the Department of Computer Science (at the University of Dortmund, in Germany) had approximately 2,000 students. Between the years 1996 and 2001, problems were occurring. A lot of students did not graduate with computer science degrees (statistic report from 2001). This report made clear that many students ended their computer science courses after three or four semesters without a degree[3] or even moved to another university; others did not take the written examinations. However, we did not know exactly why the students were failing, and so, we wanted to find out why the students were dropping their computer science studies (initial situation). We assumed that the problem was not only related to the content of the courses but connected with the 'study management' (organisational problem). The primary question was: How do German computer science students organize their studies at a university? Do they have enough information about how to organize their studies successfully?[4]

Method: a ction r esearch

Starting from the problem of the organisation of the study management, we started the WIS-project[5] in 2001. The aim was on the one hand, to find out what the barriers to studying were, and on the other hand, to establish which factors led to success for students of computer science and second to give the results back to the students in order to initiate a discussion about these issues. The primary purpose of the empirical procedure was to help students build their own online community that would be concerned with study management.

In addition to the practical purposes, we used the project in order to study people's behaviour as well as emerging changes of social structure and social roles in the online community. The project was based on an empirical exploratory research method including ethnographic observations, qualitative interviews and questionnaires as well as action research processes (Avison et al., 1999). The empirical exploratory method was essential since we did not have sufficient hypotheses in order to explain why the students dropped their studies. Our empirical procedure included the following phases of action research:

Part 1: Main steps of Implementation Process

A. Identifying the Problem(s)

In semi-structured interviews, we uncovered different students' problems with study management. The interviews, held between 2001 and 2002 with an open-ended interview guide, included 14 people face-to-face (8 students and 6 professors/lecturers). The diversity of how students manage their studies was summarized in different areas, e.g., students know the importance of attending lectures and learning groups, though they do not attend[6]; students at German universities need a high degree of self-organization but they have not learnt it (and it has not been taught); too much unstructured information. Based on these practical problems, a standardized questionnaire was sent out to the computer science students at the University of Dortmund. 384 completed questionnaires were returned. This represented a total of about 20 percent of all computer science students enrolled in the bachelor courses. The results confirmed the thesis: The majority of students knew theoretically how to organize themselves for a successful computer science course but they did not practice it.

B. Creating an Information Portal

The interview results prompted us to create an Internet-based information portal which would offer an overview of each lecture, seminar and course per semester, a graphical plan of the first four semesters (similar to a bachelor degree). We decided to use computer support for two reasons: (a) due to the large number of students that would be involved and (b) to document the process for the next generation of students. Additionally, the portal would enable information from the study management advisors and other university roles to be shared. In 2002, the first prototype of the community-system called "InPUD" was launched.

C. Supporting Communication and Collaboration

Based on empirical insights about the InPUD prototype, we added a discussion board about study management, and selected undergraduate courses some months later. The aim was to improve the transparency of successful study management factors. Knowledge sharing was based upon voluntary participation. As we will describe later, that was the beginning of an online community.

D. Continuous Improvement

From 2002 to 2006, the project team enhanced the technical system and changed some things, for example, to improve the performance of the technical system. Meanwhile, a lot of new discussion boards were added, and more information about study management was included. The InPUD community grew continuously. In 2007, InPUD 2.0 was installed. The community portal has been converted for Bachelor and Master degrees.

Part 2: analyzing the Implementation Process to study evolving social structures

Especially from 2002 to 2006, we analysed the InPUD community and its evolving social structures based on the following research methods.

First in 2003-2004, face-to-face interviews with 8 experts were held. The experts came from the area of study management, had experience of 'university management' and knew web based IT-Systems very well. We asked what the crucial factors for successful study management were in order to compare the experts' statements with InPUD's development. Based on the empirical results of the interviews with the experts, we supported the InPUD-Community with new ideas. One example was giving members with formal roles a role name and making roles visible, for instance, the study management advisors were labelled explicitly. Furthermore, we conducted participant observation of the online discussions in InPUD from 2002-2006. Moreover, the analysis also regarded user statistics, communication structures as well as qualitative content analysis focused on social relationships to understand the social interactions.

As a result, in this exploratory action research process we identified empirically based theses about the emergence of social structures through interactive technologies. The results can be found in the following section.

What Exactly is the InPUD Community?

The InPUD community (=Informatics Portal University of Dortmund, Germany) can be described as a 'socio-technical knowledge sharing community' for computer science students at the University of Dortmund in Germany (available at www.inpud.de). The InPUD-community differs from other online communities that are built in people's spare time and not a part of a company. InPUD was launched in 2002.

According to Preece et al. (2004), the InPUD community is characterized by a large size (more than 1,500 people). The community is an extended part of a Department of afore mentioned university and supplemented the existing formal organization of the university. The primary content of InPUD is knowledge—and its collaborative creation—about the study of computer science, its courses and study management. The students get information about how to study successfully, and the opportunity to discuss study management, content and exercises of lectures as well as seminars. Thus, InPUD helps to provide and share information to improve study practices. The community exists primarily online, but also has a physical presence through physical connections, e.g., networked students in different courses, seminars or lectures.

In detail, the InPUD community includes an overview of all classes and lectures which are offered during the course of a semester. The way that the information is structured is the same for each lecture or seminar. The information about the lectures, including any tutorials which are being held (and when they are being held), course materials, notices for examinations, lecturer contact information and often a free discussion forum are included as well as news and search functions.

The information and content about the study management domain were integrated with online discussion boards. These enabled potential members to build active social interactions. The discussion boards exist for each lecture as well as for study management. They are embedded into an information website that includes facts about course guidance as well as graphical maps of how to study which course at which time.[7] The discussion boards include discussions about selected lectures. At the time of writing, 30 boards are on-line, each with their own moderator. It is possible to discuss exercises and their solutions on the discussion boards. Furthermore, there is information, and discussion boards, which have been initiated by study management advisors, and course guidance. The discussion boards include questions and answers referring to study management, for example "*how to study successfully*", "*how and where to register for written examinations*", "*content of special courses*", "*which semester is best suited for studying abroad*".

The members are primarily students from the Department of Computer Science but also people who are interested in studying e.g., high school students. Some InPUD members are also made up of advisors from course guidance and study management. As mentioned, the InPUD community consists of students who could theoretically meet at lectures. However, this face-to-face communication is unlikely due to the fact that the courses are oversubscribed. Sometimes there are more than 600 students on a single course—direct social interaction with each person seems to be difficult to achieve.

How the Socio-Technical Community Grew

The InPUD community is continuously expanding. Since its launch in May 2002, more than 1,330 registered participants have written more than 24,000 contributions. Registration and login is only necessary when actively contributing. Observation and reading is possible without registration and without logging in; each user has access to all available information. InPUD is used by more than 60 percent of students within the Department of Computer Science at the University of Dortmund.

The InPUD discussion board provides an awareness tool that provides information about activities of the users, formal roles and current status, and shows who and how many users are online at the same time. The community grew without any marketing or any external advertising.

The number of requests has grown consistently—cf. Figure 1—and the access rate usually peaks at the beginning of a new semester. In October 2002 there were only 171,408 requests. A year later, in October 2003, there were 292,155 requests and in October 2004 this had increased to 491,330 requests.

Figure 2 (next page) shows the analysis of the communication structure: About 2,000 students (100 percent) are enrolled at the Department of Computer Science in Dortmund. More than 1,330 (66.5 percent of all students) were registered in September 2006. We do not know if the 'not registered persons' are lurkers (passive users), or if they do not use the platform.

About 868 of 1,330 registered members contributed actively. A core (of about 190) individuals regularly provided contributions: ranging from 26 to 391 postings (questions/answers) per individual. That is a significant number. The core members are the elders, leaders and partly the regulars (Kim, 2000). The other 678 active members (167 and 511) made postings in the range from 1 to 25. These members can be described as regulars, too, but also included novices and visitors.

462 members were registered but did not post. We assume that these registered InPUD lurkers (23.1 percent of 2,000 students) wanted to show their interest in the community although they did not actively participate. According to Preece (2000), there are different reasons why they do not post, for instance, no motivation, no personal need, and curiosity without exposure. Maybe they are waiting for the "right" moment to post.

The success of the InPUD-Community can be measured by the significant number of active students. More than 60 percent of computer science students use the community. The large number of participants indicates that a significant number of students appreciate this form of knowledge sharing. They discuss, ask questions, answer the questions of others, come up with new ideas and help each other.

Results

This section shows results that help to understand how InPUD became a sustainable, continuously growing socio-technical community, and how it evolved over time. The following results from our InPUD case study between 2001 and 2006 are not representative but indicate some empirical evident theses that show the trend from open, informal, and undefined to defined, formal structures.

1. Change of Socio-Technical Relationships

One result of our analysis is that the members of the InPUD-community, in particular students, developed social relations online. The members built different qualities of social relationships—that were dependent on individual needs (cf. previous section: differentiated structure of participants). Some people even built close ties, for example, the same people met habitually at the same discussion

Figure 1. Continuous flow to more usage (dark bars show beginning of new semesters)

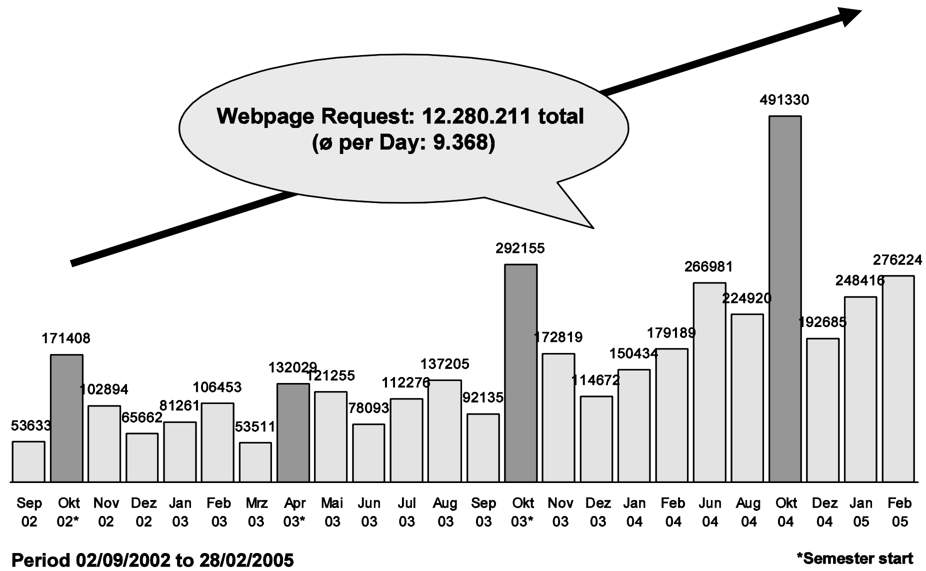
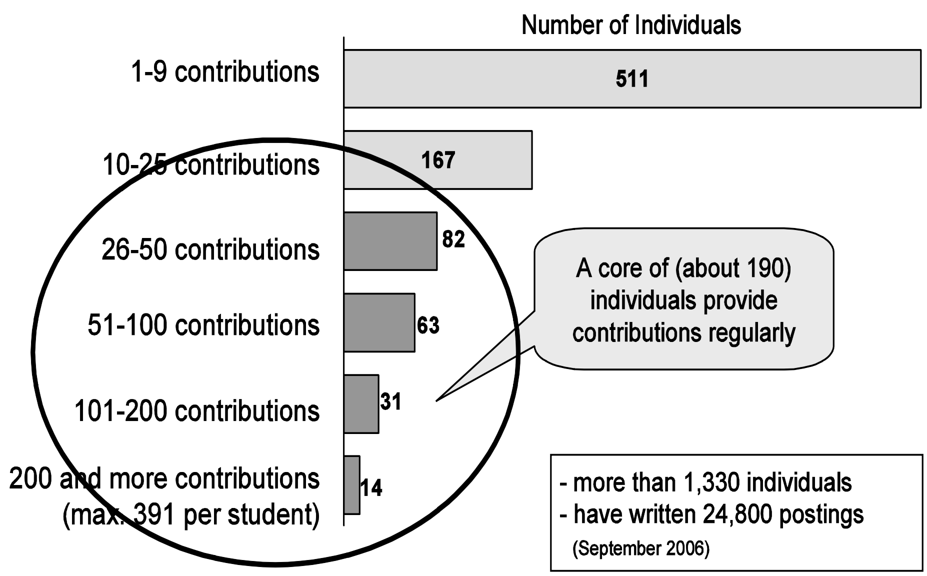


Figure 2. InPUD discussion board—Number of contributions per individual



board at the same time. Wenger et al. (2002) call these members "*the core of the community*", those whom Kim (2000) differentiates as elders, leaders and regular members. The emergence of social ties was affected by the following aspects:

First, the analysis shows that it was not necessary to create face-to-face communication among students before the online community was created. The students were unable to take advantage of the opportunity to build social relationships at face-to-face meetings (e.g. seminars, or lectures) because of the fact that there can be more than several hundreds students at lectures.

Although the interviewed experts said it would be important to promote face-to-face communication before cultivating a web-based community, we know today that this is not correct for every online group: we explain these differences with homogenous and heterogeneous groups. a) The student members of InPUD have homogenous interests, and therefore a face-to-face workshop was not relevant. The underlying idea is that homogenous groups have the same (or similar) interests and therefore the members act truthful and rely on the others (in more detail cf. point 3). b) Heterogeneous groups include people who work in hierarchical dependences. In the investigated case, people work in different formal roles, for instance, they are advisors, part of the counselling services, work at the examination office, at the registry office, and they are lecturers, and so on. Such people—in different formal roles—do not have the same goals (although they may have many similar interests in the context of student support).[8] Consequently, for heterogeneous groups it might be better to create a trust-building face-to-face workshop before supporting their knowledge sharing with IT. For example, the 'central office for study management at the University' created a face-to-face workshop for advisors.

Second, the community gave its members—through the medium of the technical system—the opportunity to find people with same interests, problems or passion. A person could find people with the same interests although the group was large with a lot of anonymous members. From an individual's viewpoint, the community helps members to become "*someone with a name*": a person who needs information from others but also has information to share with other people.

Third, the InPUD-analysis shows: members could foster their collaborative knowledge sharing with a minimum of formal regulations and limited university control. Without registration, every person can read all of the InPUD content—also external people. Registration is required only when one wants to give answers or pose questions. Registration requires just a username and an email address.

Finally, InPUD is available 24 hours a day and people are able to connect to others around the clock. Some students answered questions and helped other students at night. Instead of one-to-many users' communication, InPUD is able to support the communication from many-to-many users, and promote the "*wisdom of the crowds*" (Surowiecki, 2004).[9]

The Internet-based InPUD community gave its members easy access to many people and their combined knowledge—this is what we call the 'social capital' of a group. The analysis gave some hints about the core members of InPUD who built rather strong ties. These core members did not share only pure information but they also wrote some emotional sentences to create new social relationships. For example, the members "*wish good luck for the exams*" and said "*thank you*" when other people helped them.

These factors enabled the members to build different qualities of social relationships online—right at the moment when people need knowledge or other people. The InPUD-members combined and shared information and jointly developed their own understanding 'as a community'.

2. Online Presence and Social Proximity Through the Technical Medium

The InPUD analysis indicates that some members are more visible than others because of the number or quality of their contributions to online discussions. The degree of online presence affects the perception and reputation of people, their expectations, and finally their behaviour. For instance, an InPUD member who made postings more frequently and gave answers more regularly than others (e.g., who contributed just one time) was more visible within the web-based community than others (cf. previous section, statistic analysis: several members posted contributions every day).

The people's motivation behind this interaction—degree of online presence—is similar to aspect 1: to build social ties. Interviews with students showed that some of them wanted to "*break out*" from the anonymous mass (from a large student group of approx. 2,000 members). The online community gives the students the chance to keep in touch with people who share their problems. A second argument is the 'self-profiling' or self-expression of those people. People respect such members more when they are more present in InPUD. In other words, the high degree of regular online presence is connected with a higher degree of competency that can result in a higher status—assigned by others to such 'leaders' or 'power-users'. To conclude, some interviewees assume a connection between the frequency and quality of contributions on the one hand and a higher social status and acceptance in the community on the other hand. Moreover, such a raised online status could also impact on their lives outside of InPUD. These people might feel more confident in their face-to-face communication as a result of their higher online status. For instance, interviews with some students revealed that some of them knew the 'strong' members personally—in spite of their online nick-names. Studies of Wikipedia indicate a similar result: active power-users at Wikipedia upload their pictures in Wikipedia on a special website[10]. Wikipedia has more than 324 faces.

The online presence also influences kinds of 'online social proximity' through the technical system (what we describe as computer-mediated social proximity). Indicators for such online proximity are emotional interaction patterns, for example, they say 'thank you' or wish 'good luck' with exams and further hints. In summary, some contributions drift from the main topic—only pure information—to questions about personal interests, for example, "*where do you live*?" that have positive influences on the building of social proximity. Instead of "bowling alone" (Putnam, 1995), the InPUD case indicates that people bowl together online. One research question is: Do online contacts appear as digitalisations of offline relationships or do people have more social relationships in online communities than in our 'normal society' (what quality do they have)?

3. Pre-t rust and t rust

Although the InPUD community was mainly built through computer-mediated communication, the InPUD members who communicated with other users did not generally know them outside of this virtual space. Our observation indicates that the members respect each other and act in a trustworthy manner. In contrast, betrayal of trust can have a significant negative impact on the online community and can limit or dissolve collaborative learning. "*When there is trust among people, relationships flourish; without it, they wither*" (Preece, 2000, p. 191).

The InPUD community had the opportunity to create trust from the start. Similar to Shneiderman's model (2000) to facilitate trust, we *clarified the context*, for example, we made it transparent that InPUD is part of the Department of Computer Science. Second, it was important to "*make clear commitments*", for instance, each discussion board has a description about possible content and the announcement that "*off topic discussions will be deleted*". And finally, trust–building was supported by ensuring that each discussion board had one or more formal moderator, a task that has to be taken by academic personnel. The static information in InPUD is also checked by the academic personnel, in particular by the administrators. However, the formal moderators act moderately and not often. Nevertheless, they gave the InPUD-community the context for facilitating trust continuously.

Pre-trust as well as trust has existed since its inception, and has not significantly changed over time. This could be explained by the supporting activities of the moderators who facilitated the building of trust in the community.

4. c hange of b ehaviour and r oles

InPUD has many participating members; hundreds of people who give ideas and share their knowledge online. During the initial stages (in 2002) the majority of the community's members occupied the same position: "user". Tasks were transparent for each new member. At the outset of InPUD, the main tasks were posting/contributing, only reading, and less activities of moderation by academic staff. In the initial phase (from 2002-2004), we observed that the members began to employ new forms to communicate. We defined these new forms as 'informal moderator. Some core members did not have the formal role of a moderator but guided other members with words.

Following points illustrate some informal posting activities (in more detail, see prior work Herrmann, Jahnke, & Loser, 2004):

- **Scaffolding:** person who gives structure to the discussion, for example: "*Please, look at the thread of study management, before you ask the same questions like the others before*"; "*This question was already answered in thread 19*".
- **Conflict-mediator:** acts as mediator in emotional conflicts (when two people or more have a dispute); intervention in emotional discussions (enabling the discussion to continue), e.g.: "*I understand your problem, and it is good that you want to change something, but this thread is not the right way to solve your problem. Would you mind talking with the professor face-to-face?*"
- **Technical-support:** solves technical problems, e.g., "*Why is the board so often offline at the weekend*?" The answer of a user (not the formal administrator or moderator!) was: "*I just asked the technical project team and they said they had upgraded the software. The new version should work in two weeks. Hopefully they are right.*"
- **Promoter of the procedure:** makes the current procedure more transparent; promotes the discussion, or activities; motivates to participate, e.g.: "*Yes, I could explain the seven answers of the exam after the exam—when there are enough students who will participate. I suggest Wednesday, 14 February, 10am in room E28. I will not do this if there are just 3 or 4 people. So please, come to the meeting*".
- **Informal moderator:** Informal moderating activities are often supported by students. Informal moderators help other members and tell them "*how to ask questions*" or "*this question has already been answered on board 6*".

During its growth the InPUD community created informal roles. In this stage, the students were the driving force behind InPUD. Because of the evolving practice by the active members, new people were encouraged to become involved in this online collaboration.

In the phase of sustainable development (from 2005-2006) a lot of new members in formal roles occurred, for example, moderating activities by academic staff and professors. These new formal members started a lot of new topics on the discussion boards, for instance, studying abroad, women in computer science, discussions about new bachelor and master courses.

The formal role of a moderator as well as a promoter is essential. However, the frequency of their comments was less important than the fact that the other (or new) members knew that a moderator exists and she/he can delete contributions or comment on false contributions. If there is a moderator's role, it is also essential to make the rules and (off)topic contents visible. The moderators "*must learn to achieve a balance*", (Preece, 2000, p. 291). In the InPUD case, "balance" means that the moderator should act in a moderate way, for example, delete off-topic remarks, comment on factually incorrect answers, clarify which content may be discussed, which topics are not required, and make them visible. The InPUD-moderators have a very moderate position, they only provide answers when other students had no idea or provided incorrect answers.

5. How Online Role Naming Affects the Evolution of Socio-Technical Communities

In the case of the InPUD community the formal role of moderators were advisors of study management. They were integrated into the community by a permanent presence of a role description, for example, "*Mr. Miller, Advisor of Study Management*" or "*Mrs. Smith, Lecturer for Computer Science Study: Human-Computer-Interaction*". The formal roles were visible when people contributed online.

The 'formal role presence' helps new community members to easily assess the quality of information. The members, in particular students, ascribe more expertise and knowledge to those members who have formal roles. Therefore, the visible presence of role names improved the ability to assess the quality of the information, and this could have improved the frequency and quality of requests that finally encouraged the members and affected the evolution of the community (cf. trust, point 3).

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From the InPUD case and some observation from the Web 2.0 phenomenon, it is possible to derive a trend of tendencies evolving to socio-technical relationships. According to some Web 2.0 applications, InPUD also shows a new tendency: We await reinforcements of regulations that are socially and technically driven.

The empirical case study might help to explain under which conditions the actors developed a shared area of interests that led to new social practices, rules, norms and further new social procedures. The case study also revealed new relations between new forms of communication and socially mediated technical structures and described how these new forms can lead to a shift from undefined to defined structures (e.g., rules as well as roles).

Therefore, one conclusion is: Although easy success and non-regulated behaviour are success factors in the early phases of a socio-technical Internet-mediated network, structures and regulated behaviour grows with the networks age and maturity—a new form of socio-technical relationships has emerged. Table 1 shows the three phases of emergences and the next generation.

The first phase of evolving socio-technical networks includes mainly trust-based communities, which are formed by free participation with very informal rules. Recently, a lot of online communities and different kinds of web-based social networks in our Internet society are noticeable, for example, Facebook.com, Xing.com, online boards about Harry Potter or other topics, and Blogs of IBM or Siemens, or many different wikis in business companies. The prominent representative is Wikipedia that is "still" in the first phase. However, a lot of studies (e.g., Viegas et al. 2004; 2007) indicated a lot of new structured activities, so that Wikipedia is on its way to the second phase.

In the second phase, clear rules are evolved by social conventions, social rules and system boundaries that are mainly socially enforced. For instance, in the last years the online language "*Leet*" emerged. Leet is a written slang used primarily on the Internet in online games. Today, it is also part of Social Networking applications, in YouTube.com or in chats. A new language has developed. Leetspeak consists of letters and numbers, for example, l33t means leet. Using such a language means building new social exclusion. Another prominent example is Ebay.com. The interaction rules are not only built by the technical system but also by the social system: the company made new policies for sellers, rules for buyer, and now "rules for everyone".

In the third phase of socio-technical networks, we assume that clear rules arise but they are mainly technically determined. For the majority of people the technical determination will be hidden, for example, the Google Page Ranking: only a few people know that the web page ranking includes ten factors to rank web pages. Most of the ten factors consist of algorithms and other mathematical factors. So, the Google search list guides our behaviour through a technical rule.

The mentioned study of the InPUD community is evolving from the first phase to the second because of the emergence of new socio-technical structures which are mainly socially enforced. In the third phase, it could be observed that the InPUD community members could be guided additionally through the rules of the technical system. Not only the social mechanism but also the technical mechanisms of InPUD will enforce people's behaviour. InPUD will be more closed (in the sense of social borders and social exclusion of other people) than before through more social regulations than before.

First empirical insights show some hints for those emergent structures. For example, the development from InPUD 1 to InPUD 2 in 2007 to 2008 aimed to introduce new technical concepts. However it also included changes in the usage. InPUD 2 has a more complex system than before.

The case study of InPUD gives some evidence of the transition from undefined to defined regulations, from loose to formal structures. Social system boundaries—socially and technically mediated—are emerging in different forms. Online communication and relationships are at first mainly trust based, socially enforced, and later also technically determined. As a result, a continuous process of dissolving and re-modelling of the boundaries within as well as among networks is taking place.

conclus Ion

In this paper we have described an empirical case study which reveals the factors influencing the cultivation of a socio-technical community within an organization. The case study gave us initial results of how the relations between new forms of communication and socially mediated technical structures e.g., web-based discussion boards, e-learning, and e-government, can lead to a shift from undefined to defined structures, rules and new roles. So, one new form of our modern society is a two way communication which depends on technically mediated communication as well as regulation: a *socio-technical society* is arising.

New web-based applications will change our networks into forms of socio-technical relations. How will communication and cooperation in such a socio-technical society change our lives?

With newer 'easier-to-use' Web2.0 technologies, the socio-technical gap—what people demand and what technology does—will be narrowed relative to few years ago. Users are also becoming designers. However, the technically driven phenomenon (cf. third phase) could expand the gap again because technical systems, which include partially hidden concepts, will affect people's behaviour and most of them will not know about the technical determinism.

Further research should pay more attention to this shift in order to analyze the effects of socio-technical networks on people's lives in the future, for instance, investigations of effects on data privacy, or misuse of profiling based on data gleaned from Web 2.0 applications.

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Table 1. Towards a socio-technical society: Shift from informal to formal structures

First phase	Second phase	Third phase	Next generation
a. Mainly trust-based virtual communities, very informal rules (architecture of free participation)	b. Clear rules (conventions, borders, etc) that are mainly socially enforced	c. Clear rules, mainly technically determined (but for most people obscure):	Basis for emergence of new socio-technical networks ⇒ first phase begins again but on a higher technical level
e.g. Wikipedia's current stage	e.g. Ebay; Online Language 'Leet'	e.g. Google page ranking	"*Next loop begins*"

→ *Evolving new socio-technical relationships* →

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Key Terms

Action Research: Action research is an iterative research process which enables researchers to understand a social or sociotechnical phenomenon with the aim to improve its quality. It consists of several phases of analysis (reflection) and action (interventions) which are alternate and interwoven (cycle of activities): Action research includes a problem diagnosis, action intervention, and reflective learning in real situations, gain feedback from this experience, modify the theory as a result of this feedback, and try it again.

Formal Structures: characterized by conventional forms of behaviour; established conventions (e.g., behaviour which is formally bound by a contract).

Informal Structures: not formal, casual; spontaneous; unplanned; unofficial, loose (e.g., an informal gathering of people; informal communication at coffee breaks).

Social Relation/ship: A social relation is a relation between people. It consists of a multitude of social interactions regulated by social norms, between two or more people, with each having a social position and performing a social role. Social relations form social structures and roles.

Social Roles: A role is the sum of all Behaviour expectations of a social group (all different members) towards a concrete position, and a set of descriptions defining the expected Behaviour of a position which is being held by a person. Roles in groups are dynamic that means that they are 'created' in social interaction processes (often unconsciously).

Social Structures: Social structures within a group or society are relatively enduring pattern, interrelationship of social elements, or relations to other group members (e.g., expectations, social interaction, and relationships within social systems).

Socio-technical Community: A socio-technical community is a special form of a socio-technical system including human-computer interaction and communication from human operators that operates. Communities are bound by informal relationships, people with similar interests, problems or passion for something. Instead of online communities that are pure online groups, socio-technical communities are groups of people that have some online presence in combination with some physical connections.

Socio-technical Paradigm: The socio-technical paradigm is the study of the relationships and interrelationships between the social and technical parts of any systems.

Endnotes

1. Inspired by Bales' "*interaction process analysis" (Bales, 1950)*, who studied small groups face-to-face.
2. The strength of weak ties was analyzed particularly by Granovetter (1973).
3. The standard length of an undergraduate computer science degree in Germany is nine semesters (4-5 years). The majority of students take 12-14 semesters to complete their course (6-7 years).
4. German students often have a high degree of freedom: the decision of when to attend lectures or seminars (in which semester) or even when to take examinations (in which semester) is left to the discretion of each student.
5. WIS is an abbreviation for the project 'Development of Computer Science' at the University of Dortmund (Prof. Dr. Thomas Herrmann), promoted by the State North Rhine Westphalia (Germany) from 2001-2004.
6. It is not obligatory for German computer science students to attend lectures to take examinations.

7 German universities offer a multitude of lectures and students have to create their own semester plan for lectures; meaning they can choose which lectures they attend and when to attend them.

8 People don't have same aims since the role of 'study management advisor' is perceived as "*just an additional job*" which must be conducted by the academic staff from the Department of Computer Science. This job is an extra job besides research activities, lectures and doctoral thesis. Hence, from the viewpoint of such people, the job 'study management' is not their priority.

9 Surowiecki argues that the aggregation of information in groups, resulting in decisions, is often better than by any single member of the group.

10 Retrieved December 27, 2007, from http://en.wikipedia.org/wiki/Wikipedia:Facebook

Chapter LI
Future Living in a Participatory Way

Laurence Claeys
Alcatel-Lucent Bell Labs, Belgium

Johan Criel
Alcatel-Lucent Bell Labs, Belgium

abstract

This chapter introduces the concept of critical user participation as a means to see the socio-technical gap in context aware applications as an opportunity rather then a problem space. It argues that for context aware applications to get integrated in everyday life, the principles of critical user participation as defined in this chapter must be fulfilled. In the first part of the chapter the authors scrutinize the concepts of "context" and "participation" and argue why critical user participation principles should be fulfilled when developing and interacting with context aware applications. The second part consists of an empirical study on the existing vision and context aware applications of the "homes of the future" in Belgium and the Netherlands. In the conclusions a reflection is made upon the opportunities of the socio-technical gap to empower the users of context aware applications.

We are responsible for the world in which we live not because it is an arbitrary construction of our choosing, but because it is sedimented out of particular practices that we have a role in shaping.

—Karen Barad (1998 p. 102)

Introduct Ion

Imagine you live in a context aware house that reacts on you and the environment you live in. When you wake up lights automatically switch on and curtains open. Standing in front of the bathroom mirror when brushing your teeth in the morning, a shopping list of things you need to buy today is

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displayed based on what is in your fridge. When entering the kitchen you smell the coffee that is ready. The door locks automatically when you leave the house and when coming home in the evening the song that corresponds with your current mood and day activities is playing and your house is warm because the central heating was switched on one hour before you entered the house so that it had your preferred temperature.

The ideal situation: an invisible, personalized, adaptive and anticipatory house that mediates social interaction between you and your environment. It seems perfect to let boring routines be carried out by a system. But how will the context aware house act when you are sick and want to stay in bed? And will you be able to get coffee even if you don't have brushed your teeth, or get coffee for two when somebody stayed overnight?

Different authors (e.g. Weiser, 1991) already predicted these moral questions long time ago. Technically a lot can nowadays be realized that works very well in a lab environment. The behavior of context aware houses can be defined as a set of rules, each formulated as actions that are executed when certain conditions are met. Rules in computer programs, however, become more on more complex and are most often hidden to the users. Although technologically context aware houses can be realized, why aren't they used frequently in everyday life? Is it because they are too expensive to install? Is it because it's all about rather useless luxury applications? Maybe, but the embedded vision on 'context' within the application and the vision on 'participation' when developing applications seem also to be part of the problem.

From above examples we can distillate two important observations, typical for context aware applications. First, the issue that the vision on context awareness is very much technological driven and often do not take into account the meaning of context for the person that acts in his or her own environment. But context isn't something that describes a setting; it's something that people do, the horizon within which the user makes sense of the world (Heidegger, 1927). Therefore context cannot be defined as a fixed set of characteristics. Second, context awareness seems to imply loose of control for the person concerned. In contradiction to almost all other applications, typically for context awareness is that there is no need 'to give authorization to do this or that'. Issues as privacy, autonomy and control frequently don't seem to be implicated. Users often don't have impact on the feedback loop (Crutzen, 2005a).

We believe that these issues are an important part of the explanation for the only very slowly integration of context aware applications in everyday life. The explanation for this could lie in the difference between what society wants and what technology does, or between social requirements and technical feasibility (e.g. Ackerman, 2000). We try to define the problem in another way because we believe that technology and society could never be 'matched totally' before the adoption process starts. We consider the socio-technical gap not as a problem but as a reality. The gap implies opportunities for co-construction and diversification for the development of context aware applications.

We propose to take the 'best' out of both worlds by introducing the concept of 'critical user participation' going back to the original meaning of user participation the Participatory Design movement attached to it, namely the issue of power and its distribution (Beck, 2001).

This article starts with a theoretical exposure on user participation, context and context awareness, where after we link these concepts together to describe some principles in the way software has to be developed. Thereafter we present in the empirical part of the article our study on the future ambient living vision that is shown in the existing future living homes in Belgium and the Netherlands. In this study we analyzed how far context aware applications and environments as represented in future homes correspond with our vision on critical user participation.

the soc Io-techn Ical GaP as a real It Y

The gap between the technological 'reach' in the design process and the differences with technologies-in-practice are a reality we must face. Although mostly the Human Computer Interaction (HCI) discipline and marketing theorists have sought to narrow or to bridge the gap, their vision often starts from a fragmented approach of both society and social interaction which they believe can be modeled from the start. This might be a design fallacy (Stewart & Williams, 2005) as the starting point is the presumption that the primary solution to meet user needs is building more extensive knowledge about users, their purposes and the context they live in, into technology.

The socio-constructivist approach used in ethnographic research suggests a different perspective on the socio-technical gap and the creative processes to put technology in practice (Dourish, 2006). In ethnography the socio-technical gap is seen as a natural consequence of everyday's action and not as a problem to be eliminated. Technology is defined as a site for social and cultural production as it provides occasions for enacting cultural and social meanings. This approach has implications on different levels. First, innovation and adoption cannot be seen as two separate processes but are an innofusion process of technological design, trial and exploration, in which user needs and requirements are discovered and incorporated to get technology to work in useful application ways (Fleck, 1988). Second, technological, social and cultural practices are in a mutual shaping relationship (Boczkowski, 2004).

From this perspective we believe that a more critical user participation model (Criel & Claeys, 2007) is needed for the development of applications when aiming that technology becomes part of everyday's life and gets meaning through the enactment. We follow Cecile Crutzen (2005b) who applies the concepts of Roland Barthes (1977) on applications. She states that applications have to be developed in a way to be 'writerly (scriptable) text' rather then 'readerly (lisible) text'. In 'readerly' texts the author is an autonomous, authoritarian producer and sender, and the reader a prototyped passive consumer and receiver. The 'writerly' text, in contradiction, invites to active participation of the reader. This, however, has implications for the way software has to be developed in order to make that users could also become producers and not only consumers of applications. This means that changes have to be made on the deeper levels of software applications and not only on the way a product is designed. This is in contradiction with the current tendency of increasingly black boxing technology, certainly context aware technology, for end-users (Criel & Claeys, 2007).

context as a sl IPPer Y conce Pt

The question of context touches upon the philosophical question of how people relate to, and act within, their life world. Depending on the worldview a researcher supports a different definition of context is conceptualized. Positivist theorists believe in an objective, measurable life world that can be modeled. Socio-constructivists, or more precise, phenomenological theorists, do not believe in an objective reality[1]. In their view the world cannot be seen separated from a person. In the words of Edmund Husserl, the founder of the phenomenology discipline (1970): *"The life world is understood as what we experience pre-reflectively, without resorting to categorization or conceptualization, and quite often includes what is taken for granted or those things that are common sense"* (as cited in: Laverty, 2003: 4). Reality is seen not as a world consisting of facts that represent objects, but as a set of intersubjective constructed meanings that are defined in interaction or enactment.

Although this phenomenological approach of context has been taken up strongly from the 60's on within human sciences, the positivist vision on context is still dominant within computer sciences. For example Anind Dey defines context as *"any* *information that can be used to characterize the situation of entities (i.e. whether a person, place or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves. Context is typically the location, identity, and state of people, groups and computational and physical objects"* (Dey, Abowd & Salber, 2001: 97).

Dey's definition of context incorporates a worldview that is clearly a positivist one. Dag Svanaes (2001) makes this clear by analyzing Dey's definition. He concludes that in Dey's vision:

- A system of users, devices and their physical environment is best modeled as objects with properties and relations.
- These entities, properties, and relations have an objective existence 'in the world'.
- The interaction between the entities is best described as flow of information.
- Context can be modeled in a similar fashion, as additional properties and relations of objects of the world.

Integrating the phenomenological view on the life world within context awareness and computing in general is hard, but seems inevitable when working in an innovative way on the topic of context awareness. To take into account the meaning that is given within an enactment is a challenge engineering should address. It undermines the belief in the existence of a 'model of the user's world' or a 'model of behavior' and is impossible to implement with the current methods, languages and tools that exist within computing and are based upon a positivist worldview.

How can context aware applications be developed, taking into account this slippery, non-modeled context concept? Is it possible to see the techno-social gap as an opportunity to achieve this? We think an entry point could be to reanalyze and change the vision on user participation that currently exists within the research and design community.

PARTICIPATION AS EMPOWERMENT?

The development of new (context aware) applications envisions a central role to the user. This is for sure important when starting from a phenomenological view on the life world. Recently different participative methods were developed and are nowadays used to learn about users and their needs. Some known user-centered methods within industry are co-creation (Van Rompaey, Van Der Meerssche, Godon, Vanden Abeele, & Charliers, 2005) and working with living labs (Niitamo, Kulkki, Eriksson & Hribernik, 2006).

But what does it imply to have users participating in the development process? What is their impact? How are the power relations between technology and users? The concept 'user participation' seems to have conquered the world, but didn't the concept meanwhile also become an 'empty signifier' (Laclau & Mouffe, 1985)?

User Participation in Theory and Praxis

Since the 80's there is growing attendance for participation of the user in innovation. Different people have used 'participation' in a wide variety of different situations. Therefore some refer to participation as an empty signifier (Carpentier, 2007). The history and origin (and radicalism) of the concept as related to power issues is fading away under the diversity of different meanings on it. Jan Servaes (1999) refers to the importance of power as central entity that must be linked to participation. As he writes: *"this 'real' form of participation has to be seen as participation [that] directly addresses power and its distribution in society. It touches the very core of power relationships"* (as cited in: Carpentier, 2007: 97).

It is not traceable who focused for the first time on user participation regarding technology innovation, but the research area known as Participatory Design (PD), from origin Scandinavian, played certainly an important role. Participatory Design is a research area that initially started from Trade

Union Participation (Beck, 2001). A central concern was that workers needed to be able to participate in production design. Therefore representatives needed to understand new technologies in order to be prepared for negotiations with the management (Nygaard & Bergo, 1973). In this vision user participation is in no way related to business issues or forecasting the market, but is only seen as a vehicle for empowerment of the user in different ways. This notion of user participation is closely related to the interpretation of authors as Carole Pateman (1970) and Servaes (1999) gave to it. Later on different political, and non-political, researchers focused on the development of specific techniques to involve users in design (for an overview, see: Bjerknes, Ehn, & Kyng, 1987). Much more attention was given to usability of applications and market forecasting and the analysis of power relations faded away.

It looks like the success of user participation is accompanied with the impoverishment of the concept of 'user participation'. As Eevi Beck formulates it: *"participatory design has come to include practices that share only the historical link to participation as a vehicle for empowerment. In the non-political extreme, user participation, once politically radical, has been picked up as a slogan for marketing and other uses"* (2001: 6).

We believe however that participation and empowerment should stay intrinsically linked to each other. This form of participation is what we define as critical user participation[2]. With the use of the adjective 'critical' we want to articulate the difference with the way user participation is defined within much user-centered (design) research as discussed in the next paragraph.

Implications of user-centered design

User-centered design with the goal of 'simple and easy technology or interactions' is currently the dominant trend in design processes. Designers and developers try to know as much as possible about their future users. However, when applications are more and more tailored for individual likes, dislikes, skills or needs of a particular target population, they will less likely be appropriate for others (Norman, 2005). Another drawback is that, when working with specific target groups, the design tends to become quickly a strengthening of existing stereotypes. To put it simple: it makes everything pink and round for women, and blue and angular for men. This may conduct to shortage of individual preferences, experiences and lifes of users. Don Norman, who is perceived as a leading voice regarding user-centered design, questions the current direction of design. He states: *"Human-centered design is considered harmful"* (2005: 14).

We assume that within such a user-centered design process the outcomes of decisions stay in the hands of the developers. This includes unequal power relations between developers and users and later on between technology and people, who have to adapt to the technical restrictions. Looking at the development process one sees that the possible user's impact on the development of applications is narrowing further the development of the application is completed. Therefore one can in no way speak of more or less equal power relations. Involvement of users is very limited. Mostly existing behavior patterns are observed during the contextual investigation (pre-application time), and the interaction with the application is only studied when the application is already prototyped.

For developing context aware applications certainly a more profound form of user participation is needed, with the center power in hands of humans and not of machines. Only then context is approached from a phenomenological worldview and can be talked about critical user participation that puts empowerment of the user on the foreground.

Evolution and Participation Shifts in the Development of Context Aware Applications

During the last fifteen years intensive research in academic circles as well in the industry takes place on the topic of context awareness. One remarks, however, that most current commercial context aware applications are pre-configured and don't allow users to co-construct. The logic in context aware applications (although this counts for many other applications as well) is too black boxed in the name of user-friendliness.

Before 2000 almost all sensor specific programming code was hard wired (programmed) into applications so that only very few specialists could develop them. Building such applications was very cumbersome and re-use was almost impossible. Around the year 2000 component-oriented frameworks were constructed which helped to develop context aware applications without having to know every sensor details (Dey, 2000; Chen, Fenin, & Joshi, 2004). Although this lowered the barrier to develop context aware application for developers, this still didn't give the control to the user. The last year's step-by-step research starts on how context frameworks/applications can be adapted so that developers can implement the logic in a more declarative way. The rise of ontology based context models (Chen et.al, 2004) and reasoning engines that use rules for declaring the logic play an important role.

To fully exploit ontology based context models as asset for empowerment of users it is, important that the model reflects the world of users (as good as possible) and is flexible enough to evolve over time. This contrasts with most current models that are still too often defined by the developers at development time (Chen, Fenin, & Joshi, 2004; Strobbe, Hollez, De Jans, van Laere, Nelis, De Turck, Dhoedt, Demeester, Janssens, & Pollet, 2007). In the knowledge engineering domain, emerge methodologies for collaborative ontology engineering with evolution support (De Moor, De Leenheer, & Meersman, 2006). Combination between these two worlds, however, would create synergy leading to a step forward. Another important aspect is that the rules should be integrated in the context model, so that they are described in the same language and can evolve together with the model concepts.

Without the recommendations stated above rule, based systems or reasoners make it easier for developers. However, logic to define rules is still too complex for an 'ordinary' user.

Last years research started on how to give users control of context aware applications (Dey et.al., 2004), (Dey, Sohn, Streng, & Kodama, 2006) and on the relevance of context topics for the users, or even better to make that the users can define the context topics that are relevant for themselves.

Recent evolution shows that an increasing number of researchers in this field start to realize these technical challenges. It will, however, be difficult to let context awareness become part of everyday life. The cause is often described as the context-gap, the gap between what technologies can measure and calculate from sensor data or other types of electronic information and the complex, individually perceived context in a user's environment (Barkhuus, 2004). This makes the context topic highly interesting for transdisciplinary research. Moreover, we believe that conclusions of this research can also be used in other application domains (like in context aware web applications where the hardware sensors are replaced by software ones).

Principles of Critical User Participation within Context Aware Applications

Literature study teach us that Victoria Bellotti and Keith Edwards (2001) and Paul Dourish (2004) already defined design concerns or design principles which have to be taken into account when developing context aware applications from a socio-constructivist perspective. Their angle is different from ours and does not start from the notion of critical user participation. Generally speaking, Bellotti and Edwards wanted more attention for human aspects in the definition of context aware systems and developed principles that support intelligibility of system behavior and accountability for human users (Bellotti & Edwards, 2001). More abstractly Dourish focussed on the definition of context and activity as mutually constituent, in '*embodied interaction*' (Dourish, 2004).

None of them give very concrete guidelines, but they defined potential design consequences to support the development of context aware applications from a socio-constructivist perspective. We tried to refine and complete these existing principles and named them 'principles for critical user participation within context aware applications'.

The defined principles are the following[3]:

1. Inform the user of current contextual system capabilities and understandings
2. Provide feedback including:
   - Feed forward: what will happen if I do this?
   - Confirmation: what am I doing and what have I done?
3. Enforce identity and action disclosure particularly when sharing nonpublic (restricted) information: Who are they, what are they doing, and what have they done?
4. Provide control (and defer) to the user, on the system and various user actions that could impact him or her, especially in cases of conflict of interest.
   - *users should be able to put off context aware systems.*
   - *users should be able to put off the context aware part of the application, and it still has to work.*
   - *users have always the 'final word' in conflict of interest.*
   - *users have to give permission to put on context aware systems.*
5. Users should be able to define their own context aware behavior(being able to question context aware behavior, not only supporting routines defined by developers or installers)
   - *define their own actions related to certain context stimuli.*

Implementation of these principles implies some basic principles that must be respected before they can be used. First, take into account that developers may not design from a *'view from nowhere'* or '*detached intimacy*' but from a '*located accountability*' (Suchman, 2002). And second, users have to take their responsibility. Living in a networked society makes it essential to develop some critical digital literacy, and also some critical literacy of the digital. A necessary condition to shift power relations regarding technology, and more specifically related to context aware applications, in favor of the user is inextricably. This has to be linked to the will of users to take their responsibility in autonomous behaving and controlling their everyday's life world wherein context aware applications will possibly get integrated.

The fulfillment of these conditions will nevertheless not allow users to fully participate in the development and configuration of the context aware logic. But we believe that consequent application of these conditions will make the users more confident and empowered on context aware environment. Users will be able to play a real user participatory role in the definition of the horizon in which they make sense of the world.

We would like to make a step forward compared to the existing literature by making these principles more concrete in order to use them in an empirical researching setting by studying existing context aware applications that are now implemented in future living houses. In the questionnaire we developed for this empirical research, we made these principles 'measurable'.

Future lIVInG In belGIuM and the netherlands: an exaMPle studY

In the example study we analyze the current trends on context awareness as used in ambient living applications in future homes, starting from the critical user participation principles defined above. From this study we want to analyze to what extent the current vision on user participation in context aware applications and environments includes empowerment and control of the user, and using the socio-technical gap as a reality and opportunity rather then as an obstacle.

The formulated question is as follows: "To what extent do ambient living applications, as articulated in future homes in Belgium and the Netherlands, satisfy the critical user participation principles?"

study set-up

When searching the internet[4] for future homes in Belgium and the Netherlands, we selected following three houses, which we could visit ourselves[5]:

- The Living Tomorrow House in Amsterdam (LTA)[6]
- The Living Tomorrow House in Vilvoorde (LTV)[7]
- The Slimste Woning in Amsterdam (SWA)[8]

However, our study method has some drawbacks, which have to be taken into account. First, future homes only give a selection of the available future ambient living technologies. Second, future homes are partly a commercial initiative and a platform for companies to present, and even push, their products to the market. Therefore they represent applications in development. Third, we could not investigate the future homes applications in real conditions.

The reasons to choose future homes as example study are that the exhibited innovations are recognizable and already realistic applications as 80% of them are ready for the market, while 20% are future-oriented visions (Living Tomorrow, 2007). In SWA all applications were available on the market and could be bought. The applications can be seen as a sample on how companies envision ambient living applications now or in the near future.

Every result of this study must be situated against this background information.

We analyzed a selection of the available applications in the houses based on the different themes presented . We made following selection (in italic).

- LTA: *Information & communication technology*, Environment, Energy, Mobility, Building & Construction, Decoration & Design, Safety, Media, Health – relaxation & spare time, *Domotica & immotica*.
- LTV: *Information & communication technology*, Environment, Energy, Mobility, Building & Construction, Decoration & Design, Safety, Media, Health – relaxation & spare time, *Domotica & immotica*.
- SWA: *domotics*, flexible living, sustainable building conversion, accessible living

We also analyzed only applications for in-house use and not related to work or use outside the house. In addition we selected only the applications, which perform (automated) background activities or interactions. Background interactions, in opposite to foreground interactions, are defined as interactions that happen without explicit mediation of the user within the application (Ishii and Ullmer, 1997). We ended up with a list of 21 applications. The selected ones, grouped by their location, can be found in Appendix A. Duplicates were omitted. In the list we gave the applications a name and described in terms of actions (A) what 'do they?' (sometimes they 'do' more then one thing) and conditions (C) which means that certain actions are only performed when the specified conditions are met.

Each action-condition interaction was analyzed using a questionnaire (Appendix B) we draw up. With the questionnaire we attempted to measure compliance with the earlier stated critical user participation principles. However, we recognize this is a very limited way to test these principles in practice.

Findings

The results of the questionnaires were quantified and a frequency analysis was performed using the software package for quantitative research SPSS[9]. Our findings have to be interpreted with caution as they are based on prototypes under development. They have been made after discussions we had with our guides during our visits of the future homes and our own observations. It was also difficult to split up the applications in different independent interactions. Particularly the presence of a home-butler (in LVA called the Living Tomorrow Home computer) integrating a lot of different applications made this difficult.

Moreover it was not possible to study the internals of the applications. Therefore we could not judge to what extent the data gathered in these applications was available and secured for access from outside. By consequence the third user participation principle about identity enforcement and action disclosure could not be studied.

In the following we describe our conclusions based on our analyses and some interesting observations during our visits.

In general more than half (55%) of the applications analyzed were on the market. This rather large amount was mainly due to the products present in SWA. Furthermore comfort, household and safety took the main share (more than 75%) of the product categories.

The drive to reach Weiser's vision on invisible computing (1991) seems to be applied in the future homes. More than 60% of the sensors were invisible for the user. When visible, they only seemed it due to technical constraints.

Thereafter the satisfactions of the user participation principles were checked against the analyzed applications. From the start we noted that some of these principles were very difficult to check in real life situations. It could be questioned if the principles formulated by Bellotti and Edwards on component-oriented architecture (2001) are too theoretical and by consequence not so well applicable in real life situations.

The first principle, on the provision of information to the user about current contextual system capabilities and understandings, received almost no attention in the analyzed applications. Only in 23% of the applications this rule was met. The other 77% of applications all worked with software sensors or sensors using object identification technologies. From the moment (hidden) sensors, such as motion sensors, were used, no attention was maid to this rule. If this rule is neglected for sake of the drive to invisible computing or because nobody finds it worth or possible to search for a technical/design solution for this difficult issue remains obscure.

Concerning the second principle, namely providing feedback, we didn't found any application that really provided tools for feed forward or confirmation. Also the confusion of the guides (who nevertheless have to be seen as experts of the applications available in the houses) when something did not or unexpectedly happened, strengthen our idea that this is a difficult issue; primarily when 'ordinary' people will inhabit this 'smart' houses.

As mentioned above, the third principle was impossible to check.

On the fourth principle, providing control to the user, the smart homes score well. A majority of applications (more then 50%) provide the capabilities for user interaction with the context aware systems (mostly through the use of touch screens, buttons or switches) and in most cases it was possible to switch off or overrule the context aware behavior.

On the fifth and last principle, namely defining their own actions and stimuli on context aware systems, the smart homes also did not meet the formulated goals. More than 81% of the applications didn't provide to end-users the possibility to define or change the context aware behaviors of the application.

To summarize, concerning compliance with critical user participation principles in the future homes we noted that very little attention was paid to make easy understandable and learning-friendly context aware systems. Almost all system interactions acted as a black box. Manufacturers and installers are defining the interactions, not the users. Users can also not make changes. Therefore for the moment one cannot speak of a user-controlled vision on smart homes. The behavior and choices of users are determined by the manufactures or installers, and not by users themselves. The fact that humans do not behave as machines, and their actions are not planned in the way machines do (Suchman, 1987), is still not resolved.

Finally we want to state our analyses made it clear that it is extremely valuable to confront participation principles in real home environments leading to useful insights not retrievable on purely theoretical basis.

General conclus Ions

This article starts with defining some problems within the existing vision and implementation of context aware applications. The problem of the positivist way context is defined within computer sciences and the vision these applications embed on the role and capabilities of the user are discussed. The way user participation is used and defined in application development was the other problem discussed. We refer to the existing approach that the gap between the technological 'reaches' and the social 'aspects' has to be overcome as one of the wrong angles that reinforce rather then solve the problems. From our perspective, the socio-technical gap can never be bridged before the innovation process, therefore we rather speak of an innofusion process.

By defining the socio-technical gap as an opportunity rather then a problem space we wanted to give a new impulse to the vision and development of context aware applications.

We have done this in two ways. Firstly, we analyzed the notions of 'context' and 'participation' by putting forward the phenomenological view on context and the definition of participation as empowerment, setting forward the power relations that exist between humans and machines. Before defining the principles of critical user participation we also described our view on the evolution and the participation shifts in the development of context aware applications that happened the last decades. After the theoretical analysis of concepts, we defined, following the proposals of Bellotti and Edwards, some critical user participation principles onto where context aware applications should satisfy. Secondly, we studied the context aware applications presented in future homes in Belgium and the Netherlands and analyzed how far they fulfill the critical user participation principles. From these cases we observed that 'invisible' computing is a fact rather then a vision. The big challenge or opportunity is, to our opinion, however, to give the control of the logic embedded in the houses to the users. Analysis of the applications made clear that applied background interactions in the future houses still remain a black box. In almost all instances it was impossible to understand what would happen after an action, to know what the context was doing (or the machine) or did. Moreover in almost none of the applications the user could define its own rules or change existing ones.

The example study strengthened our believe that the principles of critical user participation, although they are probably formulated partially too theoretical, should all be satisfied in order to be able to speak about empowerment and real participation of users. Although the principles should be reformulated, we believe they are the basis to use the socio-technical gap as an opportunity. Otherwise, ambient intelligent homes will always be felt as uncontrollable and unusable.

Finally we want to comment shortly on the conducted investigation. Through this study we also wanted to contribute to the transdisciplinary work in this domain and in particularly the cross-fertilization between disciplines and research methods that we find of highest importance. When one really wants to change the technological determinist vision on society and societal change, people from different disciplines have to take time and patience to really talk and work with each other. Only then technical systems can be developed in a way they change society in a democratic and empowering way.

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KEY TERMS

Ambient Intelligence: A vision on the future that assumes that technology will be an integral part of interactions, but that the technology behind will 'disappear' and invisibly be integrated in everyday life world. Other metaphors that assume this disappearing interface and invisibility of technology are: ubiquitous computing, ubicomp, pervasive computing, everywhere or calm computing.

Context: From a positivistic worldview context are the who's, where's, when's and what's of entities.

From a social constructivist worldview context is about meanings that are constructed in interaction with persons, places or objects and not about entities as persons, places or objects as such. Context then defines interaction, but interaction is also changing under influence of context.

Context Gap: The gap between what technologies can measure and calculate from sensor data or other types of electronic information and the complex, individually perceived context in a user's environment.

Critical User Participation: A form of user participation that refers to the issue of power and its distribution regarding technology. Empowerment of the user is put forward. It is a reaction on the approach of seeing the user as in need of 'simple and easy' technology.

Empowerment: The process of strengthening of among others individuals where they get grip on their own situation and their surroundings, and this by means of acquiring control, tightening up critical conscience and stimulating participation.

Future Living: The vision on the way citizens will live in the future, mostly represented in lab context with focus on innovative technologies.

Participation: A process in which two or more parties influence each other in the making of decisions. In the decision-making each individual member has equal power to determine the outcome of decisions.

Science and Technology Studies (STS): An interdisciplinary human science discipline that focuses on society and technology. It is developed as reaction on the lack of interest within human and social sciences to study technology as materiality. Characterizing for STS is the social constructivist emphasis that it lays on the vision on technology and society. Science & Technology Studies has his roots within the so-called Strong Programme within science & knowledge sociology known by the work of David Bloor and Barry Barnes.

Endnotes

1. A basic and very known work on this paradigm shift from positivism to socio-constructivism within sciences is *The Structure of Scientific Revolutions* (1962) from Thomas Kuhn.
2. By using the concept 'critical' we estimate the relation to the tradition of critical theory as defined by Max Horkheimer of the Frankfurt School.
3. We start from the principles defined by Bellotti & Edwards (2001). The refinement and completing of their principles by us are written in italic.
4. We searched the internet with the concepts (in combination) 'smart house', 'smart home', 'future home', 'future living', 'Belgium', 'Netherlands' to find the smart homes for our research.
5. All houses were visited between October 2007 and March 2008. Taking a guided tour was obligatory. We want to thank the guides for the engaging and interesting information they provided to us.
6. Http://www.livtom.nl/corporate.aspx?node=258&lang=EN
7. Http://www.livtom.be/corporate.aspx?node=259&lang=EN
8. Http://www.smart-homes.nl/nederlands/woning/index.html
9. For more information on SPSS: http://www.spss.com/

aPPend Ix a

This appendix contains a list of the applications, grouped by location, in the house. The interactions they include are described in terms of conditions and actions, meaning that a certain action (A) is performed when the specified conditions(C) are met.

Living Room

NAME	Automated Curtain Opener
A	The curtain opens
C1	When TV is switched on
NAME	(Ambient) Light
A	The light changes or goes on
C1	When TV is switched on
A	The light changes or goes on
C2	When someone enters the room
A	The light changes or goes on
C3	When the content of the TV changes
NAME	Automated heating
A	Temperature changes
C1	Between certain times (like scheduled)
NAME	Life & Cooking product reminder
A	Show reminder
C1	When you need product for a recipe and it is not available in the house

Kitchen

NAME	Bottle-oriented wine cooler
A	Temperature of a box of the wine cooler changes
C1	To the needs of a certain bottle of wine that is stored in the box
NAME	Drawer lighting
A	The drawer is enlightened
C1	When the drawer is open or opened
NAME	Automated microwave
A	The cooking time and power of the microwave changes
C1	When a product is put in it
NAME	Intelligent fridge
A	The user is warned
C1	When some product need to be ordered
NAME	Cook TV
A	The television is switched on and shows recipes for the chosen products
C1	When certain products are taken out of the fridge

Sleeping Room

NAME	Nightlight guiding system to bathroom
A	A trace of lights go with you
C1	When person stands during night
NAME	Automatic bed light
A	Bed light is switched on
C1	When standing up
NAME	Wake-up light
A	Light goes on smoothly
C1	When at a certain time
NAME	Fall detection system
A	An alarm is given
C1	When a person falls
NAME	PAS system environnent adaptation
A	TV and music is switched off and light is switched on (and alarm goes off)
C1	When person has pushed on the PAS button

Bathroom

NAME	Diet coach
A	Your BMI is displayed
C1	When you stand in front of the mirror
NAME	Teeth brushing coach
A	Your brushing behavior is coached
C1	When brushing your teeth
NAME	Flood detector
A	A call is made to the alarm center
C1	When water is on the ground
NAME	Automated toilet
A	A toilet ritual is started
C1	When sitting on the toilet

Technical Room

NAME	Washing guidance
A1	The guides warns you
C1	When wrong (different colors) clothes are mixed when put in the washing machine
A2	The guide selects the best suited program automatically
C2	When clothes are put in the washing machine
A3	The guide selects the right washing powder
C3	When clothes are put in the washing machine

appendix b

1.	**General information**	
1.1	Product number:	____________
1.2	Product name:	____________
1.3	Location:	____________
1.4	Is this product on the market?	yes / no
1.5	If yes, in the form presented here?	yes / no
1.6	Company who made it?	____________
1.7	'Sector' of the product:	entertainment / security / leisure / work / household / comfort / other: ____________
1.8	Short description goal of product:	____________
1.9	Short description of product:	____________
1.10	Defined target group :	____________
1.11	Kind of sensors:	____________
1.12	Is the sensor visible?	yes / no
1.13	Type of sensor?	temperature / motion / other: ____________
1.14	Name manufacturer sensor:	____________
1.15	Define actuators:	____________
2.	**Vision on context awareness**	
2.1	Does the application support improvisational behavior?	yes / no
2.2	Does the application support routines/routine behavior	yes / no
3.	**Regarding informing the user**	
3.1	Does the application display aspects of its own context? (its activity and the resources around which that activity is organized)?	____________
3.2	Is the internal system structure in one or another way available for some degree of user inspectation or manipulation?	____________
3.3	What happens if the application fails?	____________
4.	**Provide feedback**	
4.1	Is there a form of feed forward?	____________
4.2	Is there a form of confirmation?	____________
5.	**Enforce identity and action disclosure**	
5.1	Can the information of the product be retrieved from outside the house?	____________
5.2	How secure is the product for data theft (from in or outside the house)?	____________
6.	**Provide control to the user**	
6.1	Can users interact with the system?	yes / no
6.2	If yes, what actions do they have to do for that?	____________
6.3	What are the used displays?	television / mobile / PC / other: ____________
6.4	What kind of 'human intelligences' is used:	linguistic / musical / logical-mathematical / spatial (visual) / bodily-kinesthetic / social / interpersonal
7.	**Off function**	
7.1	Is it possible to put the context aware application off	yes / no
7.2	if yes, it is in an easy way?	yes / no
8.	**Defining of context aware behavior by users**	
8.1	Is the application tailorable or personalizable?	____________
8.2	Where are the rules defined?	____________
8.3	Can you as an end-user change the rules?	____________
8.4	Can you from outside the house ask for rule information or change rules?	____________

Chapter LII
The Impact of Communications Technology on Trust

Paul Hodgson
British Telecom, UK

ABSTRACT

This chapter analyses the formation and generation of social trust through communications technology in postmodern society, and presents some possible solutions to social disintegration. One view of social capital sees it as the strength of a network of relationships within a community. Evolutionary theory holds that any group whose members were prepared to help one another and were truthful and trusting with each other, would be victorious over other groups. Modern communications technology in postmodern society can be seen thus far to have led to a greater individualization and atomization of experience which presents a problem for the reinforcement of social trust. Virtual communication has been built upon social capital generated in the physical world but is in danger of depleting the very basis upon which it is constructed. The author's belief is that technology that better enables and enhances mechanisms of social coordination and trust are needed. Some observations on the nature of such technology are provided.

Science is organized knowledge. Wisdom is organized life.

—Immanuel Kant

Introduct Ion

s ocial Groups

Social groups have existed for a very long time throughout human evolution and extended periods of group interaction through work and play form the basis of social trust and the accumulation of social capital. It is through life experience that people come to know and trust one another and form tightly knit bonds. The evolution of trade and commerce between groups necessarily leads to a depletion of

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trust because goods are exchanged without intimate knowledge of their provenance. Money as a medium of exchange facilitates this process when goods are exchanged in markets. Social trust is however, the basis of commercial exchange, as without it, it would be very difficult for humans to live together in groups. Social groups are characterised by a division of labour and cooperation which both rely upon trust. In fact without trust humans could not be social beings.

social capital

Social trust is very much the basis of culture in modern society and is the foundation upon which social capital is generated. Beyond commercial relationships (markets, shopping etc) people engage in many cooperative and collaborative activities that reinforce bonds and create a sense of shared experience and history. Examples of this are the so-called "third sector"; clubs, societies, schools, colleges, friends, families and religious worship. Religious gatherings are still one of the few places where people frequently sing together in large numbers (the other is football matches). This is highly significant as it indicates that a social need that is not being fulfilled in a traditional forum (as evidenced by declining attendance in churches), is now being fulfilled in a commercial setting where people pay for the experience. Football supporters participate in a strong shared identity which gives meaning and value to their lives. The experience of being there is what counts.

Postmodern capitalism

Industrial capitalism of the nineteenth and twentieth centuries was fundamentally characterised by the manufacture and exchange of goods in markets. The post-industrial society or information society is now focused upon the delivery of digitised goods and services over information networks. Property relations are changing from a traditional ownership model where a commodity would be transferred from a seller to a buyer in an exchange of ownership, to a service model where ownership of a commodity or access to a service becomes a temporal phenomena, limited to a rental period of an agreed contractual duration. Profit is still the principal rationale, but certain fundamental relationships between buyers, sellers, employers, employees, companies and consumers are rapidly and perceptibly changing. This has major implications for all parties. Traditional capitalism focused on the commodification of goods and services and has successfully reached a comfortable level of material wellbeing for vast numbers of people. Having saturated material needs the digital revolution means that modern capitalism can now extend its reach into the commodification of culture and experience. This has major implications for trust.

experience as commodity

Music is an excellent example of the way in which a shared cultural experience has been packaged, objectified and commodified for consumption way beyond its provenance. Music is fundamentally the expression, communication and sharing of emotion. For many cultures music has a meaning and significance that reaches far deeper than a purely surface or cosmetic experience. It can represent the feelings and emotions experienced by people throughout prolonged periods of conflict or struggle. It can represent a whole range of feelings, from spiritual to conflictual to celebratory, and functions as a very strong binding force within social groups. The way it is packaged and sold within modern first world markets is however very far removed from its original intent and meaning. So called "World Music" has become very popular in recent years as postmodern capitalism seeks new ways to "create" new and different commodified forms to satisfy a constant ongoing need for new marketable products. Salsa music for example, was originally a music of Latin American protest as much as Blues music was on the North American continent, with all the inherent cultural meaning that is not obvious to an outsider just consuming the music as a sensory experience. Some world musics from the Third world (such as Javanese Gamelan music and many African forms) are even very hard to empathetically cognise for those brought up on western harmonic tonal music.

Commodification is now reaching beyond reified consumable objects and moving into real-time experiential human relationships, facilitated by virtual networks and evidenced by the plethora of social networking sites that have emerged in recent years. The emphasis here is on social presentation and real-time human interaction mediated by service providers such as (Myspace, Facebook, Twitter etc). Successful human relationships are of course, based upon trust, which must be established, maintained and reinforced within virtual environments.

t echnology and s ocial c apital

The fundamental problem for postmodern capitalism is not to kill the goose that lays the golden egg as pointed out by (Boyd 2002). Virtual trust is built upon virtual acts which are ultimately built upon physical trust, which is in danger being destroyed.

"As one of the most successful e-commerce sites, eBay provides important lessons about establishing a community of commerce and maintaining community trust even through explosive growth. But its success includes a cautionary note for other sites that would imitate the community security philosophy: in its haste to add more tools to users' security possibilities, eBay could end up damaging the very foundation of its first seven years of secure operation. A danger inherent in all interest-oriented communities is that they can disband more easily than communities with more traditional bases (Moemeka, 1998). (Castelfranchi & Falcone 2000) argue that depending on the situation, control (e.g., guarantees, surveillance) can either reduce or increase trust. This essay has argued that in eBay's case, the change from a cooperative system to a controlled system will lead to a reduction in trust. But the question remains: can community be coupled with non-trusting security measures, or will such a combination harm eBay's community trust and safety?

Today users can visit eBay and click on (Why eBay is Safe 1999). But of the five reasons offered, only the first and most heavily emphasised is community-dependent (check the bidder's or seller's feedback). The community at eBay may have been originally built on trust, but only time will tell if it remains built on trust or if that trust and perhaps even that community disappears."

If interpersonal interaction and communication becomes predominantly virtual and standardised, how will this impact the ongoing generation of physical social trust that presupposes it and is the very basis of trust in the virtual world?

This immediately raises a number of questions:

1. Is it the case that trust in the virtual world is enhanced if first established in the physical world? Evidence suggests this is true. (Lancaster 2006)
2. Is it the case that predominantly virtual social interaction leads to a decline in physical social trust? Evidence suggests this is true. (Youth culture, virtual simulation in games, second lives, paedophiles, phishing attacks etc)
3. If 1. and 2. are true what is the shape of things to come and what are the threats and opportunities?

Post -Modern It Y and current trends

s ocial n orm Formation

Social norms are rules or constraints that are socially enforced and punished by sanctions and can be enforced by laws. Norms can be classified in terms of their threat to social organisation and they range across a scale that is considered weakly immoral (such as provocative forms of dress) to highly immoral (such as murder) which are punishable with the full force of the law. Studies in classical sociology have shown that people with fewer social bonds and obligations will have less meaning in their lives and will be more likely to reach a state of anomie or normlessness in which they will be more prone to anti-social behaviour. The most extreme individual expression of this is suicide (Durkheim 1897). The more a person depends upon himself and recognises rules of conduct that are only based upon his own private interests, the more vulnerable he becomes. Social forces (or the lack of) combined with a sensitive individual psychology can lead to tragedy. The message here is that meaningful social interaction and bonding creates an important sense of group belonging. An experience of belonging and identity happens at many hierarchical levels within society, from small family structures of three or four people, to small work groups, to football supporter groups of thousands, right up to whole societies of millions united under a single representative.

It is clear that we are in the middle of a major transitional period, moving from a traditional centralised, hierarchical society to a much more decentralised, fluid heterarchical society. Centralised societies are characterised by strong hierarchy, centralised control with weak feedback and relatively static social movement where social bonds are well embedded and hard to change. Examples of this would be industrial societies of the 19th and 20th centuries and a more extreme example would be a feudal society. Conversely, postmodern society is characterised by the breakdown of traditional structures with all encompassing ideological metanarratives (Lyotard 1979), and the formation of much more spontaneous, dynamic networks of group structures, that have stronger feedback mechanisms and a more relativist ideology. Networked societies are essentially made up of much more dynamic and transient social bonds. These bonds are necessarily looser and in some cases may well be an illusion.

If the forces that generate and maintain social bonding are undermined in any way there will be increased instability within a society. Clearly, there is a major breakdown in traditional social structures taking place in advanced technological societies. Evidence for this is seen in declining church attendances, a rising divorce rate, an increase in alcoholism and drug addiction, an increase in the number of people living alone (Social Trends 2006), and an increase in the number of young people (especially men) committing suicide. There is a breakdown at key hierarchical levels (e.g. family, church) within modern western society. Many people feel in need of a greater identification with social groups. At present individuals can either turn to their friends and family for advice, and a sense of belonging, or to impersonal and increasingly insecure and impersonal virtual spaces. There has also been a generic failure of institutional trust as government and local services are overwhelmed by social problems.

Two major contradictory social effects that modern communications technology is having on everyday life are the increased individualisation of experience and the possibility of rapid dynamic virtual group formation. These are having significant social consequences.

Individualisation

Modern communications technology can be seen thus far to have led to greater individualisation and atomisation within society. Communicating with people from a personal computer is very much an individual experience. Furthermore, the fact that a person can now receive telephone calls, emails and videos on a 3G mobile phone in any location, means that this individualised experience of the world extends beyond the confines of the home or office and into shared public spaces. Public spaces can now be seen to contain many people having mobile conversations with people situated beyond the physical space that they are in. Life is becoming far less of a shared physical experience. Television, which used to be a shared family experience, is now a much more individual experience with eight out of ten children aged five to sixteen having a TV in their room. Broadband packet networks mean that television (IPTV) can be piped into the living room or the mobile device from anywhere at any time of the day. Programs can be saved and watched at any time which means that what would have previously been a shared temporal experience (Football World Cup 1966, Moon landing 1969, Berlin Wall destruction 1989) now becomes an individual one. The above examples were major events, however this argument applies to the smallest events leading to a fragmentation of collective and shared experience. There is, from a historical perspective however, a human need for shared physical experience. This explains why "third sector" groups are prevalent and why collective physical experiences such as music festivals and football matches are so popular.

Virtual Group Formation

A consequential and significant force that modern communications technology is now enabling is a subtle shift in the balance of power from traditional top-down established and centralised social structures, to a more bottom-up socially networked form of social organisation. Whereas previously groups of people would meet socially in physical locations such as sports clubs or evening classes, they can now meet complete strangers online in chat rooms, newsgroups, blogs, and virtual social networking spaces such as Myspace and Facebook. This raises some serious questions over security and trust[1].

Although virtual group formation does offer the possibility of increased social sharing, exchange and cooperation, the facilitators of the networking phenomenon are increasingly a few very large multi-national companies that dominate online commerce. It is only companies such as Google, Ebay and Amazon that can actually deal with the scale involved at the level of software. The main aim of global multinational companies is to now become an integral part of the service economy, supplying value-added services to customers that enable effective customer participation in the global networked economy (as exemplified by BT's ad tag "More Power to You"). Google, for example, are now providing free software tools and storage for people to rapidly and easily extend themselves into the online world, by generating and maintaining their own content. This is the next step beyond paying specialist intermediaries for web software development. Google of course can afford to do this and the payoff will be very high. This is a subtle hegemonic strategy as it leads to the Googlisation of the Net for the personalisation of experience, which further reinforces Google's business model. This is having and increasingly will have major implications for modern society.

examples of change

Media

The formation of social norms has to a large extent throughout the twentieth century, been largely carried out by centralised institutionalised media in the form of television and newspapers. This is now in a process of rapid change as the impact of social community networking (Blogs, Myspace etc) and IP television is felt. One powerful indicator of this trend is the fact that traditional media jobs are in decline to the extent that the San Francisco Chronicle now has to take a 25% cut in newsroom staff as reported here (Chronicle 2007) .

Many Internet users do not wholly trust the main stream media and want to supplement traditional news sources with online sources. In this way they can compare and contrast different stories and form their own opinion. Rather than rely on journalistic stories that are often written to sell newspapers, online readers are able to check news sources by following links to other stories or original source material. Trust in traditional sources of information is on the decline and word-of-mouth sources such as blogs and newsgroups are on the increase. The predominant users of online media are young people.

Youth culture

A recent report on teenagers in Britain (IPPR 2006) states that "Commentators fear that British youth is on the verge of mental breakdown, at risk from antisocial behaviour, self-harm, drug and alcohol abuse. These concerns are, to an extent, borne out".

The report argues that young people today not only need academic qualifications but also increasingly need social skills to fulfill the needs of the new service economy. It says that the best way for children to gain these skills outside the family is through structured activities where they mix with other children but are mentored by adults towards defined goals. Examples of this include the cubs, scouts, drama and sports clubs.

The report also goes on to point out that on average children spend half their spare time watching television, playing computer games and using the internet, even before the age of 10. Eight out of ten children aged five to 16 have a TV in their room and over half have a personal video recorder or DVD to go with it. Around one in five children (nearly 1.5 million young people) have access to the internet in their own room. Almost half of children (49 percent) between aged 8 and 11, and eight out of ten aged 12 to 15 have their own mobile phone.

It also points out that fifty-seven percent of children have reported having come into contact with online pornography, and one in four had received pornographic spam. Although around half of all online parents had some kind of web filtering to stop their children viewing certain types of websites, only seven percent of parents were aware that their child had received sexual comments through this form of media last year.

NCH the children's charity has also published a report (Growing Strong 2007) stating that the prevalence of emotional wellbeing and conduct disorders of children has increased by 100% since the early 1990s. This report does not focus on children with mental health problems but looks at all children throughout modern society. The conclusion is that children generally have far less of a support network in the form of family and peer groups than they did in the mid-twentieth century.

Taken together these reports paint a picture of computer-literate, very brand-conscious children who are more affluent and subject to more consumer choice and pressure to "grow up quickly" than any recent generation. They are also more emotionally vulnerable as they receive less support from their immediate friends and family than previous generations.

The fact is that the UK youth market of £30bn a year is being aggressively targeted by increasingly innovative advertising which substantially increases the peer pressure to conform to group norms via financial signifiers (brand names). Having less support and more pressure to buy a sense of peer belonging, it is not surprising that children are more emotionally vulnerable.

With the advent of 3G phones the whole broadband Internet and television experience will be available on a personalised mobile device. It is already clear that users spend more on monthly mobile phone bills than on internet provider services, and the total number of mobile phones worldwide surpassed the number of TV sets in 2001, (Katz & Aakhus 2002) which indicates the possible mobile revenues involved.

threa ts

Moral Disconnection

If trust in the virtual world is enhanced if it is first established in the physical world and that predominantly virtual social interaction leads to a decline in physical social trust, then for trust to grow in the virtual world it should not be depleted in the physical world. The fundamental question to answer is what is the connection between trust in the physical and virtual world? If virtual interaction depletes physical trust what changes can be made in the virtual world to enhance trust and can trust then feed back into the physical world to create a perpetuating circle of trust?

There is increasing concern among psychologists and sociologists (as evidenced by the reports discussed above) that virtual communication is leading to a suspension of reality and an increasing lack of empathy among young people. Empathy is the ability to not only recognise but also directly feel the emotion of another person. It is the ability to put oneself in another person's position and feel the world from their perspective. This ability is fundamental for social cooperation and is clearly an ability that has coevolved in parallel with genetic evolution. In many cases an individual will have had to subjugate individual and selfish interests for the benefit of the group and the main cognitive enabler for doing this has been empathy.

Empathy however, depends very much on the ability to directly perceive others emotions. Online games and communication forums lead to a suspension of belief and very little direct emotional feedback. As has been often stated "On the Internet nobody knows you're a dog". Without the ability to perceive and feel another's emotion it is very difficult to really care about another person. Without care there can be little trust.

Another key related feature of virtual interaction in postmodernity is the fragmentation of consciousness and the phemonena of multiple identity. As we move from a world based upon ownership to one based upon service access we move from a static and autonomous notion of self to a much more dynamic and relational notion of self. Rather than people carefully constructing a singular identity and reputation, we are now moving to a world where people are becoming more virtual in their self perception and creatively script many roles and play parts in a moving theatre of multiple narratives. The self becomes much more of a networked-self, less autonomous and presented as a one-sided accentuation to suit the situation. There are as many realities as there are constructed virtual selves and these might require different representative identities.

Consequently, the opportunities to act in selfish (and criminal) ways online are many and varied and approaches to the problem are either to introduce further and more sophisticated restrictive control mechanisms or to try a new approach that attempts to regenerate the trust that is often naturally generated in social groups in the physical world.

Moral Evolution

Evolutionary theorists have been grappling with the problem of altruism and group selection for quite some time. If evolution is based upon the survival of the fittest individual (or gene) then it is very difficult to see why any individual would help another. Darwin thought that the answer to this problem was that altruism evolves as an adaptive group trait and that any tribe possessing altruistic traits would gain advantage over other tribes.

It must not be forgotten that although a high standard of morality gives but a slight or no advantage to each individual man and his children over the other men of the same tribe, yet that an increase in the number of well endowed men and an advancement in the standard of morality will certainly give an immense advantage to one tribe over another. A tribe including many members who, from possessing in a high degree the spirit of patriotism, fidelity, obedience, courage and sympathy, were always ready to aid one another, and to sacrifice themselves for the common good, would be victorious over most other tribes; and this would be natural selection. (Darwin 1879)

Computer simulations (Prisoner's dilemma, Alife simulations, Tragedy of commons) have however, shown that any individual that takes advantage of altruism within a group (a "free-rider") and acts by selfishly exploiting the altruists, will in fact gather more resources, produce more children and gain advantage. The conclusion has been that selfishness is adaptive and altruism is not. According to the "selfish gene" school of thought (Dawkins 1976), the only way in which altruism can be adaptive is either through kin altruism (Williams 1966) which means only helping relatives, or reciprocal altruism (Trivers 1971) which means assisting those that might reciprocate in the future. Altruism therefore, according to this view, is a form of selfishness.

Some however, have questioned the one-dimensionality of this view and argue that group selection could also have performed an adaptive function throughout evolution. (Wilson 2002) argues that cultural elements show variation and selection and can therefore be understood from a Darwinian perspective. Religion is analysed from a functionalist perspective (Durkheim 1915) and seen as a unified system of beliefs and practices that unites believers into a single moral community. Trade and importantly trust are facilitated by a common moral belief system based upon a rule system that is partly sacred and sanctioned at a metaphysical level. Groups that managed to transfer these beliefs into mechanisms of social coordination by exploiting different emotions were able to find a cultural solution to the free-rider problem and enjoy the benefits of trust and cooperation. Group selection therefore explains genetic and cultural adaptations that promote cooperation within groups, but competition between groups.

The advent of third generation mobile means that people will probably spend a significantly greater proportion of their time in online interaction. Unless measures can be taken to facilitate the creation of virtual group trust there is likely to be a general depletion of trust in both the online and the physical world.

It seems therefore that artifacts must be developed that enable cultural mechanisms of social capital and trust to grow and nourish relationships and groups which will contribute to generating more cohesive communities in the physical and virtual worlds.

o PPortun It Ies

Intermediation of t rust r elationships: n ew r ole

In opposition to the tendency for dynamic and transient social bonds one current observable trend is for some companies to see their customers as forming an extended part of the company. These companies take the view that it is as important to retain an existing customer as win a new one. Customers are consulted on future plans and are treated as intelligent consumers whose views are to be respected and acted on. The emphasis is to over deliver on customer expectations to build customer identity and therefore brand loyalty through the formation of a customer community. This approach is all about building social trust and bonding within an extended user community.

This can be extended beyond the immediate customer base of a company and offered as a service to any third parties needing a trusted intermediary. An intermediary is a person or organisation that mediates between a buyer and a seller. If they are trusted by both parties the intermediary removes complexity from the transaction process by offering a service to both parties. Obvious examples in the physical world are art galleries and estate agents.

In the online world trusted intermediaries are needed to facilitate effective and reliable transactions. This service could be for individuals or groups that require a level of trust in their interactions. Individuals using eBay for example, could use a third party service to check that the physical goods matched their description before any release of funds.

Another service might be for "counseled communication" (overt/covert) to help buyers and sellers reach agreement on a transaction. Lack of evidence leaves both parties in a vulnerable position. A strained and stressed society or relationship clearly needs help and direction to reestablish civilised social relations.

Intermediaries could also facilitate the growing need for trusted user group formation (TUGs) (Cofta & Hodgson 2007). With the breakdown of traditional social structures (such as the church and family) many people feel in need of a greater identification with social groups. At present individuals can either turn to their friends and family for advice and a sense of belonging, or to impersonal and increasingly insecure virtual spaces. Google, MySpace and YouTube do not fill the gap as they are essentially public virtual spaces that do not afford a strong sense of personalised group identity and privacy. Interestingly "hoodies" do form tightly-knit groups, but mostly on street corners.

Disintermediation

There is also a move away from traditional physical intermediaries (such as estate agents and art galleries) as people use web technology to sell direct to the market. For example, numerous web sites are now available that allow home owners to sell direct for a smaller fee than a traditional estate agent charges. Artists are now able to sell direct to the public by listing their own websites on artist directories.

Reintermediation

(Bailey & Bakos 1997) suggest that there are new roles emerging which include providing trust and integrity in the market, matching customers and suppliers, aggregating information goods and providing customised marketing data.

This was considered by them to be an important intermediation service as the Internet is seen as an insecure place (CSIS 2007) where it is possible to create fraudulent identities or falsify electronic documents. Matching customers and suppliers is another service that can be provided by intermediaries as consumers are often presented with too much information.

In many cases an existing high street business (such as an antiques dealer or a specialist clothes shop) which is limited by a physical location might become so unprofitable that the owner decides to close the shop and sell online. This is termed "reintermediation" by (Chircu & Kauffman 2001) where an intermediary has been pushed out of a profitable niche market and re-establishes themselves by exploiting the capabilities of technology to become an e-commerce intermediary.

Rather than buying their own server and incurring the overhead of installing and maintaining complex software they will use the services of global providers such as Google, eBay, Amazon, Microsoft and Yahoo. Here we see efficiency and consolidation based upon economies of scale, whereby global multi-national companies are becoming generic infrastructure based upon a hegemonic alliance that depends upon consumer collaboration and consent. Anyone who uses these global systems is contributing to the creation of a larger-scale distributed system that removes intimate contact with the customer (but not intimate knowledge of) from the commercial equation. In fact knowledge of the customer will become much more personalised and much more complete (Cofta, 2007).

Quality of c ommunication: t raditional r ole

Circle of Trust

Improving the quality of the virtual substrate and providing reliable reputation information will mean that users will have much stronger evidence upon which to make trust decisions. This increased confidence will feed back into the physical world and replenish the depletion of trust that is currently taking place. This will then feed back into the virtual world to create a self-perpetuating circle of trust linking the physical and virtual worlds.

More Communication Means More Trust

There is no doubt that an increase in the quantity and quality of communication provides more evidence on which to build confidence and therefore trust. Communication is not just about a physical signal, but also about the personal meaning and feeling behind the signal. Exchanging any number of SMS messages about the purchase of a car on eBay will provide less trust information than a video conference, which will provide less than a face-to-face meeting. As technology evolves, ever more faithful representations of the real world will be available in the virtual world, and virtual emotional indicators will become more realistic and reliable.

More Trust Means More Communication

Systems that supplement sensory impressions with comprehensive reliable reputation indexes based upon exhaustive autonomic analysis of personal online presence will further build confidence (Cofta, 2007).

Confidence in the reliability of information means that people will be much happier about using it and will therefore use it much more.

conclus Ion

Modern communications technology can be seen to have thus far led to greater individualisation and atomisation and less of a shared physical experience. Throughout human history conscious physical presence (Hodgson & Cofta 2008) has been the substrate upon which social interaction and cooperation has been built, providing a solid basis for reliable trust formation. Virtual communication is based upon social capital accumulated in the physical world, but the current technical implementation of virtual social interaction is limited in its ability to provide sufficient evidence of trust to exploit the cohesive cooperative benefits that are generated through physical experience. This situation however, can be ameliorated by improving the quantity and interactive contextual quality of communication and by generating comprehensive reputation indexes based upon autonomic analysis of personal online presence, without compromising privacy. This will provide much more reliable virtual evidence to create a circle of trust between the physical and virtual worlds.

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Key Terms

Hoodies: Term for young men wearing hooded sweatshirts that afford anonymity and symbolize defiance.

Physical trust: The level of trust that can be established in the physical world.

Social Capital: The accumulated level of goodwill that exists within a social group or community, realized through shared norms and values that afford cooperation.

Social Norms: Rules of accepted social practice that reduce the complexity of communication.

Social Trust: The level of trust that exists within a social group or community.

Trust: The level of willingness of the trustor to be vulnerable to the actions of the trustee based on the expectation that the trustee will perform a particular action important to the trustor, irrespective of the trustor's ability to monitor or control the trustee.

Virtual Trust: The level of trust that can be established in the virtual world.

Endnote

[1] In the UK Birmingham Police have stated on Radio 4 that the number of paedophiles on their books has increased over the last ten years by three orders of magnitude.

Chapter LIII
Good and Evil in the Garden of Emerging Information Technologies

Kenneth E. Kendall
Rutgers University, USA

Julie E. Kendall
Rutgers University, USA

abstract

This chapter explores the social, organizational, and individual impacts of emerging information technologies using the advent of recent technologies including push and pull technologies; DSS dashboards for decision makers complete with widgets and gadgets; and mashups that join together preprogrammed Web-based applications in new ways as examples to explore the question of good and evil as it applies to technology. The design, purchase, and use of emerging information technologies offers a double-edged sword; in that they can be deliberately designed and used for either good or evil purposes, however sometimes their use provokes unintended consequences. While many emerging technologies purport to improve the lives of workers, the quality of their work, and the overall productiveness of society, there are other consequences that belie grimmer, multifaceted impacts that can create malevolent outcomes or even disastrous consequences for their users. Our practical contribution is to formulate a series of questions to assist designers, users, and managers who purchase IT in considering the helpful or harmful consequences of emerging technology design decisions.

Good and evil are essential differences of the act of the will. For good and evil pertain essentially to the will; just as truth and falsehood pertain to the reason, the act of which is distinguished essentially by the difference of truth and falsehood (according as we say that an opinion is true or false.) Consequently, good and evil volition are acts differing in species.

—Thomas Aquinas (c. 1225-1274).
Summa Theologiae, I-II
[i.e., "First Part of the Second Part."]
q. 19, art. 1 (c. 1077-1078).

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Introduct Ion

In this chapter we explore ideas of good and evil as they play out in the arena of several emerging information technologies; we explore their intended applications and uses, as well as their unintended uses and consequences, and we compare and contrast potential good and malevolent impacts of innovations on individuals, organizations, and societies.

Many new technologies have been introduced in the last decade. To begin, we take the example of pull technology, or seeking out information on the Web. The term pull technology can simply indicate surfing the Internet or it can refer to an advanced technology that permits an ever changing, independent evolutionary agent to explore the Web for you. Push technology describes a range of information activities that send or push information to the user ranging from well-understood models such as broadcasting to selective content delivery via sophisticated evolutionary filtering using data mining techniques.

We will also detail the emerging information technology of dashboards, which are often designed to support individuals. A dashboard displays information in the form of metrics to help support a decision maker. We consider the deliberately designed uses and impacts of dashboards on individual decision makers, as well as the consequences of bias and unintended consequences of other display deficiencies on the organization and society. With the advent of customizability for many DSS dashboard displays, the potential for good as well as evil influences from these new technologies are increasingly unpredictable, but bear exploration.

New software innovations often termed "widgets" or "gadgets," are now available to systems designers for designing desktops and dashboards. They can be user-customized, or they can be placed on a desktop without any user intervention. While the usefulness of calculators, clocks, "sticky notes," weather forecasters and so on are superficially apparent, the discovery of how these items are useful, whether they serve as distractions to organizational goals, or slip by unnoticed as hosts of spyware, will also be explored.

Mashups are applications that take one preprogrammed Web-based application and join it with another to create a new application. There are five key areas that hold potential for good or evil in the design and use of mashups. They include reliability, legal concerns, the dynamic nature of the Web itself, the availability of user support for mashups, and the way in which development occurs (spontaneously versus systematically).

This paper is practically grounded by examining specific examples of emerging information technology design, use, and evolution. While we believe that emerging information technology is similar to other types of technology, there are two compelling views of what the future holds for designers and users of technology. The British author George Orwell feared that what we hate will ruin us. But his compatriot, Aldous Huxley, believed that what we love will be our ruin (Postman, 1985). This chapter explores the paradoxical possibility of negative and positive consequences, as well as deliberate and unintended consequences of the use of emerging information technologies. We offer questions for designers, users, and those who purchase IT for organizations to assist them in mindfully confronting the larger questions of good and evil precipitated by new technologies.

We take an approach labeled by Graber (1976) as the intuitive method of verbal analysis. (Verbal here refers to both oral and written material.) Our steps in analysis include establishing a goal for the investigation, sampling written and oral material for relevant clues, piecing together a picture and then interpreting what emerges. The complexity of this approach is evident when one considers that it demands a simultaneous analysis of the context afforded by the society along with the interactions of a multiplicity of writers, their opinions, and their objectives for the present and the future.

We conclude with a series of questions for use by information systems designers to begin assessing the "good" and "evil" uses of the systems they design. Using the intuitive method of verbal analysis we expose some helpful and harmful consequences of emerging information technologies and their implications for designers, individuals, organizations and societies.

Pull and Push technolo Gles

Pull technologies involve the seeking process of a user trying to get information. Pulling a piece of information from the Web is akin to pulling a book off the shelf of a library. The word pull connotes grabbing and yanking something from the Internet. Pull technologies can be simple or complex. Kendall & Kendall (1999a and 1999b) identify four types of pull technologies categorized as alpha, beta, gamma, and delta-pull technologies, beginning with surfing the Net.

We focus our attention here on delta-pull technologies. This involves the use of an advanced evolutionary agent that observes the behavior of the user and then refines the search in such a way that facilitates more accurate locating of information. In this instance, the evolutionary agent uses their observation of a user's behavior to form an opinion about what the user really needs to fulfill their search, in contrast to what the user wants. The strength of the individual, organizational, and societal embrace of pull technologies will dictate how revolutionary the changes they bring about will be.

Some cumbersome aspects of searching can be replaced as delta-pull gets into full swing. The evolutionary agent will observe and understand a user's behavior, seeking out information the user needs. Efficiency of Web searches will also be improved with full use of delta-pull technology. If users are more satisfied with the results of initial searchers, searches will be valued as more effective.

When users want information sent to them, push technologies are appropriate, either through subscription processes or through delivery processes. There are four types of push technologies (Kendall & Kendall, 1999a and 1999b) beginning with the simplest form, alpha-push (Webcasting), ranging then to beta, gamma, and the most complex which is delta-push. We concentrate here on that fourth level.

In the delta-push level, services are customized for an individual user based on demographics, data mining (Codd, 1995; Gray & Watson, 1998; and Watson & Haley, 1997), and the behavior of the person using the push technology. The evolutionary agent delivers what the user needs, not just what they want, based on observation of their behavior.

Many believe that push technologies will transform the strategies, and even the goals and missions of organizations. Some of the early corporate leaders have been National Semiconductor, Wheat First Securities, MCI and Church & Dwight (the maker of Arm and Hammer baking soda products) (Sliwa & Stedman, 1998). Many of these first and early efforts were basic attempts to speed up decision making by using corporate Intranets to supply information to managers rapidly so that decisions can be made in a timely manner when competition is keen.

Push technologies can also assist in unexpected or unusual circumstances, which could be highly changeable, or even too unusual to be categorized an emergency. For example, MCI used PointCast to send outage information to over 6,000 operations employees. Push is coming of age in what were often low-level corporate systems such as e-mail. Even corporate users can create a multimedia experience for the receiver. Where e-mail was originally the province of scientific researchers, Downes and Mui (1998) note its adaptation for advertising and information delivery.

Often used in a malevolent or harmful way, memes (Brodie, 1996) are inserted into push technologies to replicate and spread content. Push technology is successful in reproducing messages that could potentially change the behavior in a way that the push provider desires. When a meme is copied in such a situation, it can be classified as a push-virus. This type of virus can scare users away from using push technology to its full advantage.

A useful concept that can help explain some of the helpful as well as harmful aspects of push technology is that identified by Whitworth (2005) as "polite computing." In this highly original conceptualization, politeness in software is equated to the idea of offering a choice to the user. The absence of politeness indicates the lack of choice, and therefore lack of control. For instance, choices to exert control include: a choice whether a user would like to upgrade their software, where they want to save a file on their disk, a choice of what they would like their home page to be and so on. When software does not act in a polite way, users can avoid the software, using it only when forced to do so, or may avoid it altogether, such as not returning to an ecommerce site that is not polite (i.e. which rides roughshod over user control during transactions). For a more detailed examination of the negative consequences associated with the use of evolutionary agents, see Kendall and Kendall (2007).

Push technologies provide an advantage in that viruses are so irresistible that they can result in users becoming infected with an idea, a song, a way of problem solving and other ideas that may be beneficial only if large groups of people share in it quickly. One useful example is preparing a large population for an impending emergency such as a forecast hurricane. Mounting a concentrated effort for solving a large-scale transportation strike or unifying negotiators in identifying a solution to a peace process within a short time frame (for example, a kind of electronic shuttle diplomacy) might also translate into useful purposes for push technologies.

But in situations of numerous push technologies, there is always the possibility of information overload. Overload creates stress on users, who then may be unable to distinguish between useful and dysfunctional push technologies. It is possible that companies may react negatively to these technologies by banning these services from the office environment, since they are not helping them achieve corporate goals.

There are serious drawbacks to the implementation of push systems. People may not like the content that is being pushed. If they dislike the content, they may give up the technology. In this instance, users may give up on new push technologies before their true emergence and prior to the true realization of all benefits. There is the possibility that people will become disenchanted and unplug, before the most helpful applications are developed.

Even more threatening, delta-push technology may feature evolving memes with an evil message of ethnic hate, that eventually reinforce a nation's resolve to go to war against a neighboring country, or even to war against its own citizens. With the use of push technology, evolving memes may be too overwhelmingly memorable to support or allow any other forms of thinking.

dashboards

As we continue with our themes of good and evil, dashboards serve as an illustrative example of the decisions available to systems designers, decision makers, and those who purchase IT. Part of the revolution in the design of decision support is the increasing popularity of dashboards (Eckerson, 2005; Few, 2006), which can include several emerging information technologies. These include widgets and gadgets.

A dashboard sets up all of the pertinent metrics and other performance gauges necessary for a decision maker to view. Providing all content and displays at the fingertips of the decision maker, is intended to enable and alter the decision maker's decision-making process. It may even contribute to the evolution of the decision maker's thinking as they interact with the dashboard.

Decision makers work in highly visual environments, which enables them to quickly identify problems or potential opportunities. If a sensor demands a decision, the decision maker can carry through, and then monitor the aftermath. This cycle can be repeated as monitoring continues and a new action is required.

Dashboards are not just aural, with bells and alarms; they also can feature dials and graphs that permit a snapshot of what occurred at particular time in the organization. The research of Tufte (1983; 1990; and 1997) supplies clear ideas for DSS designers in creating meaningful visual displays. The ideas of HCI also help designers create useful dashboards.

Dashboards, just like the dashboard that appears in front of an automobile driver, are intended to be an attractive and engaging array of gauges or measurements. Each gauge can display a light (similar to an indicator light cautioning that the automatic braking system is not functioning) that signifies an exception to the normal functioning; a gauge (similar to the speed in kilometers or miles per hour); numbers (like an odometer which simply counts the distance traveled), or even a text message describing a problem in words.

One of the unintended negative consequences of dashboard design is the problem of introducing bias into information displays. Bias will hinder rather than support good decisions. Bias on a dashboard display can impugn the good reputation of the systems analyst, especially in the question of how well they are serving the cause of change.

Flexibility of dashboard displays is paramount, and must be a goal of the analyst or designer. Increased customization in a variety of systems such as database queries and desktops translates into the expectation of customization for the design of dashboards as well. Executives are better served if the useful items are all together on a single page of the display screen, where they expect, rather than making them go beyond the dashboard to seek out the desired information. In an upcoming section, we will discuss the drawbacks of the possible negative consequences of dashboard design for decision makers and designers.

Designers are experiencing a surge in new tools and approaches for designing due to Web 2.0, also called the programmable Web. These new tools, including widgets, and gadgets are also making it possible for decision makers to begin designing their own decision support systems (DSS).

Widgets and gadgets are small programs, that reside on a special layer of the desktop, typically written in JavaScript or VBScript, and they require no specific design training in order to be used by a layperson. Widgets and gadgets include a graphical user Interface (GUI) between the desktop and the application. There are displays that require no interaction at all, but users can then perform specified functions by clicking on the widget or gadget (Olsen, 1998; Davidson and Dornfest, 2004). Widgets were so named by the creator of Konfabulator (Joyce, 2005) and Yahoo! (2008), and are called dashboard widgets by Apple Computer (2008), and gadgets by Google (2008) and Microsoft. They are any type of small program that is useful or playful that can be added to a current system.

Users can add relaxing activities such as games, music podcasts, and leisure pursuits to their desktop. The widget library is a repository composed of many clocks, calculators, post-it notes, bookmark assistants, translators, search engines, weather forecasters, and quick launch panels.

Users on the executive-level in organizations may desire standard business indicators like stock tickers, foreign exchange information, weather updates and RSS feeds featuring news, updates on products, or industry perspectives. Middle managers may want to use gadgets to facilitate tracking of express packages and to indentify convenient schedules for airline, train, or other transportation.

Some positive consequences of designing with widgets and gadgets include the idea that users can be empowered by taking design into their own hands and creating their own desktops. Coincidentally, designers who observe the user-created desktops can discern a great deal about users' preferences.

On the evil side, charges have also been made that widgets and gadgets are vulnerable to spyware. Privacy of users may be jeopardized in ways that they have not imagined. This puts the designer who makes widgets and gadgets available to users in an awkward spot. Is it better to ignore this phenomenon or is it better to plan for their use and then to implement other security features (security software) that scans widgets and gadgets for spyware and reports the results or refuses a download based on that assessment?

Some organizational administrators believe that widgets and gadgets can distract employees from system-supported tasks. In addition, employers have complained that when users customize their desktops with stock tickers, games, and so on, they are being wasteful of corporate time, and should not be encouraged in these pursuits.

Another unintended harmful consequence of personally customized desktops is that when clients visit an employee in their office, they may receive a less-than-professional impression if their office computer desktop is too idiosyncratic. So in this way, the customization afforded decision makers via widgets and gadgets can be seen to possess a dual nature. Customizability offers freedom and personal expression, but it can also serve to isolate individuals from their work group's common frame of reference, create an unprofessional office environment, and potentially permit the introduction of spyware into the corporate environment.

Mashu Ps

Application Programmable Interfaces (APIs) are sets of "routines, protocols, and tools for building software applications," (www.webopedia.com, 2008). APIs provide all the necessary building blocks for DSS developers to rapidly develop an application (Wenz, 2006). A designer would use a specific API to make sure that all programs using that particular API will have a similar interface, so that all programs using that API will have a similar look and feel because of the similar interface. For example, one Web site that uses Google Maps will be perceived by the user as very similar to another Web-based application (Gibson and Erle, 2006) that uses Google Maps. Decision makers who already use the interface will easily adjust to the new application because of its familiarity.

Mashups provide another example of an emerging information technology with which to explore the idea of good and evil uses of technology. Mashups are becoming popular with information systems designers. A mashup is composed of parts consisting of APIs and other components such as RSS or JavaScript. An analyst can even take public data and merge private corporate data together to form a mashup. Mashups take public and private corporate data and form them into an enterprise mashup (King, 2006).

Even a cursory look demonstrates that mashups can be used for political reasons. An example of mashups and political causes is On NY Turf (2007) that combines APIs to produce a color-coded map, called "NYC No-Freedom Zones," to show which city council members have spoken out clearly against the police making rules restricting the First Amendment rights of US citizens. Health Care That Works (2007) has set up a Web site of hospital closures for New York City over the past 20 years and combined them with Google Maps, and racial and income data for the city. This information is then used to explain its political position that low income communities or communities of color are disadvantaged by recent decisions made about health care provision. For a more complete examination of mashups, see Kendall and Kendall (2008).

There are several negative consequences of mashups that designers and users need to consider. While these may not reach the depths of truly invidious impacts, there are five key considerations: 1) reliability, 2) legal concerns; 3) the dynamic nature of the Web; 4) user support; and 5) systematic versus spontaneous development (MarketWatch: Technology, February 2007; MarketWatch: Global Round-up, January 2007; and Gerber, 2006).

Reliability refers to whether users will be able to access mashups seamlessly. If not, developers risk losing their hard won reputations for reliability, and users risk losing valuable access when they depend on it most. Legal concerns are another consideration for use of mashups in DSS enterprise applications. Legal experts (Gerber, 2006) caution that since mashups by their very nature involve combining "someone else's information or data," into a new information service or innovative application, that a plethora of legal issues must be considered before too much development time is devoted to their creation.

Many legal issues (although not a key consideration here) arise from the development of mashups including contract law, copyright, patent law, trademarks law, unfair competition/false advertising, obscenity and the rights of privacy and publicity, as well as warranty disclaimers. Mashups may enable the use or copying of work of others in ways that violate the norms of the society, as well as violating laws against piracy and copyright.

The third reservation involves the dynamic nature of the Web itself. The truth is that what a user sees on the Web today may not be there tomorrow. While this caveat is intertwined with reliability, it serves to highlight the question of whether information systems designers who create mashups will ever be able to vouch for the mashups they create in the same way they guarantee other applications.

User support is the fourth consideration related to the use of mashups for DSS development. Once again, this reservation is linked with the issues of reliability and the nature of the Web. Notice that it subtly shifts to examining what happens when users experience problems with mashups. Given the nature of mashups, what is the possibility that this level of support can ever be proffered successfully?

A fifth and final important reservation for developers creating DSS with mashups involves the bigger question of systematic versus spontaneous development. When mashups are developed in an "agile way" with an absence of planning, documentation, or explicit corporate participation, how does that affect the systematic process of analysis, design, development, implementation, and evaluation developers have worked so hard to inculcate in users participating in systems projects over the years? Additionally, the education and work life of designers and analysts will undoubtedly change if this type of methodology is embraced (see Kendall and Kendall, 2005 for a detailed discussion).

Creating Meaningfulness through Positive Design

Emerging information technology has no value unless it is meaningful. It doesn't matter whether it is implemented if it has no tangible or intangible value. A person who owns a mobile phone but doesn't turn it on (or has no friends to call) doesn't see the value of the phone. The same is true on the organization level if the company provided a BlackBerry to employees, but does not send email to them. Society would not benefit unless the users of mobile phones used them to replace transportation with communication. Here is a discussion of meaningfulness as it relates to good and evil uses of technology on all three levels.

Creating Meaningfulness for Individuals

The use of emerging technologies in every aspect of one's life including work, home, and play may cause humans to seek authentic human experiences that are essentially real life (high touch, low tech) experiences that do not involve plugging in to any electronic media. There is a problem of "information fixation," as described by Heim (1993). He stated that what people do while unplugged was more important than the length of time they spent away from technology. Heim notes that technology retrains our nervous system, creating a new pace and tempo to which we adapt, but with which we could ultimately be uncomfortable. Many spiritual groups ask their participants to unplug during their retreats (Yuen, 1998). This idea of the harmful potential of machine-driven paces is being anecdotally and clinically supported through reports of epileptics who can be vulnerable to seizures due to viewing of disturbing patterns on Web sites.

Based on our research and observations, we can suggest technology-free sectors (e.g. public parks) where people can be unplugged minus any worry that they will be accosted by others being able to "reach" them electronically in the wilderness. We might want to make it socially approved or sanctioned to unplug in these sectors. Parks could become spaces for retreats, concerts, and meditation. A new generation may have to imagine cultural norms that support a number of different ways of behaving, where the structure of thought is not dictated by the incessant and ubiquitous interactions with information technologies such as those prevalent on the Web.

If we are to continue creating as systems designers, we need time apart from technologies such as push technologies, dashboards, and mashups. That time can aid us in developing new paradigms and innovative approaches to solving our problems (some of which paradoxically arise due to our interactions with new technologies). We need time to reflect.

We may even need time alone. Once we can safely unplug, our creative and innovative solutions to new and old problems should be promising enough for the society to want to continue to inculcate this practice.

c reating Meaningfulness for o rganizations

Many corporations believe that they can successfully manage information overload, and that strategies should be tried as soon as a problem is recognized. In fact, they can even be planned for in advance. Although one remedy has been characterized as "pushing back" by simply getting rid of their multiple channels, Picarille (1997) notes that "Corporate users are looking for better ways to manage the critical information they receive."

Organizations can positively sanction structured meetings and events, or informal face-to-face time when certain forms of thinking can be introduced. These can include brainstorming, or other ways to stimulate creativity or evaluate new ideas. It is instructive to note that planned face-to-face activities that completely remove managers from the grasp of intrusive new technologies are already the norm for executives in some large corporations such as Microsoft.

Heim (1993) asserts that the topics that occupy managers' minds during times of being unconnected are equally important to the length of time spent away. Another example of a corporate remedy is that pursued by National Semiconductor who added its own channel to PointCast, which they have called "National Advisor." Three streams of product-related data were included to focus the managers on corporate tasks and activities (Cronin, 1997).

Organizations can frame values in such a way that that (most) employees are not expected to exist with 24-hour connectivity. In fact, they can be discouraged from this behavior, since new research reveals that workaholism negatively impacts an entire work team, not just the worker engaged in it (Kakabadse, Porter, and Vance, 2007). Just as connectivity can be woven into a strategic IS plan, so can sanctioned time away from e-mail and the interaction with CSCW systems.

c reating Meaningfulness for s ociety

The question arises as to how do the emerging information technologies, shape and even alter the existence and sustainability of the countries of the world, their boundaries, and their view of the world? In general, the world will predictably experience problems and face decisions resulting not only from information overload, but also from a diversity of perspectives due to emerging information technologies.

Just as those who are sensory deprived tend to hallucinate and create meaning due to underuse, so perhaps those who are overloaded with information tend to shut down their meaning creation faculties due to overuse.

Pos InG Quest Ions For soc Io-techn Ical des IGn

Researchers in socio-technical design need to establish a process of questioning which information systems designers and users can undertake as they grapple with key issues of good and evil in relation to impacts of their design, as well as more specific issues of user creativity and accessibility, and ethical purposes of the designer. These are put forward as a beginning, not a solution.

The questions are intended to create awareness of some ways in which design and use decisions can avoid evil uses or negative consequences, and they are also meant to foster an ability in the designer and users to contemplate ways in which to discriminate among positive and negative consequences of design.

The almost paradoxical quality of information technologies to be used for good or evil is notable. While some information technologies might be deliberately designed for good or evil; deliberately used or procured for good or evil; some have unintended consequences of design. These may be significant or insignificant; indeed most designers realize that users devise unforeseen uses for their software. Still other technologies designed for positive uses might be perverted into an evil use.

The same information technology, designed with good purposes in mind, may be used for good or evil. For example, while popular social networking sites such as Facebook, Bebo, Friendster, and MySpace encourage more participation with others and may help users overcome fear of technology, helping them understand people beyond their immediate locality, the sites are also used by child predators and others who are interested in illegal activities, not legitimate friendships or social networking.

Another paradoxical use of information technology is apparent when discussing the use of ecommerce on the Web. Ecommerce continues its expansive global growth due to its time-shifting aspects, the replacement of transportation with communication, the ease of payment, the transparency of warehouse inventory, and so on. However, some organizations block employees from ecommerce sites while at work, believing that making purchases during office hours is a distraction from corporate goals, harbors a possible compromise of computer security, and sanctions a diversion of corporate computing resources to personal use.

We can also recognize that once an information technology is invented, it cannot be "put back" so to speak, even if it is later deemed too powerful, or too disruptive (the atom bomb is an example). It is therefore more likely that an innovative technology would supersede it, and the old technology would be abandoned or fall into disuse as obsolete.

As we can see, information technology may not in and of itself be good or evil. It is dismaying to recognize that what is apparently good or neutral technology might be misappropriated for evil or might unintentionally cause negative behavior or create corrupting relationships. This recognition leads us to ask, "Do the intended or unintended uses of the technology help or harm?"

In that spirit, we ask that designers, practitioners, users, and managers in companies who must design, decide on, or purchase technology confront several questions that delve into the prospective good or evil uses, impacts, and effects of emerging information technologies. Raising the following questions is intended to endow the design, purchase, and use of new technologies with mindfulness of their potentially good or evil consequences.

- Does it harm psychologically by creating offensive or negative thoughts or emotions?
- Does it waste others time by presenting material they don't need?
- Does it add to information overload?
- Is it continuously distracting people?
- Does it reduce individual freedom of choice by forcing them to receive information?
- Does it make computer interaction unpleasant, thus reducing overall use and benefits?
- Does it disclose private information that the user does not want to reveal?
- Does it encourage people to participate and contribute online?
- Does it scare people because it is a possible vehicle for viruses?
- Does it frustrate people because it is unreliable?
- Does it help to wrongly copy the work of others against the norms of information piracy and copyright?
- Does it help creative thought or does it make people more mechanical?

Notice that all of the foregoing questions focus on whether a technology is helpful or harmful to the user, designer, or purchaser. However, a larger question is whether something is evil because it is harmful. Figure 1, showing positive and negative consequences of dashboard widgets, may help us visualize a response to this question.

The horizontal axis plots the continuum of helpfulness versus harmfulness, while the vertical axis plots the continuum of deliberate actions versus unintended consequences. In the upper right hand quadrant, we show three consequences of features the designer intentionally introduced into widgets in order to make them helpful to decision makers. These include providing useful information, allowing quick and easy access to information, and being able to quickly identify problems.

In the lower right hand quadrant, we see that some unintended but helpful consequences occur while the widgets are being used. The empowerment of users, and the creation of playful widgets may not have been intended by the dashboard designer but have evolved naturally and perhaps unintentionally. Furthermore, the helpful consequence of changing users decision processes may not have been part of the original design. For example, a decision maker who only used tables but who is alerted to the availability of easily accessible graphs, may prefer to adapt their decision making style to rely on these graphs.

On the evil side, we show the upper left hand quadrant. Some designers of widgets have deliberately introduced spyware built into their widgets, and the spyware proceeds to operate without the knowledge or consent of the user. Another deliberate distortion may be intentionally adding bias into a decision picture to force decision makers to make a choice favorable to the vendor or designer.

The lower left hand quadrant shows three unintended consequences. All of them have a harmful quality to them. They include wasting productive time and becoming distracted, two complaints of management who would like to restrict the use of widgets and other programs used by employees during work hours. Finally, we note that the proliferation of widgets can contribute to information overload, which causes stress and the inability to properly process information.

Given this example of dashboard widgets, we can debate the question of whether harmful consequences of the development of new technologies are evil.

Socrates said "The only good is knowledge and the only evil is ignorance." (Socrates, date unknown). If this statement is true, that would imply that all harmful consequences, whether deliberate or unintended would be evil. If designers were ignorant or were unable to predict the consequences of the technology, then they would be at fault. For example, the developers of email failed to recognize that people would not want to receive mail from unfamiliar sources and therefore should be held accountable for the proliferation of spam.

Thomas Aquinas took a different approach:

Evil denotes the lack of good. Not every absence of good is an evil, for absence may be taken either in a purely negative or in a privative sense. Mere negation does not display the character of evil, otherwise nonexistents would be evil and moreover, a thing would be evil for not possessing the goodness of something else… (Aquinas, 1077))

We need to encourage our designers and developers to anticipate the negative consequences of new technologies. In the process of doing so, they can be empowered to design software and systems that knowingly incorporate helpful uses and the opportunities for intended, positive outcomes while diminishing the potential for negative uses.

Addressing the Negative Consequences of Emerging Information Technologies

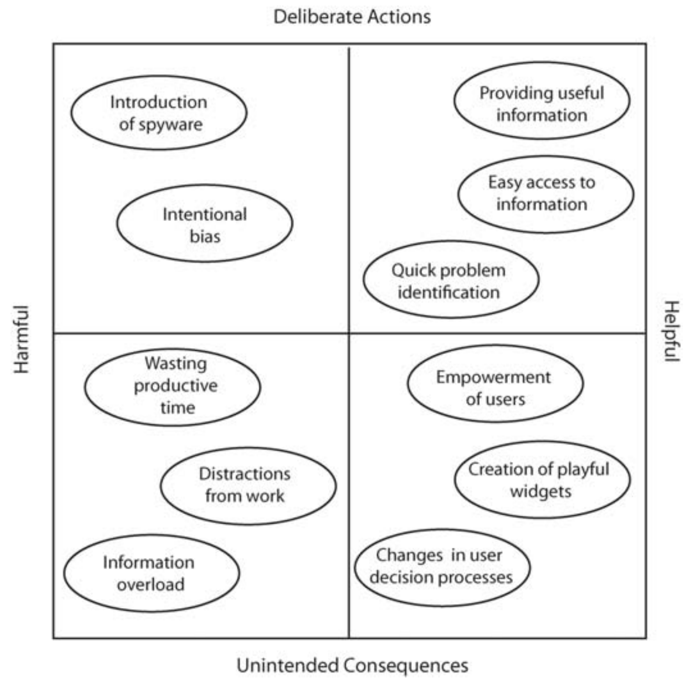
One of the key responses that can be taken to address the frightening aspects of emerging information technologies is that of understanding, and then valuing, what it is we are facing.

We offer no magic bullets. The following is not a panacea. What we suggest are positive actions and behaviors that contribute to alleviating the evil or negative uses of emerging technologies. Therefore, we refer to these as remedies. Just like a remedy for a cold, the participants involved must believe in and follow the advice if the remedy is to work.

Education as a Remedy

People need education about the possible negative consequences of using emerging information technologies. One dialogue that must be entertained is to tell users and designers about how media alters

Figure 1. Helpful and harmful consequences of dashboard widgets may occur either deliberately or unintentionally



the very structure of our discourse. One starting point is to educate decision makers and other users of new media about the need for balance.

We can also educate content providers about the need for context. Perhaps pushing a coherent story is more important than displaying a fragment. For instance, CNN Headline News uses a one-sentence headline on the bottom of its screen, which changes constantly, and which is interrupted unceremoniously for commercial breaks. Stories are often indecipherable due to the constrained display space. In addition, they are frequently interrupted in mid-sentence to insert a commercial advertisement. The value of balance in stories presented like this is absent, but it can be recognized and remedied.

humor as a remedy

Many philosophers and essayists, as well as researchers (see for example de Bono 1992), suggest that humor is the heart of creativity. Others suggest (Postman, 1985) that we should not only laugh at ourselves, but indeed we should parody ourselves. Kendall (1997) found that systems designers could assess the gap between the actual versus intended addressing of critical success factors important to systems implementation by examining the posting of cartoon humor by users.

Designers are well equipped to understand the complexity of design and their potential to influence users if they are able to see both humor and problems in the results of introducing new technologies. The ability to regard the emerging information technologies as often producing humorous results along with their capability to pose serious threats puts the designer in a superior position to understand the complexity of what they are doing and the possible influence of their designs on how humans function.

unplugging as a remedy

Users are experiencing an overload, which they decry, but ironically they are also eager to get ever-increasing amounts of information; more of what they love. Other thinkers share similar concerns. The contemporary philosopher Heim (1993) wrote, "With a mind-set fixed on information, our attention span shortens. We collect fragments. We become mentally poorer in overall meaning."

Friedman (in Kelley, 1998) states that, "It's not clear that (connectedness) enhances the quality of our lives or the productivity of our work lives." How does possessing the capability for 24-hour connectedness influence our behavior with emerging new technologies? Others are amazed at the potential for electronically induced "soul sickness" (Crabb as quoted in Kelley, 1998) of exhibitionists and voyeurs alike as people procure Web cameras to exhibit every manner of bodily function to viewers on the Internet.

Often times, the act of unplugging from electronic media is a reaction to overload. It is also symbolic of making a change, taking a break, or making a "clean break" from our current environment. An example of unplugging is when an individual feels inordinate pressure from being connected to technology on a 24-hour, seven days per week basis and subsequently takes some sort of action to disconnect from the artificial world of technology. The individual resumes a life in the physical world, the one populated with people, not just machines. Some researchers have even gone so far as to suggest that when we are on the Web, we are experiencing an alternative reality that is too far removed from the physical world. Unplugging can take on different meanings on the individual, organizational, and societal levels.

conclus Ion

What we learned from reflecting on the good and evil uses of emerging information technologies through examples of push and pull capabilities, dashboards with widgets and gadgets, and mashups, is both distressing and invigorating. We are experiencing a revolution of dramatic proportions, with breathtaking positive and negative consequences at every turn of design, adoption, and use. As designers, adopters, and users of new technologies we can take an important step in our understanding by increasing our awareness of the paradoxical aspects of technology revealed in both good and evil uses of IT embodied in our individual, organizational, and societal responses to emerging information technologies.

Our contribution was to consider both the duality (and sometimes plurality) of good and evil aspects of emerging information technologies and their deliberate and unintended consequences for individuals, organization, and society. We suggested several ways to address harmful consequences that would remedy, mitigate, reconcile, or avoid harmful consequences altogether. We formulated a series of questions for designers, purchasers, and users of information systems that highlight the consequences of design decisions and which permit them to explore possible scenarios of good and evil impacts during the design, purchase, or implementation of information systems projects.

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keY t er Ms:

Application Programmable Interface (API): Application Programmable Interface (APIs) are the essential building blocks for application developers to rapidly develop a software application. They are composed of sets of tools, protocols, and routines, that aid designers in developing software applications.

Dashboard: A dashboard is a display for decisionmakers including a variety of visual displays of relevant performance measurements. Dashboards often include dials or gauges.

Decision Support System (DSS): An interactive information system that supports the decision-making process through the presentation of information designed specifically for the decision maker's problem solving approach and application needs. A DSS does not make the decision for the user.

Design: Design is the process in which a person, often called a systems analyst or systems designer considers the needs and wants, opportunities and problems, balanced with technical and economic feasibility limits to describe or model a new system.

Emerging Information Technologies: Emerging information technologies are those innovations in computing, MIS, and ecommerce that are becoming recognized as beneficial and practical. They are technologies that are not yet generally accepted or in use. In the emerging stage, technologies may be carefully studied and shaped to be more reliable, practical, and helpful.

Mashups: A new application crated by combining two or more Web-based APIs, or application programming interfaces, together.

Pull Technologies: Pull technologies involve the seeking process of a user trying to get information. Pulling a piece of information from the Web is akin to pulling a book off the shelf of a library. The word pull connotes grabbing and yanking something from the Internet. Pull technologies can be simple or complex.

Push Technologies: Push technology describes a range of information activities that send or push information to the user ranging from well-understood models such as broadcasting to selective content delivery via sophisticated evolutionary filtering using data mining techniques with electronic media such as the Web or email.

Socio-Technical Design: Sociotechnical design is the representation and modeling of the interrelatedness of the social aspects of people, organizations, and society along with the technical aspects of machines, computers, and other technologies. It is argued that taking into consideration both the social and technical aspects allows for meaningful design that promotes efficiency, productivity, individual well being, and a benefit to society as a whole.

Widgets: These are small programs (sometimes called gadgets), usually written in JavaScipt or VB-Script. They reside in a special layer on the user's desktop. They provide a graphical user interface between the desktop and application. Some require user actions to function, while others, such as clocks or stock tickers, do not.

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About the Contributors

Brian Whitworth is a senior lecturer at Massey University (Albany), Auckland, New Zealand. He holds a BSc in mathematics, a BA in psychology, an MA (1st Class) in neuro-psychology, and a PhD in information systems. He has published in journals like *Small Group Research*, *Group Decision & Negotiation*, *The Database for Advances in Information Systems*, *Communications of the AIS*, *IEEE Computer*, *Behavior and Information Technology (BIT)*, *Communications of the ACM* and *IEEE Transactions on Systems, Man and Cybernetics.* Topics include generating online agreement, voting before discussing, online communication processes, legitimate by design, spam and the social-technical gap, polite computing and the web of system performance. His hobbies include motorcycle riding, quantum theory and philosophical songs. See http://brianwhitworth.com for more details.

Aldo de Moor (ademoor@communitysense.nl) is owner of CommunitySense, a research consultancy firm on community informatics. In 1999, he got his PhD in information management from Tilburg University, the Netherlands. From 1999-2004, he was an assistant professor at Infolab, Dept. of Information Systems and Management, Tilburg University. In 2005-2006, he was a senior researcher at the Semantics Technology and Applications Research Laboratory (STARLab) of the Vrije Universiteit Brussel. Aldo's research interests include the evolution of virtual communities, communicative workflow modeling, argumentation support technologies, language/action theory, conceptual graph theory, and socio-technical systems design. Aldo has been a visiting researcher at the University of Guelph, Canada, and the University of Technology, Sydney, Australia. Aldo has been program co-chair of the International Conference on Conceptual Structures, the Language/Action Perspective Working Conference on Communication Modeling, and the Pragmatic Web Conference. Key publications have appeared in journals like *Communications of the ACM*, *Data and Knowledge Engineering*, *Group Decision and Negotiation Information Systems*, *Information Systems Frontiers*, and *Information Systems Journal.*

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Mark Aakhus is associate professor of communication in the School of Communication, Information, and Library Studies at Rutgers University. Aakhus' research focuses on the emergence and management of conflict as people organize and make decisions, solve problems, and learn. These investigations explore how innovations in communication practice and technology affect the quality of human activity and reasoning in complex situations. His publications appear in international journals on communication, technology, discourse, argumentation, and disputing processes. He earned his PhD at the University of Arizona in communication with an emphasis on management information systems.

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José Abdelnour-Nocera is senior lecturer at the Institute for Information Technology, Thames Valley University. His interests lie in the design of people-centred systems, having worked in this area as both researcher and consultant in Latin America and Europe. He has been involved in several projects in the UK and overseas in the areas of e-learning, including social development, e-commerce, e-government and enterprise resource planning systems. Dr. Abdelnour-Nocera gained an MSc in social psychology from Simon Bolivar University, Venezuela and a PhD in computing from The Open University, UK

Mary Allan completed her PhD in 2005 at the University of Canterbury, New Zealand. Her thesis investigated Internet mediated collaborative learning at tertiary level, and proposed a new methodology that enables micro and macro investigation of computer mediated collaborative actions. A software pack is currently under development, converting the methodology into a usable tool. Mary's research focuses on electronically mediated interactions for the construction of collaborative knowledge across diverse contexts such as tertiary teaching and learning, workplace training, and research institutions working across sites nationally and internationally. Mary has been awarded the 2008 BRCSS post doctoral fellowship in which she will be investigating ways of encouraging and facilitating wide spread of sustainable research activities using teleconferencing technologies for lowering carbon footprint.

Dee Alwis is currently involved in teaching both undergraduate and postgraduate courses in the areas of financial accounting and company performance. This follows her professional career working in major multinational organisations based in the UK including Wilkinson Swords, Dell Computers and THORN-EMI, where she held the positions of management accountant, financial analyst and financial controller. Trained and qualified as a chartered management accountant, Dee is an associate member of the Chartered Institute of Management Accountants (CIMA). She obtained a master of science degree in information systems and a doctoral degree on intellectual capital from Brunel University. Her PhD thesis examined the impact of intellectual capital on organisational performance and value creation. Her current research interests relate to: intangible assets and their effects on organisational performance; corporate governance with a particular focus on corporate financial reporting; disclosures in annual reports.

Junghyun An is currently a visiting instructional designer at academic outreach in the University of Illinois at Urbana-Champaign. She graduated from curriculum and instruction at the University of Illinois, with a specialization in instructional technology (2008). Her research interests include online communities for collaborative and inquiry-based learning, cultural and identity issues emerging within a virtual learning space, discourse analysis, and ethnographic research in technology studies. In examining educational computing policies and practices, she has engaged in the study of alternative and interdisciplinary curriculum development for technology education in pursuit of fostering socially responsible professionals and teachers in the field.

Theresa Dirndorfer Anderson is an early career researcher who explores the relationship between people and emerging technologies. She has a particular interest in examining ways information systems and institutional policies might better support creative and analytic activities. Her research builds on her PhD thesis ("*Understandings of Relevance and Topic as they Evolve in the Scholarly Research Process*") to focus on human decision processes, information retrieval interactions and e-scholarship. In 2005 Theresa's thesis was awarded the 1st Annual Emerald/EFMD Outstanding Doctoral Research

Award (information science category). She designs and delivers courses (postgraduate & undergraduate) in information retrieval & organisation as well as in social informatics. Theresa is active in a cross-faculty e-Learning research group, and has a particular interest in developing integrated online and face-to-face teaching strategies. Prior to joining UTS, she served as a diplomat, technical writer and environmental education officer.

Jeff Axup is a user experience researcher and designer currently based in San Diego, CA, USA. He has a BS in computer science and a PhD in interaction design, which primarily focused on mobile device concepts and research methods for studying mobile communities of backpackers. Jeff is currently Sr. UI design engineer and lead of the user experience team at Websense, Inc, where he helps develop a range of enterprise security products. He keeps active in his spare time running mobile community design consulting and the associated blog mobilecommunitydesign.com.

Ronald Batenburg (1964) is associate professor at the Department of Information and Computing Sciences, Utrecht University. He studied sociology at Utrecht University and completed his PhD in 1991 at the University of Groningen. His research interests are in field of business/IT alignment, and the adoption and implementation of enterprise information systems, including ERP, e-procurement, CRM and PACS. He is member of the editorial board of *Journal of Electronic Health* and the Dutch *Tijdschrift voor Arbeidsvraagstukken.*

Mohamed Ben Ammar is a PhD Student for the *REsearch Group on Intelligent Machines (REGIM)*, at the University of Sfax, Tunisia. His research interests include affective computing in learning environments, intelligent environments, human-like learning in machines, emotionally expressive avatars and facial expression analysis. He received his master's degree in cognitive science from Victor Segalen University of Bordeaux-2, France. He has published in journals like *International Research Journal on Digital Future* (FormaMente), *Transactions on Advances in Engineering Education*, and *International Journal of the Computer, the Internet and Management.* See http://membres.lycos.fr/emaspel/ for more details.

Jos Benders (1965) holds the chair "organization concepts" at the Department of Organization Studies at Tilburg University and is a senior researcher at the Nijmegen School of Management, Radboud University Nijmegen. He studied business administration in Tilburg (MBA) and Indiana, and completed his PhD in 1993 at the Catholic University of Nijmegen. His research interests include employment relationships, organization concepts, and technology, work and organization. He serves as associate editor Europe of *New Technology*, *Work and Employment.*

Jeremy Birnholtz is an assistant professor in the Department of Communication and the Faculty of Computing and Information Science at Cornell University. He also holds an appointment in the Knowledge Media Design Institute at the University of Toronto. Jeremy received his PhD from the School of Information at the University of Michigan in 2005, and is interested in improving the usefulness and usability of collaboration technologies through a focus on human attention, and in the intersections of social science theory and technology design. He uses both laboratory and field methods and has conducted field research in a diverse range of settings.

Ann Borda is the executive director of the Victorian eResearch Strategic Initiative (http://www.versi.edu.au), a five-year Australian state government-funded program to provide a coordinated approach to accelerating the uptake of e-research on state and national levels. Concurrently, Dr. Borda is a research fellow at London South Bank University, where she has been investigating HCI and collaborative technologies. Previously, Dr. Borda held the position of programme manager with the Joint Information Systems Committee (JISC, http://www.jisc.ac.uk) based at King's College London, responsible for government-funded projects in developing a UK-wide e-Infrastructure. Dr. Borda has published in a number of areas, including HCI, data modeling & knowledge transfer.

Jonathan P. Bowen (http://www.jpbowen.com) is Chair of Museophile Limited, a museum and IT consultancy company. He is also a visiting professor at King's College London and an emeritus professor at London South Bank University. In 2007, he was a visiting academic at University College London and in 2008 he has been a visiting academic at Brunel University. Previously he was at the University of Reading, the Oxford University Computing Laboratory and Imperial College, London. In 2002, Bowen founded Museophile Limited (http://www.museophile.com) to help museums online, including the areas of virtual communities, wikis, etc. Bowen is a fellow of the Royal Society for the Arts and of the British Computer Society. He holds an MA degree in engineering science from Oxford University.

Paul Bracewell is the Director of Analytics at Offlode Ltd., an Australasian analytical consultancy firm. Prior to joining Offlode, Paul lectured in statistics at Massey University's Albany Campus (New Zealand), where in 2003 he earned a PhD degree in statistics. Paul is an accredited doctoral and masters associate supervisor at Swinburne University of Technology in Melbourne and is also a SAS Institute certified trainer delivering training throughout Asia-Pacific.

Petter Bae Brandtzæg joined SINTEF ICT and the Department of Cooperative and Trusted Systems in 2000. His expertise is in analysing user trends and patterns of use in new digital media, and in with a particular focus on online communities. Brandtzæg holds more than 30 international publications. He is at present researching a PhD on online communities/social networking sites at the Department of Media and Communication, University of Oslo and SINTEF.

Bertram (Chip) Bruce is a professor in library & information science at the University of Illinois at Urbana-Champaign. He conducts research on democratic education. This includes research on community inquiry through collaborative community-based work, the theory of inquiry-based learning, and new media for learning. Recent publications include *Libr@ries: Changing Information Space and Practice* (2006, with Cushla Kapitzke) and *Literacy in the Information Age: Inquiries into Meaning Making with New Technologies* (2003), various articles, and presentations. He is co-founder of the Community Informatics Initiative co-developer of computer systems to support collaboration and community action, such as Quill, the Inquiry Page, and Community Inquiry Labs (iLabs).

Jamika D. Burge is currently a postdoctoral research scholar in the College of Information Sciences and Technology at Penn State. She is managing a wireless network research project under the guidance of John M. Carroll at Penn State University. Burge completed her PhD in computer science from Virginia Tech in 2008. She has received several awards, including IBM PhD Research Fellow (2005-2006). Burge is affiliated with several professional organizations, including the Association for

Computing Machinery (ACM), and the CSE (Computer Science Education) and CHI (Computer-Human Interaction) Special Interest Groups.

Licia Calvi is head of the Learning Centre at Lessius, a College of the University of Leuven (K.U.Leuven). She is also (part-time) senior researcher at the Centre for Usability Research, within the Centre for Media Culture & Communication Technology, at K.U.Leuven. Her research interests are in the area of reading and writing new media, sociability and virtual communities, digital libraries and repositories, design, usability and evaluation of IT systems, specifically e-learning and mobile systems.

John M. Carroll is Edward M. Frymoyer Chair Professor of Information Sciences and Technology at Penn State. He was Professor of Computer Science, and Head of Department, at Virginia Tech (1994-2003). Recent books include *Making Use* (MIT Press, 2000), *HCI in the New Millennium* (Addison-Wesley, 2001), and *Usability Engineering* (Morgan-Kaufmann, 2002). Carroll serves on several editorial and advisory boards, and is Editor-in-Chief of the *ACM Transactions on Computer-Human Interactions*. He received the Rigo Award and CHI Lifetime Achievement Award from the Association for Computing Machinery (ACM), and the Alfred N. Goldsmith Award from the Institute of Electrical and Electronics Engineers (IEEE).

Laurence Claeys is a sociologist and communication scientist. She received an MA in sociology, an MA in gender studies and obtained a PhD in communication sciences at the University of Ghent, in Belgium. She does research within the residential networked application team of Alcatel-Lucent Bell Labs, Antwerp, Belgium.

Elayne Coakes is a senior lecturer in business information management at the University of Westminster. Her current research relates to knowledge sharing in organisations. As the vice-chair of the BCS sociotechnical special group she is active in promoting this view of information systems and has edited three books of international contributions in this field. Since then she has co-authored *Beyond Knowledge Management* and an *Encyclopedia of Communities of Practice in Information and Knowledge Management* in July 2005. Additionally, she has published more than 60 book chapters, peer reviewed journal chapters, and conference chapters. She is editor in chief of the forthcoming journal: *International Journal of Sociotechnology and Knowledge Development*. She is an internationally acknowledged expert on sociotechnical thinking and knowledge management and was visiting professor in Seville University, Spain, under the government grant scheme for distinguished, international scholars; a visiting research fellow in Queens University, Canada; and a keynote speaker at Manchester University, UK, at the tribute day for Enid Mumford.

Tanguy Coenen has a master's degree and a PhD in economic engineering from the Solvay Business School at the Vrije Universiteit Brussel. His research investigates knowledge sharing and how this can occur over social networking systems and social media in general. Besides research, he does consultancy, teaches and performs development in this area.

Piotr Cofta is with British Telecom (UK) as a chief researcher, identity and trust. He is responsible for strategic research in trust, identity and privacy. Previously he has been working for many years for Nokia and more recently for Media Lab Europe, concentrating on the relationship of trust between technology and society. Dr. Cofta has recently published his book *Trust, Complexity and Control: Confidence in a Convergent World*. He is an author of several patents and publications, from areas such as trust management, digital rights management and electronic commerce. Dr. Cofta is a contributor to several international standards, he publishes and speaks frequently. Piotr Cofta received his PhD in computer science from the University of Gdansk, Poland. He is a member of BCS and IEEE. You can contact him at piotr.cofta@bt.com or through his site http://piotr.cofta.eu

Johan Criel studied engineering in computer sciences at the university of Ghent. He focused his work since some years on the topic of context aware applications. Since 2005 he is researcher within the Residential Networked Application team of Alcatel-Lucent Bell Labs, Antwerp, Belgium.

David Davenport holds a BSc & PhD in electronics from Birmingham University in the UK. Following several jobs in industry and independent consultancy work, he joined the engineering faculty of Bilkent University in 1987. His research interests include philosophy of mind and computation, computers in learning, and social and ethical issues related to information technology. He is a member of ACM and acting chair of the local SIGART chapter.

Peter Day has a long history of academic and practical experience of community technology. A senior lecturer at the University of Brighton, he is a founder member of the Sussex Community Internet Project (SCIP) and principal investigator of the ESRC funded community network analysis project and BSCKE funded community needs assessment project. He is a founder member of the Community Informatics Research Network. Peter has published extensively in the field of community informatics and is particularly interested in promoting dialogue between community practitioners, policy-makers and academics about the potential of community media and community network research and practice for community development in the network society.

Claire de la Varre is a PhD student in educational psychology at the University of North Carolina at Chapel Hill. She is currently a research assistant at the National Research Center on Rural Education Support and holds a master's degree in information science. She recently spent three years at the learning technology section at Edinburgh University in Scotland, as an e-learning developer on the Edinburgh Electronic Medical Curriculum (EEMeC), which was awarded the Queen's Anniversary Prize for Higher Education in 2005. Ms. de la Varre has also worked as a health services research librarian, and digital library programmer.

Harry S. Delugach is an associate professor of computer science at the University of Alabama in Huntsville. He has over 20 years of teaching experience, as well as an extensive scholarly publication record in knowledge based systems, conceptual graphs, and formal models in software engineering. He serves on several conference program committees, including a senior role in the International Conference on Conceptual Structures (ICCS). He is the author of CharGer, an open-source conceptual graph visualization package. He serves on the USA ANSI L8 committee, which is one of the technical advisory groups to ISO/IEC JTC1's SC32 subcommittee on data interchange, under whose auspices he served as editor of the Common Logic standard (ISO/IEC 24707:2007).

Peter Denning, a MIT alumnus, is distinguished professor of computer science at the Naval Postgraduate School in Monterey, California, where he chairs the CS department and directs the Cebrowski Institute for innovation and information superiority. He discovered the locality principle, now universally used to optimize storage systems; he codeveloped powerful performance prediction models for computer networks; he cofounded CSNET, the precursor of the NSFNET and modern Internet; he led the team that designed and produced the ACM digital library; he created a great principles framework for computing; and he codiscovered the eight generative practices of innovation. He is a past president of ACM and a prolific author. He holds twenty-four awards for distinguished service and technical contribution.

Cleidson Ronald Botelho de Souza is an associate professor of the Faculdade de Computação at the Universidade Federal do Pará, Brazil. He received his PhD in information and computer sciences from the University of California, Irvine, in 2005. He is the author of a number of technical publications in journals and conferences. In general, his research interests are in the field of collaborative software engineering, i.e., computer-supported cooperative work as applied to software engineering.

Ines Di Loreto graduated in philosophy, and is currently a PhD candidate in computer science at the Università degli Studi di Milano–Italy. Her research interests include social media and their societal impact. In particular, she investigates the relationship between ICTs (information and communication technologies) and the representation of self, analyzing how it impacts the resulting relationships, in the Web 2.0 framework.

Dan Dixon is a senior lecturer at the University of the West of England, but has 10 years of commercial Web design and development experience. His main interests are around designing multi-platform services that make the best use of the social aspects of shared use. Prior to moving to academia he had roles as a senior consultant with Headshift, a leading social software company, product manager for the BBC's online communities and production director for new media agency Syzygy. Currently he is carrying out research on online social spaces, service design, and pervasive gaming.

Ken Eason is emeritus professor of cognitive ergonomics at Loughborough University and senior consultant at the Bayswater Institute in London. He has worked on socio-technical systems theory in its application to work systems for 40 years including a period at the Tavistock Institute of Human Relations. He has conducted many research studies of the way user communities in work systems adopt and adapt to new technology and, at the Bayswater Institute, has been particularly involved in the formulation and use of methods of engaging user communities in the development of new working practices using electronic resources.

Rebecca Ellis is a researcher and PhD supervisor at the Centre for Research in Economic Sociology and Innovation (CRESI), Department of Sociology, University of Essex. CRESI is the first UK centre for economic sociology research and examines socio-economic transformations. Rebecca has a PhD in human geography from the University of Sheffield. She was funded on a two year project by the UK Economic and Social Research Council to explore the social and cultural aspects of eBay, the Internet auction site. Her publications include chapters in *Everyday eBay: Culture, Collecting and Desire* and *Intelligent Spaces: The Application of Pervasive ICT.*

Thomas Erickson is an interaction designer and researcher at IBM Research in New York to which he telecommutes from his home in Minneapolis. His primary interest is in studying and designing systems that enable groups of all sizes to interact coherently and productively over networks. More generally, Erickson's approach to systems design is shaped by methods developed in HCI, theories and representational techniques drawn from architecture and urban design, and theoretical and analytical approaches from rhetoric and sociology. In addition to computer-mediated communication, other research interests include virtual communities, game-like interactions, genre theory, personal information management and pattern languages.

Umer Farooq is a PhD candidate in information sciences and technology at Penn State, and his advisor is John M. Carroll. His research interests include understanding and supporting group and community collaboration through the design and evaluation of computer supported cooperative work (CSCW) tools. In June 2008, he successfully defended his dissertation, which investigates the feasibility, effectiveness, and consequences of supporting everyday creative scientific collaboration with computer-supported awareness in distributed settings. He has many refereed articles in national and international conferences and journals.

Thomas Finholt is research professor and associate dean for research and innovation at the School of Information, University of Michigan, and an adjunct assistant professor of psychology. He is also director of the Collaboratory for Research on Electronic Work (CREW) and the Center for Information Technology Integration. Finholt's research focuses on the design, deployment, and use of cyberinfrastructure in science and engineering. He was a co-developer of the world's first operational collaboratory, the Upper Atmospheric Research Collaboratory (UARC) , which was a finalist in the science category for the 1998 Smithsonian/Computerworld awards. His recent work has focused on the development of NEESgrid, the collaboratory component of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). He has also conducted research on the impact of geographic dispersion and computer-mediated communication on trust and performance in virtual teams, on the effect of electronic and cash incentives on response rates for online surveys, and on the use of archived digital content. He co-founded the Collaboratory for Research on Electronic Work (CREW), and has served as the director of CREW since 1997.

Brent Furneaux is a doctoral candidate at York University's Schulich School of Business specializing in the field of information systems. His current research interests include the processes surrounding individual and organizational decision making, the strategic management of organizational knowledge, and questions related to end of life phenomena such as the end of the information system life. He is currently pursuing dissertation research that seeks to better understand the factors that drive organizational decisions to discontinue their use of information systems. Brent is a graduate of the University of Western Ontario and the University of Toronto's Rotman School of Management.

Göran Goldkuhl, PhD, is professor in information systems at Linköping University and Jönköping International Business School, Sweden. He is the director of the research group VITS (www.vits.org). He has published several books and more than 120 research papers at conferences, in journals and as book chapters. He is currently developing a family of theories, which all are founded on socio-instrumental pragmatism: workpractice theory, business action theory, and information systems actability theory. He has a great interest in qualitative and pragmatic research methods and he has contributed to the development of Multi-Grounded Theory, (a modified version of Grounded Theory).

Wallace Hannum is an associate professor of educational psychology at the University of North Carolina at Chapel Hill and associate director for technology of the National Research Center on Rural Education Support. Hannum's focus has been on applying learning theory to the design of effective instructional programs in public and private organizations both in the US and internationally. His work integrates empirical learning research with processes for improving organizational effectiveness and focuses on instructional uses of technology, especially distance education to benefit those in rural areas. Dr. Hannum's goal remains improving human competence and capability through education.

Catherine Heeney is a sociologist working at the Ethox Centre, at Oxford University. Her work combines both empirical and theoretic approaches; she draws neo-Kantian philosophy and science and technology studies literature. She has worked on the 'Privacy and Data-sharing' project, at Edinburgh University; this looked at data sharing in the public sector. Her doctoral thesis, on the role of privacy and confidentiality in the production of official statistics, was completed in the sociology department of Manchester University. She was a Marie-Curie Fellow at the information management department of Tilburg University.

Jan Heim is chief scientist at SINTEF ICT. Heim has been associate professor and head of the department of psychology at University of Trondheim. He joined the research institute SINTEF in Oslo in 1995 where he has worked in the field of human-computer interaction with a focus on user requirements, adaptation of usability methods and psychological aspects of mediated communication in various European research projects. He is author or co-author of several international papers.

Thomas Herrmann is a professor of information- and technology-management and a fellow of the electrical engineering department. His research interests and teaching areas include design methods for socio-technical systems in the areas of knowledge management, groupware, (work-)process management and service engineering, as well as human-computer interaction and privacy. He was faculty member from 1992-2004 at the computer science department at the University of Dortmund and was in charge of the development of infrastructure and new media for the University. He holds a PhD in computer science of the Technical University of Berlin (1986) and a master of art in communication science of the University of Bonn (1983).

Dirk Heylen received his PhD from the University of Utrecht. After that he became assistant professor in the human media interaction group at the University of Twente where his research involves modeling conversational and cognitive functions of embodied conversational agents. His work on the analysis and synthesis of nonverbal communication in (multiparty) conversations has been concerned with gaze, and head movements in particular. He is involved in European and Dutch national projects on multi-party interaction, emotion research and the building of models of communicative agents. This includes building models of affective interaction, particularly in tutoring situations.

Starr Roxanne Hiltz, a sociologist and computer scientist whose work focuses on "human centered" information systems and is currently distinguished professor emerita, information systems department, College of Computing Sciences, NJIT. For 2008-2009 she has been chosen to be the Fulbright/ University of Salzburg Distinguished Chair in Communications and Media. Her research interests include group support systems (virtual teams and online communities), evaluation research methods, asynchronous learning networks, emergency management information systems, pervasive computing, and the applications and impacts of "social computing" ("Web 2.0") systems. (Http://is.njit.edu/hiltz)

David Hinds is a management consultant, adjunct professor and researcher. His research interests are focused on new forms of social and work-oriented groups which have emerged around Web 2.0 technologies including their implications for strategy, marketing, management and entrepreneurship. He recently completed his PhD in business administration with a concentration in information systems. Previously, he held senior management positions with Deloitte Consulting, Cordis Corporation (Johnson & Johnson), and The Wurth Group. He was also president and owner of Trend Distributors, a building supply distribution company. In addition to the PhD, Hinds hold a BS in engineering science, an MS in operations research, an MBA, and he is a licensed professional engineer.

Paul Hodgson works for British Telecom (UK) as a senior researcher, security and trust in the mobility research centre. He is responsible for research in convergent security and trust, specifically in trust, identity and privacy. He joined BT in 1997 and has previously worked in the security research centre on defensive technologies and the future technologies group on applying nature inspired approaches to network security. Prior to joining BT he worked on music and artificial intelligence at the University of Sussex, where he did work in computational/musical creativity. Prior to this he ran his own music software company and worked as a musician after completing a first degree in social science and philosophy at the University of Manchester. His research interests include the technical and social aspects of creativity, trust and security with special reference to opportunities in convergent environments. Dr. Hodgson is author of several publications and patents, from areas such as computational creativity, e-mail anti-virus protection, mobile services encryption and trust management. Dr. Hodgson is a contributor to several international journals and he publishes and speaks frequently. Paul Hodgson received his DPhil in cognitive science from the University of Sussex, UK. He is a CISSP, a fellow of the RSA and a visiting Research Fellow at the University of Sussex. You can contact him at paul.w.hodgson@bt.com

Paul Hoeken (1955) is lecturer at the Nijmegen School of Management, Radboud University Nijmegen. He studied business administration at the Eindhoven University of Technology. Prior to his present job he was active in consultancy, information management and logistics. His research interests include effectiveness of information systems projects, information architecture development and packaged software implementation.

Janet Holland completed a PhD in teaching and leadership, instructional design and technology, with a minor in communications from the University of Kansas. Dr. Holland currently serves as an assistant professor at Emporia State University, teaching pre-service teachers and master degree students in instructional design and technology.

Dan Horn is an associate at Booz Allen Hamilton. He received his PhD in cognitive psychology at the University of Michigan. He served as a post doctoral research fellow at the University of Michigan's School of Information, supporting the development of the George E. Brown, Jr. Network for Earthquake

Engineering Simulation (NEES). His research interests include social network analysis and computer-supported cooperative work.

Wilson Huang is associate professor in the Department of Sociology, Anthropology, and Criminal Justice at Valdosta State University. His PhD degree in criminology is received from the University of Maryland, College Park. He has published refereed articles in the areas of cybercrime, hotel crime, criminal sentencing, and criminal violence across nations. His teaching interests include police-community relations, comparative criminal justice, crime and technology, and program evaluations.

Matthew J. Irvin received his PhD in education with a specialization in educational psychology from the University of North Carolina at Chapel Hill. His research interests include student risk and resilience and the use of distance education for student learning and professional development for educators. Dr. Irvin has also had experience teaching college-level courses that incorporated elements of distance education and development of online courses.

Isa Jahnke, Dr. phil., assistant professor, studied social science in Germany. She worked three years at a consultancy company. From 2001 until 2004 she researched in the field of socio-technical systems and knowledge management. After her PhD study, she moved as a postdoctoral research assistant to the Department of Information and Technology Management. Since April 2008, she is an assistant professor at the Dortmund University of Technology at the Center for Research on Higher Education and Faculty Development. Her research topics are computer-supported cooperative work, collaborative learning, Web 2.0, and Internet-based communities. Further information: http://www.isa-jahnke.de ; Contact: isa.jahnke@tu-dortmund.de

Monique Janneck is junior professor for work and organizational psychology at the University of Hamburg, Germany. She studied psychology and earned a doctorate in informatics with a thesis on the design of cooperative systems from a communication psychology perspective. Her research focus is on the interplay between human behavior, social structures and technological development: She is interested in the way humans interact with technology, the way theories and findings on human behavior can inform the design of information technology, and the way technology impacts individual, organizational, and social behavior and structures.

Julie Keane is a PhD student in education (culture, curriculum and change) at the University of North Carolina at Chapel Hill. She is currently a research assistant at the National Research Center on Rural Education Support. From 1993-2004 Ms. Keane was associate project director at the Center for Children and Technology, EDC, Inc. in New York. She participated in nationally-based research examining technology in school reform, including analysis of federal and state education policy, professional development programs, curriculum reform initiatives, and the impact of technology on the social context of teaching and learning. Ms. Keane holds a MA in political science.

Julie E. Kendall, PhD, is a professor of management in the School of Business-Camden, Rutgers University. Dr. Kendall is a fellow of the Decision Sciences Institute and a past chair of IFIP Working Group 8.2. She was awarded the Silver Core from IFIP. Professor Kendall has published in *MIS Quarterly*, *Decision Sciences*, *Information & Management, CAIS*, *Organization Studies* and many other journals.

Additionally, Dr. Kendall has co-authored *Systems Analysis and Design*, 7th edition *Project Planning and Requirements Analysis for IT Systems Development.* She co-edited the volume *Human, Organizational, and Social Dimensions of Information Systems Development* and is on the senior advisory board for *JITTA* and is on the editorial boards of the *Journal of Database Management* and *IRMJ.*

Kenneth E. Kendall, PhD is a distinguished professor of management in the School of Business-Camden, Rutgers University. He is one of the founders of the International Conference on Information Systems (ICIS) and a fellow of the Decision Sciences Institute (DSI). He served as the president of DSI and as a program chair for both DSI and AMCIS. Dr. Kendall was named as one of the top 60 most productive MIS researchers in the world, and he was awarded the Silver Core from IFIP. He co-authored, *Systems Analysis and Design*, 7th edition, and *Project Planning and Requirements Analysis for IT Systems Development.* He edited *Emerging Information Technologies: Improving Decisions, Cooperation, and Infrastructure* and co-edited *The Impact of Computer Supported Technologies on Information Systems Development.*

Manuel Kolp is an associate professor in information systems at the Université catholique de Louvain, Belgium where he is also head of the Information Systems Research Unit and Academic Secretary of Research for the Louvain School of Management. Dr. Kolp is also invited professor with the University of Brussels and the Universitary Faculties St. Louis of Brussels. His research work deals with agent-oriented and socio-technical architectures for e-business and ERP II systems. He was previously a post doctoral fellow and an adjunct professor at the University of Toronto. He has been involved in the organization committee of international conferences and has chaired different workshops. His publications include more than 50 international refereed journals or periodicals and proceedings papers as well as three books.

Olga Kulyk is a PhD student in the Human Media Interaction group, University of Twente, the Netherlands. She is also a visiting researcher in the Human Computer Interaction, Multimedia and Culture group of the Vrije Universiteit Amsterdam. Her current research is on situation awareness support to collaboration of multidisciplinary teams in life sciences. She holds a MSc in computer science and post-MSc in human-computer interaction design. Her research interests include human-computer interaction, computer supported cooperative work, group awareness in co-located collaborative environments, and ubiquitous computing.

Ivan Launders is a technical solutions architect for British Telecommunications. He has twenty-two years of software and telecommunications experience working with network and system integration solutions. He received his Master's Degree in 1996 from Sheffield Hallam University and is currently working towards the completion of a PhD in transaction agent modelling and knowledge representation at Sheffield Hallam University. His research interests are in smart applications, particularly in capturing and modeling the exchange and use of knowledge in business transactions and business processes.

Ronald M. Lee has nearly 30 years of research experience in electronic commerce, Web-based initiatives, and formal modeling. For the last five years, he has conducted research at Florida International University on open sourced e-learning, e-tourism, e-culture, and virtual world environments. For the previous ten years, he was director of the Erasmus University Research Institute for Decision Information Systems (Euridis). He previously held positions at the University of Pennsylvania, the University of Texas and the International Institute for Applied Systems Analysis. Lee holds a BA in mathematics, an MBA, and a PhD in decision sciences from the University of Pennsylvania (Wharton).

Ronald Leenes is associate professor in IT, law and (new) technology at TILT, the Tilburg Institute for Law, Technology, and Society (Tilburg University). His primary research interests are privacy and identity management, regulation of, and by, technology. He is also involved in research in ID fraud, biometrics and online dispute resolution. Leenes (1964) studied public administration and public policy at the University of Twente and received his PhD for a study on hard cases in law and artificial intelligence and law from the same university.

Mikael Lind is an associate professor with the University College of Borås, Linköping University, and Jönköping International Business School, Sweden. He is the leader of the informatics department and the founder of InnovationLab at the school of business and informatics in Borås. He is also associated to the research network VITS in Sweden and is active in different international communities such as language/action and Pragmatic Web. His current research interests are business process management, e-services, method engineering, co-design of business and IT, private-public partnership, and research methods for information systems development. His research is mainly characterised by empirically driven theory and method development. He is involved in several action-research projects focusing co-design of business processes and information systems. He is also the project manager of the citizen-centric e-service project e-Me—turning the Internet around (www.e-me.se). He is also associate editor for the open journal, *Systems, Signs & Actions* (www.sysiac.org).

Rachel McLean is a senior lecturer in business information technology within the business school at Manchester Metropolitan University, UK. She has contributed to both national and international conferences and journals, and managed a number of funded research projects. Her research and publications are in the field of the adoption, implementation and use of technology in a variety of organisational and social contexts.

Dario Maggiorini is assistant professor at the Università degli Studi di Milano–Italy; where he received his master degree and PhD in computer science in 1997 and 2002 respectively. He joined as a faculty member the department of Informatics and Communication in 2003, where his teaching activity is typically related to operating systems and network protocols and architectures. In the past, he has been working on quality of service for IP networks, multimedia content delivery, application-level networking, and software architectures for service provisioning. Currently, his research interests focus mainly on software and network architecture for entertainment applications and content/service provisioning in distributed environments.

Christopher A. Miller is chief scientist and co-owner of Smart Information Flow Technologies, a small business in Minneapolis, MN specializing in research and development of intelligent human-automation systems. Previously, Dr. Miller was a fellow at the Honeywell Technology Center. His interests include human automation integration, human performance modeling, and politeness and etiquette across cultures and in human-human and human-machine interaction. Dr. Miller's PhD was received from the Committee on Cognition and Communication in the Psychology Department at the University of Chicago. He is a member of the Human Factors and Ergonomics Society and of the Association for Computing Machinery.

Anders I. Mørch is an associate professor at InterMedia, University of Oslo, Norway. He received a PhD in informatics from the University of Oslo and an MS in computer science from the University of Colorado, Boulder. He has worked in industry for 3 years at the NYNEX Science and Technology Center, New York. His general interests are technology-enhanced workplace learning, human-computer interaction, and participatory design. His specific interests include computer-supported collaborative learning, educational applications of software agents (critics; pedagogical agents), and socio-technical interaction design. Dr. Mørch is a senior researcher and InterMedia project leader in the European Knowledge-Practices Laboratory (KP-Lab) project (2006-2011). Contact him at anders.morch@intermedia.uio.no.

Mahmoud Neji received the PhD degrees in computer science from the UPS Toulouse, France in 1984. He is currently a postdoctoral researcher. His research interests include pattern recognition, computer vision, and automated face analysis such as face modeling, facial expression recognition, affective computing in learning environments, intelligent environments.

Dorit Nevo is an associate professor of information systems at York University's Schulich School of Business. She received her PhD in management information systems from the University of British Columbia and her MSc in economics from the Technion–Israel Institute of Technology. Her current research interests include expectations management, requirements analysis, and design and evaluation of knowledge management systems.

Anton Nijholt received his MSc degree in mathematics and computer science from Delft University of Technology and his PhD degree from the Vrije Universiteit of Amsterdam, the Netherlands. He held positions at various universities in the Netherlands, Belgium and Canada. Currently, he is chair of the Human Media Interaction group of the University of Twente. His main research interests are multiparty and multimodal interaction, and social and intelligent (embodied) agents. He is involved in European projects on multi-party interaction, emotion research and embodied agents. game research and brain-computer interfacing also receive his interest in some large-scale Dutch national projects.

Pernilla Qvarfordt is a research scientist at FX Palo Alto Laboratory, where she conducts research in the area of human-computer interaction. Pernilla's current research is focused on developing technology for enhancing human-human communication and collaboration. Pernilla received her PhD in computer science from Linköping University, Sweden in 2004. Her dissertation work focused on exploring the use of eye-gaze information in multimodal interaction. During her graduate study she worked Université Paris-Sud and the IBM Almaden Research Center as a visiting researcher.

Emilee Rader is a doctoral candidate at the University of Michigan, in the school of information. After earning a master's degree in human-computer interaction from Carnegie Mellon University, she spent five years working with an interdisciplinary team of researchers at Motorola Labs, designing and evaluating next generation applications for mobile technologies. Her current work focuses on understanding the social and cognitive processes that affect how collaborative groups use social software for information management, in order to design technological or social interventions to make storing, organizing, finding and sharing information easier.

David Redmiles is an associate professor and Chair of the Department of Informatics in the Donald Bren School of Information and Computer Sciences at the University of California, Irvine, USA. He received his PhD in computer science from the University of Colorado, Boulder, in 1992. He is the author of a number of technical journal and conference publications. In general, his research interests are in the overlap between software engineering, human-computer interaction, and computer-supported cooperative work.

Rutger Rienks received his MSc degree and his PhD from the University of Twente in the Netherlands. His activities focus on the extent to which computers can replicate the human abilities to perceive and comprehend both single- and multiparty interaction. He has published on meeting modelling in general and on a number of topics where technology can aid the meeting domain. He has shown possibilities for applications on various dimensions of the meeting process.

Laura Anna Ripamonti is assistant professor at the Università degli Studi di Milano–Italy, where she teaches "Economics and Enterprise Management" to computer science undergraduate students and "Laboratory of Computer Science" to students graduating in biosciences. She graduated in engineering and managerial sciences at Politecnico di Milano and she got a PhD in computer science. Her research interests focus on the relations between ICTs (information and communication technologies) and social networks. Due to her multidisciplinary background, she is interested both in the technological and in the organizational aspects of the topic, which she prefers to investigate through an "action research" approach.

Peter Rittgen received a master of science in computer science and computational linguistics from University Koblenz-Landau, Germany, and a PhD in economics and business administration from Frankfurt University, Germany. He is currently an associate professor at the School of Business and Informatics of the University College of Borås, Sweden. He has been doing research on business processes and information systems development since 1997, especially in the areas business and IT co-design & collaborative modeling, business network governance and business process simulation & improvement. Dr. Rittgen is the vice-chair of the AIS Special Interest Group on Modeling and Simulation, SIGMAS (www.ModellingAndSimulation.org) and an associate editor of the *Informing Science Journal*. He is also a PC member in several international conferences and serves on numerous review committees for international journals and conferences. He published over 70 works including 2 edited books, 8 book chapters and 10 journal articles. For further details refer to http://www.adm.hBSe/~PRI/.

Mary Beth Rosson is a professor in information sciences and technology at Penn State. Her research interests include community computing, environments and tools for learning and using object-oriented design and programming, and visual programming environments. She co-authored *Usability Engineering* (Morgan-Kaufmann, 2002), and has numerous articles in national and international conferences, magazines, journals, including the *Communications of the ACM* and International *Journal of Hunan-Computer Studies*. In 2008, she was inducted into the CHI Academy for her extensive research contributions to the study of HCI.

Andee Rubin, Senior Scientist at TERC, has done research and development in the fields of mathematics, educational technology, and online learning for over 25 years. Her recent research has focused on how students and teachers develop statistical reasoning, how video can be used to introduce ideas of movement over time, and how mathematics can be integrated into informal settings such as zoos and aquariums. She is the author of *Electronic Quills: A Situated Evaluation of Using Computers for Writing in Classrooms* (with Bertram Bruce) and an editor of *Ghosts in the Machine: Women's Voices in Research with Technology.*

Roel Schouteten (1969) is assistant professor at the Nijmegen School of Management, Radboud University Nijmegen. He studied management and organization at the University of Groningen where he completed his PhD in 2001. His research interests include quality of working life, technology, work and organization, and HRM and performance. He serves as editorial secretary of the Dutch Journal of Labour Studies (*Tijdschrift voor Arbeidsvraagstukken*).

Ben Shneiderman (http://www.cs.umd.edu/~ben) is a professor in the Department of Computer Science and founding director (1983-2000) of the Human-Computer Interaction Laboratory (http://www.cs.umd.edu/hcil/) at the University of Maryland. He was elected as a fellow of the Association for Computing Machinery (ACM) in 1997 and a fellow of the American Association for the Advancement of Science (AAAS) in 2001. He received the ACM SIGCHI Lifetime Achievement Award in 2001. His books include *Designing the User Interface: Strategies for Effective Human-Computer Interaction* (Addison Wesley, 5th ed. 2009) and *Leonardo's Laptop: Human Needs and the New Computing Technologies* (MIT Press), which won the IEEE Distinguished Literary Contribution award in 2004.

Malcolm Shore started his career in ICL, UK before completing his degree in computer science and emigrating to New Zealand where he accepted a commission in the RNZAF as a computer specialist. On retiring from the RNZAF, he took the position of manager computer security at the government communications security bureau. Dr. Shore subsequently left the government and returned to industry as technical director, CES communications where he was responsible for the design and development of secure voice, satellite, and radio products. Dr. Shore is currently the head of security for Telecom NZ and a senior fellow at Canterbury University where he lectures in computer forensics and information warfare.

Jonas Sjöström, BSc, is a systems designer, software developer and teacher currently working on his PhD studies at Uppsala University, Sweden. His research is centered around socio-technical design of information systems. His PhD work aims at providing a coherent and useful conceptualization of the IT artifact founded in semiotics and social action theories. Furthermore, he works actively with conceptualizing use qualities of IT artefacts, as a means to improve IT design and organizational change processes.

Peter A. C. Smith is president of The Leadership Alliance Inc. (TLA), an Anglo-Canadian management-consulting company he founded in 1988. Peter maintains a very active international consulting practice assisting client organizations in both public and private sectors. He largely specializes in helping clients enhance their performance by optimizing strategies for design and development of critical innovation drivers such as organizational learning, knowledge management, leadership, collaboration and motivation. Peter is a past associate of Peter Senge's Organizational Learning Center (MIT) and of the Agility Forum. He is editor-in-chief of the online *Journal of Knowledge Management Practice*; *Consulting*, and special issue editor for the scholarly-refereed journal *The Learning Organization*; executive director, International Foundation for Action Learning-Canada; and past-chair, International Community of Action Learners. Peter has had published over forty scholarly chapters on a broad range of topics related to performance enhancement, and is internationally in demand as a speaker, workshop leader and conference chair.

Ronald Stamper studied mathematics at Oxford in the 1950s, where he developed a passion for singing opera but, was diverted into hospital administration and then the steel industry, where he began to apply computers. Soon disillusioned by the poor organisational returns from technically excellent systems, he began to look for an alternative approach. The opportunity came when asked by the steel industry staff college to create courses for systems analysts in heavy industry. At that time, computer companies ran all the other courses for marketing their products. Instead, he treated organisations as the real information systems in which computers could play a part—if appropriate. He was one of the main contributors to a national training programme in systems analysis and was invited to join a team at the London School of Economics to develop teaching and research in information systems in 1969. His book *Information*, based on organisational semiotics, was published in 1973. He began the research mentioned here in 1971 with research council funding. The theoretical work was largely completed before he left the LSE 20 years later for the University of Twente. With his students there and at other universities, the theory was put to the test in a large number of diverse organisations. Since retiring in 1999 he has continued the work, with funding from the EPSRC concentrating on writing up results from this lengthy research programme.

Charles Steinfield is a professor and chair in the Department of Telecommunication, Information Studies, and Media at Michigan State University. His research interests include the uses of online social networks, individual and organizational collaboration via ICT, and e-commerce. He is currently pursuing projects on social capital and online social network site use, collective action and the diffusion of information technology standards, and ICT use in knowledge-oriented business clusters. He is a recipient of MSU's Teacher-Scholar and Distinguished Faculty awards.

Tom Stewart is joint managing director of system concepts. He is a chartered psychologist and a fellow of the Ergonomics Society. He was a founder member of the Human Sciences and Advanced Technology (HUSAT) Research group at Loughborough University in 1970. In 1979, he joined the management consultancy Butler Cox and Partners and worked on assignments in Europe, North America and Australia. He joined System Concepts in 1983, and became managing director in 1986. He chairs a number of British, European and International standards committees and is founding editor of the international journal, *Behaviour and Information Technology*. He is president of the Ergonomics Society.

Matti Tedre holds a PhD degree in computer science. He works as an associate professor and head of BSc program in information technology at Tumaini University, Tanzania. Previously he has worked in the Department of Computer Science and Statistics at the University of Joensuu, Finland, as an assistant, researcher, and lecturer; and he spent two years in South Korea visiting the universities of Yonsei and Ajou. He has also been a visiting instructor at the University of Pretoria, South Africa.

Earlier, he worked as a programmer and as a software analyst. His research interests include social studies of computer science, the history of computer science, information technology education, and the philosophy of computer science.

David Thorns is professor of sociology at the University of Canterbury, New Zealand. He has over 40 years experience as an urban researcher working in the fields of housing, social policy, social inequality, tourism, research methodology and the implications of globalisation. He has published extensively including 10 books. He is a principal researcher and member of the *Management Group of the Building Research Capability in the Social Sciences* project and principal researcher on a three year Marsden funded project *Winners and Losers in the Knowledge Society.* He is also a member of steering committee of the Asia Pacific Housing Research Network. social science commission of NZ UNESCO and vice president social sciences of the Royal Society New Zealand and board member of the Centre for Housing Research Aotearoa /New Zealand. International Social Science Council and Capability Building Fund for the NZ Advanced Network.

David Tuffley Since 1999, a lecturer in the School of ICT at Griffith University, and a senior consultant in the Software Quality Institute (partnered with the Software Engineering Institute at Carnegie-Mellon University). Before academia, he began his IT career in London in the late 1980's as a technical writer and from there to business analysis and software process improvement work in Australia working with public and private sector clients.

Wouter Van den Bosch holds a BA in international business studies and currently studies sociology. He works as a researcher for Memori, a research and consulting group of the University College of Mechelen, Belgium. His work focuses on the design and development of social software applications and their use to support online community building, knowledge management, citizen participation and social inclusion.

Veerle Van der Sluys is freelance Java and Drupal software engineer and has a passion for web development and new technologies (web2.0). She received her MSc and her PhD in theoretical nuclear physics from Ghent University (Belgium). Veerle's research interests are in decision support, social network analysis and network visualization. She has been involved in the KnoSoS research project at the Free University of Brussels, Belgium and Katholieke Hogeschool Mechelen, Belgium.

Gerrit van der Veer has a MSc in cognitive psychology and a PhD in computer science. His research interests are in user interface design methods, visual design, and mental models of ICT users. He is emeritus professor in interaction design at the Vrije Universiteit Amsterdam, and full professor of human-computer interaction at the Open University Netherlands. Currently he is also a visiting professor in the Human Media Interaction research group of the University of Twente.

Paul van der Vet studied chemistry and philosophy of science and holds a PhD in chemistry. He joined the Department of Computer Science at Twente in 1989 to work on AI projects related to natural science domains. He has carried out research in text mining, information extraction, and information retrieval. He has an interest in ontologies and knowledge representations, again of natural science subjects. Since 2000, he is member of the Human Media Interaction group at Twente. Currently, he is involved in several national and international research projects.

Betsy van Dijk is an assistant professor in the Human Media Interaction research group. She graduated in mathematics and has a PhD on teaching methodology in computer science. Currently, her research interest is in the field of human-computer interaction where the main topics are interface and interaction design, user evaluation, user modelling and personalization. Her focus is on multi-modal and multi-party interaction and ambient intelligence. She is involved in several national and international research projects on human-computer interaction.

Shun-Yung Kevin Wang serves as a research analyst with the Justice Research Center in Tallahassee, Florida. He has intensive experience in retrieving and analyzing delinquent juvenile data stored in the information system of Florida Department of Juvenile Justice (FDJJ). Prior to his current employment, he served as a program evaluator and data analyst for organizations in Florida. Mr. Wang holds a MS from the College of Criminology and Criminal Justice and a specialist degree from the College of Information at Florida State University (FSU). Currently, he is a candidate for a doctoral degree in criminology and criminal justice at FSU.

Yves Wautelet is an IT project manager and a postdoc fellow at the Université catholique de Louvain, Belgium. He completed a PhD thesis focusing on project and risk management issues in large enterprise software design. Dr. Wautelet also holds a bachelor and master in management sciences as well as a master in information systems. His research interests include aspects of software engineering such as requirements engineering, software project management, software development life cycles and CASE-Tools development as well as information systems strategy.

Hans Weigand studied computer science at the Vrije Universiteit in Amsterdam, with minors in linguistics and organization theory. His PhD thesis applied linguistics to the field of knowledge representation. In 1989, he moved to Tilburg University where he is currently associate professor at the Faculty of Economics and Business, Dept. of Information Management He has participated in several European industrial projects and research networks, and is one of the founders of the Language/Action Perspective workshops and the Pragmatic Web conference.

Heike Winschiers-Theophilus is involved in cross-cultural design and usability engineering research in Namibia since 1995. She received her PhD in computer science from the University of Hamburg in 2001. She has been a faculty member of the University of Namibia and is now heading the Software Engineering Department at the Polytechnic of Namibia. She is part of an international researcher community engaged in human computer interaction for development propagating community centered design as an adaptation of participatory design.

Shumin Zhai works at the IBM Almaden Research Center. He has published about 100 research papers, received numerous patents, contributed to three IBM Research Division Accomplishments, and led major IBM product innovations. His work has been broadly reported in the news media. He is on the editorial boards of *Human-Computer Interaction*, *ACM Transactions on Computer-Human Interaction*, and other journals. He has been a visiting professor and have lectured at various universities in the US, Europe and China. He earned his PhD degree at the University of Toronto. In 2006, he was elected to ACM's inaugural class of distinguished scientists.

Index

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D

E

J

K

L

M

N

O

P

Q

R

S