Virtuality and Virtualization

Edited by
Kevin Crowston
Sandra Sieber
Eleanor Wynn

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VIRTUALITY AND VIRTUALIZATION

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- Open conferences;
- Working conferences.

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VIRTUALITY AND VIRTUALIZATION

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Edited by

Kevin Crowston
Syracuse University
School of Information Studies
USA

Sandra Sieber
IESE, Business School
University of Navarra
Spain

Eleanor Wynn
Intel Corporation
USA

Springer

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Introduction
Virtuality and Virtualization

Kevin Crowston[1] and Sandra Sieber[2]
1 Syracuse University School of Information Studies
Syracuse, NY 13244 USA
crowston@syr.edu
2 IESE Business School
Avda. Pearson 21, 08034 Barcelona, Spain
sieber@iese.edu

1 Introduction

In today's rapidly changing global work environment, all workers directly experience increased organizational complexity. Companies are functionally distributed, many across the globe. Intense competition for markets and margins makes adaptiveness and innovation imperative. Information and communication technologies (ICT) are pervasive and fundamental infrastructures, their use deeply integrated into work processes. Workers collaborate electronically with co-workers they may never meet face-to-face or with employees of other companies. New boundaries of time, space, business unit, culture, company partnerships, and software tools are driving the adoption of a variety of novel organizational forms. On a macro-level, these changes have started to reshape society, leading some to speak of the "Network Society" and the "Information Age."

The word "virtual" has become a compelling catchphrase to describe these changes, but with different underlying meanings. "Virtual" is used to identify emergent work forms that differ from traditional work on dimensions such as the location of the workers, where and how work is done, how workers and teams or managers interact, and the relationships between partner organizations. "Virtual" can describe work environments where individuals are dispersed in time and space. Examples are individuals working at home (telecommuting), teams of employees from different organizations managing a supply chain or a shared project, or organizations that are established only for a certain time for a concrete purpose. Teams may disband when a project is over, and individuals may work on several teams at a time. Finally, these novel work arrangements may be called "virtual" because the work is done via ICT with simulated images and processes rather than exchanges of physical materials and performance of physical processes.

While there is broad agreement about the nature of these changes, their scope and significance demands more in-depth research and debate. The increasing reliance on computer-mediated interaction has been heralded by some as the emergence of a new organizational form, while others have criticized this perspective as techno-utopian, pointing out that in fact, organizations and individuals often resist attempts to change, or change in unanticipated ways. The phenomenon of virtuality highlights

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the dual nature of technology, in which human action and the social context in which the action takes place both shape technology, while simultaneously technology influences human actions and social structures. This perspective invites us to reflect more deeply on the nature, direction, and future of technology, organizations, individuals, and virtuality. The papers in this book contribute to this reflection, addressing a wide range of topics relating to our understanding of virtuality and virtualization, from leadership to processes to fiction.

2 Frameworks for Understanding Virtuality and Virtualization

The book begins with consideration of possible frameworks for understanding virtuality and virtualization. D'Eredita and Nilan examine the phenomena associated with virtual collaborative work and present a framework for understanding issues related to virtual teams and their use of information technology. They note that a team focused on some problem requires participants to engage in sense-making, sense-giving, and organizing in order to generate collaborative action. An implication of this perspective is that systems for virtual teams should explicitly support rather than take for granted these fundamental processes.

Jha and Watson-Manheim turn attention to the firm level, reviewing papers on virtual organization in terms of the type and goals of the organization and the strategies employed to manage this kind of virtual work. Although they found very little empirical research, the conceptual work suggests that the strategies employed vary with the goals of the organization: virtual organizing for abstract resources had decentralized network structure and collaborative ties with partners, while virtual organizing for specific goals had centralized network structure and opportunistic ties.

This topic is also addressed by two panels, which are described briefly in the final section of the book. In the first, "Virtualization and Institutions," panelists Barrett, Davidson, Silva, and Walsham explore how institutional theory might be valuable for understanding virtualization of work practices. In the second, "Exploring the Nature of Virtuality," panelist Panteli, Chiasson, Yan, Poulymenakou, and Papargyris examine the multi-dimensional nature of what virtuality has been, is, and may become, and specifically its global and local dimensions, as well as the different interpretations that are given to these dimensions.

3 Process Issues to Achieve Virtualization

The book next includes papers that consider ways of analyzing virtual work in terms of work processes. Nilan and Mundkur describe a procedure for generating user-based cognitive and social cognitive models of tasks/problems/contexts that can be employed to create readily navigable link structures for virtuality-mediated communication and collaboration purposes. Based on the description by 128 respondents of the steps taken during an interactive e-Commerce situation, they develop a model of e-Commerce as a series of logically necessary steps over time.

Katzy and Crowston describe the organizational activities necessary for firms to cooperate within a virtual organization called the *Virtuelle Fabrik* (the Virtual Factory), which reliably engineers and delivers manufacturing projects. Firms in the network can access market opportunities and additional needed competencies through a process they call "competence rallying." They argue that the success of manufacturing projects in this virtual organization is predicated on specific organizational activities in four phases of the competence rallying process: 1) identification and development of competencies, 2) identification and facing of market opportunities, 3) marshalling of competencies, and 4) a short-term cooperative effort.

Consideration of work processes leads to consideration of the coordination of those processes. Cummings, Espinosa, and Pickering note that spatial (distance) and temporal (time zones) boundaries affect collaborative work by making informal and synchronous communications more difficult, respectively. They use social network data from 615 team members (representing 5919 pairs) across 137 global teams in a multi-national semiconductor firm to explore the impact of these boundaries on coordination delay and team outcomes. They found, as expected, that boundaries increased delays and decreased outcomes, and while communication helped reduce these effects, it did not help distributed pairs more than others.

Three papers examine coordination issues through in-depth case studies. First, Wiredu examines how global software development units deal with uncertainty from other units. From a case study of a software developer, he suggests that variety in information systems is needed for managing these uncertainties. Specifically, he notes five characteristics of variety that are needed: agility of developers, continuity of developers, high frequency of communications, varied communication modes and technologies, and virtuality that makes global expertise accessible.

Ocker, Huang, Trauth, and Purao discuss the complexities of accomplishing knowledge work within a hybrid team configuration in which members alternate between co-located and distributed contexts, with differing levels of availability. From a case study of a research team writing a paper together, they identify reasons for member unavailability and contrast them with the expectation of availability.

Finally, Sharma and Krishna investigate the level of process maturity in geographically dispersed software sustenance activities. They report on a case study of one organization that maintains proprietary software from three different locations. From this case, they describe a variety of processes that were adopted to support the organization, including carefully documented processes supported by shared workspaces.

4 Group Processes in Virtual Teams

The third section includes papers that examine group processes within virtual teams, focusing in particular on leadership and group identity. Heckman, Crowston and Misiolek present a two-order theory of leadership in virtual teams, building on behavioral leadership theory and structuration theory. Their theory describes four classes of first-order leadership behaviors (task coordination, substantive task contribution, group maintenance, and boundary spanning), and defines second-order leadership as behavior that affects changes in the structures that guides group action. They propose that effective virtual teams will exhibit a paradoxical combination of shared, distributed first-order leadership complemented by strong, concentrated, and centralized second-order leadership.

Reilly and Ryan introduce the notion of Ambassadorial Leadership, arguing that leaders of globally distributed virtual teams should have the characteristics of an Ambassador, someone who is culturally sensitive, able to span boundaries created by geography and functional background, and able to help build a collective identity for the virtual team. They develop an instrument for assessing Ambassadorial Leadership and test its measurement properties in a small pilot study.

Finally, a set of papers examines how virtuality affects individuals' identity and involvement in their work. Vaast applies Goffman's theoretical perspective to investigate how people present themselves in the virtual yet work-related environments of occupational online forums. Specifically, she analyzes the profiles of more than 300 registered users of an online forum dedicated to issues of interest to bankers. Four categories of profiles emerged, which she names after the typical characters in a play: Protagonist (the leading character), Deuteragonist (a secondary character), Tritagonist (a minor character whose specific background the audience is not made aware of), and Fool (a humorous character).

Brooks also argues that Goffman's terminology and concepts afford a powerful way of integrating the study of virtual action and interaction with the study of social action and interaction more generally. Specifically, she considers how participants in virtual environments interact with each other, as they would in co-present situations, and argues that several important aspects of virtuality can be well-accounted-for by this approach: the non-virtual "Real World," the meaning of simulated images and processes, immersion in simulated images, and processes and virtual social interaction.

Williams, O'Leary, and Mortensen note that increasingly people are members of more than one team at a time and they, their team leaders, and organizations must manage the challenges posed by relying on multiple team memberships (MTMs) as a way to structure work. From interviews and a survey of 401 professionals about the prevalence and nature of MTM in their work, they find that MTM is quite common, and requires individual members and team leaders to negotiate competing demands.

The conference also includes a panel organized by Chong, Erickson, Lee, and Siino. "The Social in the Virtual" discusses social elements of virtual environments, such as how social presence, influence, and awareness operate in virtual environments and the interplay between social patterns and structures in the physical and the virtual.

5 Knowledge and Virtuality

In the fourth section of this book, we consider the role of knowledge in virtual settings, considering its impact on group learning and competence management issues, as well as the impact of cultural differences. Annabi argues for the importance of group learning for virtual group effectiveness. To examine how and when virtual groups learn, she studies the developers of the Apache Web Server, who are geographically and organizational distributed. From the email transcripts of the group, she develops a taxonomy of what she calls *learning triggers*, events that initiate learning opportunity episodes by demonstrating the possibility for the group to learn to perform better, for example, a problem or the realization of a possible innovation.

Wei uses a case study to explore Chinese workers' perceptions of the impact of national cultural difference (China vs. U.S.) on knowledge sharing activities in global virtual teams in a high-tech company. Four cultural dimensions (language, education, technology and material culture, and attitudes and values) are identified. Her results show that language has the most salient impact on individuals' knowledge sharing activities, followed by education, attitudes and values, and technology and material culture. Individual characteristics, organizational culture, time zone problem, and leadership style have a mediated impact on the knowledge sharing activities.

Scott and Venters consider the implications of virtuality for our own knowledge development practice, by examining developments in e-science (that is, virtualization of research practice) and in e-social science in particular. As they state, "The standards and shared approaches implicit in engaging with e-social science enable the exciting prospect of conducting large scale research in ways not possible before." However, they caution that such innovations also create the need for novel kinds of research efforts (e.g., data curation), require a rethinking of the standards and norms for our own work (e.g., increasing the need for research teams rather than solo investigators), and potential privilege of certain kinds of work (e.g., that based on easily-shared quantitative data).

Westergren examines strategies that an organization can use to keep competences within a client organization when outsourcing services. She examines this question in a study of the relationship between a large minerals company and its service provider. She documents several strategies employed to maintain competences, such as exploiting the full potential of the partnership in order to learn from the supplier, and heavy investment in information technology.

Oshri, Kotlarsky, van Fenema, and Willcocks explore management of expertise in offshore outsourcing projects and conclude that it consists of three key processes, namely development, coordination, and integration. They find evidence for these processes in a case study of the ABN AMRO bank outsourcing to TATA Consultancy Services. They suggest that the management of expertise in such projects involves the coordination and integration of expertise that is both locally and globally developed, within and across projects.

A panel organized by Majchrzak and Wagner brings together professionals in both industry and academia to discuss "The Role of Shapers in Knowledge Sharing" The panelist define shaping (or gardening) as involving dynamically editing, integrating, distilling, refactoring, identifying areas of convergence and discrepancies, identifying topics receiving little attention in the community, and significantly rewriting the contributions of others.

6 The Role of Fiction in Structuring Virtuality

Virtuality can imply simulated images and processes, and a final set of papers considers the role of such fiction in structuring virtuality. Tapia, El-Nasr, Zupko, and Maldonado evaluate the efficacy of building virtual environments for influencing girls' interest in computer-related careers. Specifically, they developed a set of courses for middle and high school girls they in which they taught technology skills including programming, design and visual editing through developing video games. They find that the use of virtual environments and games captures the attention of participants, increase self-efficacy, and inspire some to consider computing as a career.

Rennecker and Schultze reconceptualize synthetic worlds such as Second Life as an emergent communication medium. They differentiate synthetic worlds on two dimensions—realism vs. fantasy and progression vs. emergence structure—to differentiate four kinds of worlds, but argue that all are a legitimate form of communications medium. They suggest possible research questions that IS researchers could address in these environments.

Finally, Ramiller considers processes by which organizations create and enter the new world of the virtual. He notes the particular importance of fictionalizations in the constitution of the future, suggesting that they can be generative, pulling the world towards a desired imagined state. As he says, "a real organizational innovation such as virtual work reflects, for a considerable period of time, an uneasy and dynamic mix of discourse and material activity." In other words, to understand the nature of virtual work, we need to understand what he labels the *narrative-virtual* that organizational actors create to predict and create this future state.

A panel on "Game Architectures and Virtual Teamwork," organized by Esther Baldwin of Intel Corporation, discusses the possibilities for virtuality of "serious games," noting that game architectures offer qualities that are missing in many collaboration tools, such as multi-tasking through objects, multi-teaming through context switching and "rooms," stimulating visuals and action environments.

7 Conclusion

In addition to the papers and panels discussed above, the conference program includes two keynote speakers. Michael Cohen's presentation, "Beyond Distributed Cognition: Widening Our Conceptual Foundations to Better Support Virtual Organization," argues for consideration of habit and emotion (in addition to cognition) as a basis for understanding virtual organizing. John Leslie King addresses "Dig the Dirt: Hashing Over Hygiene In the Artifice of the Real" to show how the "the patently 'unreal' notion of virtuality makes a rhetorical play for the status of 'real'" making virtual reality just a particular kind of reality. Two additional panels discuss specific types and applications of virtuality. Panelist Bélanger, Watson-Manheim, Harrington, Johnson, and Neufeld discuss, "The IT Artifact and Telecommuting," considers how research on telecommuting addresses the information technology artifact, which has been argued to be central to information systems research. Panalists Kaplan, Elkin, Gorman, Knoppel, Sites, and Talmon discuss “Virtual Patients” and explore virtuality in health care environments, with a particular focus on the virtual patient. Panelists explore different aspects of how developments leading towards virtual patients point towards significant issues of virtuality in other environments. The conference closes with a summative conversation between General Chair Wanda Orlikowski and Geoff Walsham.

Taken together, the papers and panels in this book present an impressive snapshot of the current state of the art in research on virtuality and virtualization.

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Section 1

Keynotes

1

Beyond Distributed Cognition

Widening Our Conceptual Foundations to better support virtual organization

Michael D. Cohen
School of Information, University of Michigan,
312 West Hall, Ann Arbor, MI 48109-1092 USA
http://www.si.umich.edu/~mdc
mdc@umich.edu

Abstract. American social science since World War II has been centrally shaped by the "cognitive revolution." Fields as disparate as behavioral economics and cognitive anthropology have exploited a shared core of ideas about the workings and limitations of human cognition, such short-term memory and judgment heuristics. This cognitive toolkit has been a principal asset in the efforts to understand and better support the requirements of newly emerging forms of virtual organization. This keynote address examines two other human faculties, habit and emotion. Across western intellectual history these have often been understood as equally important determinants of organized action, and this was the case in the period before World War II. However, since then habit and emotion have not been tightly integrated dimensions of our analyses of social life, including virtual organizing. Rather they have served, if present at all, as labels for clusters of exceptions, cases that involved issues not well handled by the default cognitive approach. Both habit and emotion are rising in psychology as topics of inquiry. These two additional human faculties are notable for being significantly less available to direct introspection, but powerful new measurement techniques—most notably various forms of scanning—are bringing into focus their large role in determining our actions. The keynote provides an overview of these developments and some suggestions some of their implications for the understanding and supporting virtual organizing with concepts that make habit and emotion more central to the primary analysis.

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About the Author

Michael D. Cohen is the William D. Hamilton Collegiate Professor of Complex Systems, Information and Public Policy at the University of Michigan. His research centers on processes of learning and adaptation that go on within organizations as they adjust to their changing environments. He has written numerous articles contributing to the theories of organizational decision making and learning—many employing computer simulation. The most influential of these is "A Garbage Can Model of Organizational Choice," co-authored with James G. March and Johan P. Olsen. It inaugurated the use of what is now called agent-based simulation as a tool for refining theories of organizational process.

In recent years his empirical research has focused increasingly on the organizational effects of information technology and has focused on organizational implications of new developments in psychological studies of memory. The work has involved laboratory studies as well as observation and prototype construction in field settings such as case management agencies and hospital radiology services.

Cohen was a founding co-director of CREW, the Collaboratory for Research on Electronic Work, a multi-disciplinary research group of University of Michigan faculty. Subsequently, he joined an interdisciplinary group of faculty in creating the new School of Information that was formally chartered by the University of Michigan in 1996. He is a member of the core faculty group that founded Michigan's Center for the Study of Complex Systems. His work on complex systems led to his book with Robert Axelrod, *Harnessing Complexity*. He also serves as co-director of the Interdepartmental Committee on Organizational Studies (ICOS), an interdisciplinary research seminar of doctoral students and faculty that has met weekly for seventeen years. He has served as an External Faculty Member of the Santa Fe Institute and as a long-term consultant at the Xerox Palo Alto Research Center.

2

Dig the Dirt

Hashing Over Hygiene In the Artifice of the Real

John Leslie King
University of Michigan

"Let's put some dirt into virtual reality..."
Laurie Anderson

It seems kind of strange that eating parasitic worms causes a cure rather than a disease. Yet, this fact is no stranger than many other man-bites-dog stories about "real life" in contemporary times.[1] Such stories arise at moments of changing equilibria in the processes of the social construction of reality. They are especially evident during periods of intense dialectic in which long held theses are being upended by powerful antitheses, and the glimmer of an eventual synthesis is still occluded by ignorance and confusion about what is at stake. The emergent dialectic among the "real" and the "virtual" provides a particularly interesting opportunity to explore the mechanisms of such dialectics. The opening quote from Laurie Anderson is a device to explicate the tension between the real and the virtual, and the mechanics of reconciliation by which a new equilibrium might be forged.

In this story the patently "unreal" notion of virtuality makes a rhetorical play for the status of "real." This fundamentally deconstructive act reverses the established hierarchy of opposition among the terms, revealing both to be children of a more generic parent. The initial hierarchy of opposition casts the real in a superior position to the unreal, in a manner similar to other constructs such as truth/fiction, fact/opinion, informed/ignorant. Reversal is necessary for the unreal—in this case, the virtual—to establish claims of attention by which the unreal is not judged merely in inferior contrast to the real but as an essential part of the very notion of the real. Without this, the virtual cannot establish its own reality. The initial attempt at this

[1]Ingesting the helminth *Trichuris suis* (pig whipworm) has been proved an effective therapy for the auto-immune disorder Crohn's disease. A. Reddyand B. Fried, The Use of *Trichuris Suis* and Other Helminth Therapies to Treat Crohn's Disease, *Parasitology Research* 100, No. 5, April, 2007, 921-927.

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reversal has already occurred in contemporary discourse, stabilizing the position of the virtual as "like unto" the real. This shifted the comparison from difference in kind (real and unreal as mutually exclusive) to difference in degree (real and unreal as related but distanced from one another). Virtual depictions of the real could then be discussed as relatively closer to or farther away from the real, rather than simply as "not real."

A good example of this shift is found in growing awareness of the role that cognition plays in shaping sensory inputs into a synthesis an individual can think of as representative of the real world. Cognition turns out to be trickier than first assumed, as seen in the discovery that viewer perception of audio *and* image quality rise as a function of improved audio quality without change in image quality.[2] Selective manipulation of sensory inputs makes possible cognitive "immersion," in which experience of representations in cinema, video or other multimedia draw ever closer to the experience of the real. When degree replaces kind, the rhetorical discussion shifts from whether to when and the virtual and the real are, in principle, one. This process is well underway, as seen colloquial acceptance of the oxymoronic signifier "virtual reality."

"Virtual reality" is on the verge of becoming both linguistically and experientially tractable, such that people think of virtual reality as a particular kind of reality, and not merely as an approximation. This happens through convergence on a notion of "real" that encompasses not only what people prefer in an idealized sense, but also what they mean when they say that something is "too real." In the context of Laurie Andersen's comment about getting the dirt into virtual reality it is clear she was aiming at the question of how to make virtual reality more realistic. This provides a hint about the transcendent notion of reality that subsumes both "normal" reality and "virtual" reality. The transcendence is accomplished by abandoning a static notion of what is real—what might be described as "*the* real"—and assuming instead multiple plausible realities, any number of which might be seen as real in any given moment. This has two advantages. It accommodates the well-established philosophical and psychological insight that point-of-view can influence perceptions of reality dramatically, such that different individuals looking at the same set of facts see very different realities (for example, the Rashomon effect). It also accounts for why different and sometimes contradictory things are seen as real at different times, even by the same people.

A useful mechanism for explicating this while staying on topic with dirt is to examine the changing reality in relationships among human disease and the immediate environment of the household. A good entry point to this is the work of Ruth Schwartz Cowan in her study of the complex role of household appliances in what she called the "consumption junction," where technological diffusion meets social reorganization.[3] The consumption junction often contains a subtle and viscous

[2] W.R. Neuman, A.N. Crigler, and V.M. Bove, Television Sound and Viewer Perceptions, *Proceedings of the Joint IEEE/Audio Engineering Society Meetings,* Detroit MI, Feb. 1-2, 1991.

[3] R.S. Cowan, The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology, in: *The Social Construction of Technological Systems*, edited by W.E. Bijker, T.P. Hughes, and T. Pinch (MIT Press, 1987) pp. 261-280.

circle in which technologies such as vacuum cleaners used to clean households were touted as labor-saving devices for housekeepers while, at the same time, they were part of a larger social mobilization to raise the expectations regarding the cleanliness of homes.[4] The reality of labor-saving technology enabled an extraordinary level of household cleanliness with far less labor, but the expectation of how clean a household should be accelerated even faster than the rise in cleanliness. The result was actually more work for the homemaker than had previously been the case. Households were simultaneously cleaner and insufficiently clean.

There is nothing inherently contradictory in these two facts: they are both part of a larger ecological mix evolving in the US, the UK, and other industrializing countries between the 1840s and 1930s as various hygiene movements swept middle and upper class society starting in the 1840s.[5] The household hygiene movement coincided with replacement of earlier "humoral" theories of disease with the germ theory of disease through the work of early 19th Century scientists such as Agostino Bassi, John Snow Joseph Lister, Louis Pasteur and Robert Koch. Throughout the mid to late 19th Century these scientific discoveries were incorporated into a wide variety of hygienic improvement schemes, some involving civic infrastructure (for example, the separation of sanitary sewers from water supplies) and others involving residential infrastructure (the invention and deployment of the recently developed sanitary flush toilet). Of special importance was the dissemination of hygienic practice as a necessary innovation among those responsible for "keeping house," namely married women and other female servants and caretakers who had charge of food preparation and childcare. By the late 19th Century there was an explosion in printed literature aimed at women either directly or through educational programs in which women participated.[6] Combined with instruction on other housekeeping activities, this became the core of "domestic science" and "home economy" programs that were incorporated into the growing Land Grant college movement, and that formed the first collegiate curricula aimed directly at women.

The central notion of household hygiene was simple: disease is caused by germs and germs live in dirt—human and animal waste, putrefying food, and even simple soil. Getting rid of dirt would reduce disease. At the beginning of the 19th Century dirt was an unavoidable part of everyday life: many dwellings had dirt floors, and the expression "spring cleaning" meant "annual cleaning." By the late 19th Century the

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[4] R.S. Cowan, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (Basic Books, New York, 1983).

[5] Household hygiene was only one of many such movements: others adjectives prefixed to the noun hygiene include industrial, dental, social, racial, mental, child, and female. Some intersect with household hygiene, while others go very far afield.

[6] The following provide a glimpse of this: R.T. Trall, *The Mother's Hygienic Hand-book: For the Normal Development and Training of Women and Children, and the Treatment of their Diseases with Hygienic Agencies* (S. R. Wells, New York, 1875); C.B. Allen and M.A. Allen, *The Man Wonderful in the House Beautiful: An Allegory Teaching the Principles of Physiology and Hygiene, and the Effects of Stimulants and Narcotics:* for home reading: also adapted as a reader for high schools and as a text-book for grammar, intermediate, and district schools (Fowler & Wells Co, New York, 1887); E.S. Reynolds, *Primer of Hygiene* (Macmillan, London, 1894); A.T. Schofield, *The Home Life in Order; or, Personal and Domestic Hygiene* (Hodder and Stoughton, London, 1906).

ideal of a disease-free home could be pursued through constant cleaning in the effort to maintain a dirt-free home. Improved construction standards as well as improving standards of living made better dwellings affordable. The second industrial revolution brought new mechanical and chemical technologies for cleaning. Education and other mechanisms of socialization created an expectation of household cleanliness that was simply expected at the upper end of social strata, and enforced by social workers, child welfare advocates, public health officials, and similar authorities at the lower end. In the span of a few generations, "reality" for most families shifted from *life-with-dirt* to *life-without-dirt*. The corollary decline in infectious diseases reinforced the presumed rightness of this change, and further established the sense that progress entailed driving out dirt. By the mid 20th Century dirt was being driven out generally, not merely from households and public facilities, but from routine life broadly through anti-litter campaigns. In an odd twist on Herbert Simon's distinction between the "natural" and the "artificial", nature became "dirty" and artificial became "clean".

It was into this strange dichotomy that virtual reality was born. The faint glimpse of what might happen at the intersection of digital computers and human experience took life at the Fall Joint Computer Conference in 1968 when Doug Englebart first demonstrated the computer mouse and other devices that allowed a human to interact with a computer.[7] This was a mere six years after Rachel Carson launched what became the environmental movement through her publication of *Silent Spring,* and just two years before the first Earth Day in 1970.[8] Works in praise of pastoralism, such as Thoreau's *Walden,* were resurrected, and public consciousness began to accept the idea that all of life is tied together by a complicated natural ecology. In the process, dirt was slowly rehabilitated by the recognition that even lowly soil was teeming with micro-organic life essential to the survival of plants and animals, including humans. The reality of germs-are-bad was slowly displaced by a new reality in which germs might be good or bad, depending on the context. This displacement required improved understanding of context, often alluded to as "environment" or "milieu." This new perspective enabled, for the first time, the idea that a household could be *too* clean.

Perhaps the most macabre development in this line of argument was the emergence of the so-called hygiene hypothesis, which explained the rise in incidence of allergic and other autoimmune disorders on insufficient exposure of individuals to routine pathogens as children.[9] That is, people got sick because their households were too clean. The mechanics of this hypothesis fit the ecological model through

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[7] C. Engelbart, and W.K. English, *AFIPS Conference Proceedings of the 1968 Fall Joint Computer Conference*, San Francisco, CA, December 1968, Vol. 33, pp. 395-410.

[8] R. Carson, *Silent Spring,* serialized in *New Yorker,* June 16, 23 and 30, 1962, published in hardback by Houghton Mifflin, 1962.

[9] See D.P. Strachan, Hay Fever, Hygiene, and Household Size, *British Medical Journal,* 299: 1259-1260, 1989; S.T. Weiss, Eat Dirt—the Hygiene Hypothesis and Allergic Diseases [Editorial], *New England Journal of Medicine* 347:930-931, 2002; F. Guarner, R. Bourdet-Sicard, P. Brandtzaeg, H.S. Gill, P. McGuirk, W. van Eden, J. Versalovic, J.V. Weinstock, and G.A. Rook, Mechanisms of Disease: The Hygiene Hypothesis Revisited, *Nature Clinical Practice Gastroenterology and Hepatology* 3: 275-284, 2006.

the use of evolutionary adaptation: the human immune system must be "trained" by exposure to pathogens routinely encountered over the course of human evolution. Without this training, the immune system cannot be calibrated appropriately. Poor calibration causes the immune system to mis-read certain environmental signals and start autoimmune actions that damage normally functioning systems. The hygiene hypothesis has been controversial, yet considerable support for it has come from studies linking the absence of common intestinal parasites to the presence of particular autoimmune disorders. This is the story behind this paper's opening observation about ingesting pig whipworms as a treatment for Chron's disease. This shatters the idea that health is simply the absence of disease, and by extension, the absence of disease pathogens, and enables the idea that health might be some kind of equilibrium that requires the presence of certain pathogens. The oxymoron of the "friendly pathogen" becomes real.

Laurie Anderson's aspiration to put some dirt into virtual reality is superficially a plea to make the virtual a little more like the real by incorporating an essential element of the real—dirt. This has two dimensions worth pondering. One is the fairly modest observation that virtual reality has been stuck, probably inadvertently, in an extension of the hyper-clean ideal into which it was born. Virtual reality pursued cleanliness in the tradition of hygiene, at least in part because the virtual lacks both biological pathogens and the mechanisms by which they might operate—it is in no sense "alive". This was just an inadvertent appropriation of the prevailing expectations for households and public spaces at the time the movement got going. By putting dirt into virtual reality, it might be possible for the virtual to "catch up" with the real—to look or smell or feel a little more real. The more interesting dimension of the issue has to do with the realization that reality itself has long been somewhat unreal in failing to accommodate the importance of dirt. By injecting dirt into virtual reality it is possible to inject dirt into reality itself. In a remarkable way, virtual reality holds the potential to be more real than reality itself through incorporating alternative past and future realities that actually did or will obtain in the world.

The virtual and the real converge when the idea of static reality is suspended in favor of a more flexible and dynamic idea of reality itself as virtual. In this sense, what we call reality is an approximation of a large number of different realities as seen and experienced by myriad participants—a statistical characterization of conditions and attributes that describe putative things as opposed to what Kant described as the *ding an sich*, the "thing in itself". By suspending the sense of reality as altogether concrete, and incorporating abstraction as a central part of reality at any given moment, the virtual is given the opportunity to participate in the real. This has the effect of making the virtual concrete as well as abstract, and in symmetry, making the real abstract as well as concrete. Under this conception, the difference between the virtual and the real stops being a difference in kind and becomes solely a difference in degree. As technology and facility improve the virtual, the real itself is reshaped and the distance between the virtual and the real decreases. The question of whether the two will converge disappears, and only the question of when remains.

About the Author

John Leslie King is Vice Provost for Academic Information and Professor and former Dean in the School of Information at the University of Michigan. He has published more than 175 books and research papers on the relationship between technical and social change in highly institutionalized production sectors, including government, education, health care, transport, finance, electric power utilities, and common carrier communications. He was Editor in Chief of the INFORMS Journal Information Systems Research from 1992-1998, and is a Fellow of the Association for Information Systems. He has served in a number of professional capacities, including the Computing Research Association Board of Directors, the Apple Computer University Executive Forum, the Executive Strategic Council of IMS Global Learning Consortium, the Institute for Social Research Executive Committee, and Center for Science, Technology and Society Advisory Board. Since 2003 he has been working with the US National Science Foundation as a Senior Scientific Advisor for Cyberinfrastructure and as a member of the advisory committees for the NSF Directorates for Computer and Information Science and Engineering and the Social, Behavioral, and Economic Sciences.

Section 2

Frameworks for Understanding Virtuality and Virtualization

3

Conceptualizing Virtual Collaborative Work

Towards an Empirical Framework

Michael A. D'Eredita[1] and Michael S. Nilan[2]
1 School of Information Studies
322 Hinds Hall, Syracuse University, Syracuse, New York
Phone: 315 443 1878
maderedi@syr.edu
2 School of Information Studies
330 Hinds Hall, Syracuse University, Syracuse, New York
mnilan@syr.edu

Abstract. The purpose of this paper is to define the phenomena associated with virtual collaborative work from both a cognitive and social cognitive perspective. The authors put forth an approach that assumes all people are natural sense-makers, sense-givers and organizers. The authors posit that the collaborative work we observe within both informal (ad hoc teams or communities) and formal (organizational) environments derives from fundamental, ubiquitous cognitive and social behavior intimately tied to context-specific problems or situations. The paper begins by challenging the need to re-define terms like "virtual" and "team" in a manner which works to subtly shift the focus of study from "proximal vs. distributed" to the more fruitful "fundamental behavior vs. technological constraints." The paper then presents a framework for virtual collaborative work and discusses its implications on issues related to teams, leadership, creativity, and the design and use of information technology.

1 Introduction

In a very short period of time the Internet has become the primary environment for organizing and coordinating virtual collaborative work. The potential for this globally networked hyperspace is truly immense; thus, it is fruitful for scientific research to address the issue of how to structure this environment in a manner that maximizes the effectiveness and efficiency of collaborating. It is safe to assume that

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face-to-face and virtual environments are different. However, we are slowly learning about the relative merits of these two environments and the significance of these differences. We assume that the differences of most significance are those that lend insight into how each environment constrains natural collaborative processes. This leads to the question of which constraints associated with a face-to-face environment should be applied to structure the Internet and which constraints, unique to the Internet, need to be further developed in order to optimize collaborative work. This is in contrast to, for example, following the constraints suggested by the technology itself, or carrying forward constraints inherited from print and broadcast technologies, or assuming that organizational constraints developed in face-to-face contexts are equivalent for the Internet. The aim of this paper is to present a new perspective on collaborative work based on the assumption that natural, ubiquitous collaborative processes exist and suggest that it is upon these processes that research on teams, leadership, creativity and the design of new technological environments should be centered.

As a recent historical lesson, virtual reality (VR) research was being fully funded before the emergence of the Web. VR was envisioned as having a very realistic but nevertheless simulated world in which a user or users would move around and interact with actual or virtual counterparts. This vision and the research approach for developing it was very much a technology-driven effort (a solution looking for a problem). What dramatically reduced the funding and interest in VR however were human sensory perquisites, for example, very exacting synchronization between visual and auditory cues which was one of the causes of "simulator sickness" in virtual environments [1] and the huge expense required to meet these requirements. Although this represents more of an ergonomic issue, we believe that a lesson to take away from VR research is that we need to look carefully at the human perquisites for collaborative work on the Internet earlier rather than later. In other words, we should apply inherited constraints, as they are applicable *only after* we have addressed the baseline human perquisites. The relevant human perquisites under consideration for collaborating would be mainly cognitive and social rather than ergonomic given that thus far the Internet does not emulate the sensory presence of VR.

As we look at the emerging research on virtual collaborative work, we note that it is relatively common practice of any scientific research domain to construct terminology that works to reify commonly referenced phenomena [2]. Scholars within the domain of "virtual organizing" have already begun this reification process [3, 4, 5]; not unlike many domains, they have chosen to reconstruct the meaning of terms that have previously been reified by larger communities—those composed specifically of actual "workers" within organizations—for the purposes of communicating within the smaller communities of scholars interested in studying organizing. The codified results of the larger communities can presumably be found in a number of commonly published dictionaries while those of the academic communities can be found in, for example, peer-reviewed publications. Ultimately, these larger communities populate the organizations and—hopefully—"practice" what the academic community is "preaching." In the spirit of Peter Drucker's educated person [6], we wish to explore the vernacular before moving too quickly to the reconstruction of commonly communicated words. It is through such terminology that we feel the notions, theories, and findings of scholars will most likely be communicated to those who work within the organizations that operate within the larger marketplace (corporations, not-for-profit organizations other than universities, etc.).

More importantly, it is through the application of the *relationships among the phenomena* to which these concepts refer that enable an academic community to create a more valid understanding of our world. We challenge the need to reconstruct the meanings of commonly used terms like *team*, *organizing*, *virtual* and further suggest that the inherent tensions between the vernacular and uses within academic communities helps to illustrate the tensions inherent in the phenomena of interest. We suggest that, although it is common *practice* to apply these terms when referencing a seemingly "common" phenomena, that the referenced phenomena itself is being too easily overlooked. For example, this appears to have led to a common practice of treating the notion of a "team" as a "black box" in much the same way cognitive psychology references terms like "attention" and "memory" (but for different reasons), [7, 8, 9, 10, 11, 12, 13]. While we agree that it might be functional and/or practical to do so in some cases, we hope to open the black box of virtual collaborative work—if only to "take a peak"—to see if we can better understand (1) what the phenomena are, (2) how they function and interrelate and (3) explore the implications of various composition and behavior factors on "virtual collaborative work."

Continuing with our example, the term "team" is a relatively new idea, at least as applied to people. According to etymological dictionaries, "team" first appeared, in the mid-1550s, in the context of a group of animals harnessed together to pull a wagon or cart (actually, the term has German roots). The first time the metaphor was applied to people, in 1828, it was recorded in the Oxford English Dictionary as "teamwork" ("a group of people acting together to bring suit"). In any case, collective life [14] involved well-understood roles and functions for participants.

There are at least three types of advantages associated with having a group of individuals strive for the same goal: Sheer strength in a brute force sense, as in a team of oxen (a sales-force, [15]); and comprehensiveness in the sense of 'two heads are better than one' (a collective mind, [16]); or a combination of both in the sense of most team-based competitive environments (a team-based athletic environment, [17]). It is important to point out that behaviors pursuing one of these advantages can interfere mightily with behaviors pursuing the other. The modern organizational term is seemingly a metaphor derived from a "team" of oxen, that is, one where a common control and orienting mechanism are paramount [18]. And there seems to be a dearth of conceptual work focusing on the phenomena themselves that work to *naturally* "yoke" individuals to each other. Certainly the type of task (known parameters versus unknown parameters) makes a difference in which behaviors are appropriate. Performance criteria (mostly efficiency criteria from a management perspective) exist, but these criteria provide no insight into which behaviors actually maximize the effectiveness (outcome measures) *and* efficiency (process measures) of team efforts through organizing manipulations. The behaviors in between, specifying the task and examining outcomes, are in a "black box" that obfuscates those phenomena. It would seem that understanding these behaviors and being able to argue for one over the other is the essence of organizing and managing.

We treat the individuals on teams as if they are still somehow "yoked," but seemingly less directly so than a team of oxen joined by a wooden yoke that functions to *physically* join them and facilitates direct control. In terms of being physically yoked, humans are not literally tied together and are often not even co-located but rather are loosely joined through some form of Information Technology (IT), Internet-based or otherwise. At great remove we might assume that the human team members have more autonomy than, for example, a team of oxen. But do they? Both the oxen and humans are yoked. The oxen by physical yokes and the humans by behavior that is collaborative in nature, something by which the oxen are simply not capable of being tied. To the oxen we physically place a wooden yoke across their shoulders. As we discuss below, to the humans we present "the problem" (to solve). However, it seems that control remains a central issue. With oxen, we steer the yoke itself and the oxen follow accordingly. With people how do we know what to control and why?

The popular notion of virtual collaborative work—groups of people "linked" by network technology—is becoming pervasive. We suggest that the tension inherent in the definition (and application) of *virtual* helps one to remain vigilant to the fundamental issues related to, for example, *virtual* teams. That is, we believe it is more fruitful for researchers to focus on "the essence" of the phenomena as it is, in this case, the essence of a team (that which works to yoke individuals) to which "virtual" refers. Otherwise, we could intuitively "see it" and "hold it" and simply call it a team. Virtual implies that you cannot intuitively "see it" or "hold it" *yet* we would still assume or perceive a functioning team. What is it about what teams do that allows this to happen? It is on this essence of virtual collaborative work—specifically, the action of collaborating—that we focus this paper.

We proceed by suggesting that researchers' first move the focus of research on collaborating, from that of individual differences and how these differences interact across multiple contexts (team dynamics, [5]), to that of differences across multiple contexts of "problems" and how they interact within the dynamic of ubiquitous human behaviors. Further, we propose new applications and refined definitions of previously used terms. We then proceed by showing how this shift of focus from individual differences to ubiquitous behaviors has implications on how one might perceive "team," "leadership," "creativity" and the design and/or understanding of technology.

2 Towards a Conceptual Framework Suitable for Inquiry

In this section, we develop a framework by articulating a series of assumptions and definitions of terms while articulating how they combine to form a new framework for the discussion and study of virtual collaborative work.

In order to frame our assumptions and definitions, we will introduce the framework here and then proceed by further defining its components. The framework centers on the assumption that if all of its aspects are appropriately addressed then collaborative (team-based) behavior will result. Determining the reliability, effectiveness, and efficiency of the resultant behaviors is intricately tied to context (the problem being addressed, expertise or experience of the respective team members, technological constraints, etc.); thus our concern is with the nature of collaborative behavior that we posit to be fundamental to being human.

While teams are often defined by their membership or collective expertise, we place "problem" at its nexus and view team as more of a series of collaborative behaviors geared to address a *specific* problem that is a common focus of its members. Otherwise, we would simply have a collection of individuals. While we do not question the validity of approaches characterized in terms of, for example, traits, personalities, skills, or structure, we suggest that an undo amount of variability, complexity, and ambiguity is introduced by trying to balance such vast array of potential variables. These variables focus on the group members' characteristics to specify behaviors and performance rather than on the problem or task context. We choose to focus on behaviors from the perspective of the problem or task because we posit that the behaviors are ubiquitous across all humans and that they are robust behaviors that do not vary when viewed at a fundamental level: sense-giving, sense-giving and organizing. These components are discussed below in detail. However, for now, it is sufficient to discuss these components in general terms.

We begin by juxtaposing individual notions and collective notions of sense-giving [19, 20]. In general, we assume that humans construct meaning (or "their reality") based on previous experience [21]. We assume that this process cannot be inhibited voluntarily or otherwise. If one is cognizant, one is sense-making. Whether "making sense" to others around them, or not, they are sense-making. Sense-giving is essentially redefining problem and constraints in such a way that others are able to sense-make in a more reliable, effective, and efficient manner, or not; the existence of sense-giving behaviors is not dependent on the outcome. Unlike sense-making, sense-giving can be inhibited by self-imposing or imposing an array of constraints (intentional behavior working to inhibit communication). However, we would view a case where collaborative behavior exists without any sense-giving behavior to be rare, if even possible. Finally, these behaviors require a type of structure in which to work. These structures can be imposed as in a formal structure and regulations of an organization [18] or emerge as in social practices [22, 23].

We suggest that collaborative action will result if a group of individuals experience all of these components in a *functionally similar manner*. Each is intricately tied to the other as sense-making, sense-giving and organizing; all interact in a manner that complement each other and the problem at hand (to a small or large degree). A functioning *team* is a case of collaborative behavior where shared experience outweighs that of individual experiences requiring "over-writing" before becoming functionally compatible [21].

We suggest that system design should align with these behaviors as opposed to designing technology with an implicit reliance on the robustness of these behaviors as they interact with the technology. In short, we suggest that systems should not become a problem, but a constraint reinforcing sense-making, sense-giving, and organizing. People will "figure out" how to address a problem whether technology enables them to or not—again, humans do this naturally. We suggest, however, that design not impose complexity into the issue of how to organize or how to redefine the problem *given the technological constraints*. Instead, it should simply enable people to address problems in as natural a way as possible. It is this "natural way" we wish to expose and eventually apply to system design.

We now move to a more detailed description of the components of this perspective with the hopes of adding clarity, but also moving a seemingly intangible overarching discussion of collaboration to one that is tied to specific definitions and assumptions. We believe that progress within this area (and field) can progress after the discussion results in a set of agreed upon definitions and assumptions from which to build theory and then application.

2.1 Assumptions and Definitions

To begin, we need to specify several assumptions and definitions related to sense-making, sense-giving, and organizing that anchor our cognitive and social cognitive perspective.

2.1.1 Sense-making

- The existential human condition is to make sense of a constantly changing environment in order to survive and prosper [19, 24]. Making sense of changes in the environment makes this essentially a creative cognitive behavior. In other words, sense-making is the cognitive observational behavior that is the antecedent to action [21, 24].
- All behavior is focused or "situated" in terms of a specific situation [19, 21] or problem [25, 26] as perceived by the individual(s) involved. This means that cognizing is "about" some set of conditions that are anchored in time and space.
- Individuals cognitively perceive sets of changing or novel conditions as a projection into the future from their current time and space context[1]. Often (but not always) this projection can be seen as having a desired outcome in terms of specific situational conditions and/or in terms of values desired. This projection is a dynamic representation, one having sequential temporal conditions, of the perception(s) and is a socio-cognitive construction grounded in past sense-making (both direct and vicarious). We call this construction a "problem" which is a preliminary product of sense-making that is necessarily constrained by the past experiences of the individual. In a very real sense, this existential behavioral sequence is the beginning of a logically necessary sequence of steps we call "organizing" which begins with defining the problem.
- Constructing a problem definition essentially means to accept (or create) a certain set of constraints over all possible perceptions as well as envisioning a desired end-state or goal.
- Subsequent to constructing a problem, other constructions are possible if the individual decides to address the problem (ignoring it is much more likely

[1] Dervin [19] has pointed out that we often do this from a point in time/space prior to the present. For example, when we find ourselves in a problematic situation and we might ask: "How did we get here?" Clearly, this is projecting from the past into the present.

in practice). Various solution scenarios are constructed in terms of steps[2] and sequences of steps that might be taken. Some of these steps involve seeking resources to help better determine additional steps and potential outcomes.

- Resources can include other individuals who have better or more experience with similar problems and these resources are tapped directly either face-to-face or via some technological interaction medium, or indirectly via information or data. The experience, whether direct or indirect, must be substantively related to the problem at hand; all else constitutes noise—whether perceived or not.

2.1.2 Sense-giving

The foregoing addresses the sense-making of an individual, which must precede involving other people. Sense-giving [13, 20, 27] now becomes essential.

- Collaborating with others improves the observational and movement potential of individuals [19, 24, 28, 29]. This means that others have more or different experience and multiple perspectives increases the chances to prosper [21, 24]. From this perspective, collective action becomes a more probabilistic event rather than a proscriptive sequence of actions.
- Being human implies a fundamentally collaborative "stance" towards one's environment. In other words, "reality" is socially constructed [31] and maintained through interpersonal collaborating.
- This stance is realized largely through linguistic interaction throughout one's life. Cognitively, this collaborative interaction can be seen as a series of language-based sense-making and sense-giving behaviors (e.g., listening and talking) with others.
    - Language is a very general notion and includes all symbols and/or signs intended—whether explicitly or not—to convey meaning.
    - A meaningful utterance [32] is composed of BOTH a topic (or what I am talking about) and a comment (or what that topic means to me).
- Sense-giving is NOT an automatic function of presenting meaningful utterances—it is a negotiation of meaning that is most effectively *and* efficiently accomplished in conversation (i.e., people talking and listening to each other either face to face or via technological media) about a particular problem or context [33]. There must be a certain amount of agreement (both definitional and procedural) among the individuals involved in order to proceed.
- Others are seen as knowledgeable to the extent that they have more or better experience in the past with the problem at hand or because they have experience with other step-taking behaviors (e.g., sense-giving, planning, technical skills, etc.). Knowledge then is experience with the problem at hand or related problems [21].

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[2] We employ Dervin's [19] (see also [24]) notion of "step" to refer to any cognitive behavior, i.e., the cognition preceding action or movement. We wish to avoid the confusion between Kaplan's [30] "act meaning" and "action meaning."

- Information and data resources are technological artifacts of past sense-making efforts (therefore are vicarious or indirect) and are intended (not always successfully) as sense-giving resources.
    - This type of resource is very often less accessible in a sense-giving fashion because the basic sense-making/ sense-giving dynamics are absent (and usually assumed). Specifically, while "topic" is usually explicit, the "comment" relationship between the artifactual resource and the problem solver(s) is not negotiable as is practiced routinely in a face to face interaction.
    - This type of resource is also much less accessible because of the forms we have inherited from publishing and broadcasting technologies. For example, the one paragraph that might be useful is buried in a book that is in turn buried in a collection that is only accessible efficiently through a type of organization logic (e.g., Library of Congress Subject Headings) that is not natural in the same way that face-to-face sense-giving and sense-giving are.

2.1.2.1 Task Scenarios

As resources (human or artifactual) address uncertainty in defining a problem, it becomes possible to construct potential solutions to the problem, which we will call "task scenarios."

Collaboratively, task scenarios are potential solutions in the form of steps taken over time.

- In arriving at agreement on the selection of steps (individual or collective behavior), selection and type of resources needed (including other people), roles, sequencing of steps, and dealing with coordination among them [34] it is likely that criteria are articulated (or assumed).
- Before a specific task scenario can be chosen, agreement or buy in on each of these dimensions is necessary in order to functionally define the task. The task represents an agreed-upon method of movement that constitutes the functional constraints on the task and those involved in its solution.[3]

2.1.3 Organizing

Establishing steps, selecting resources, defining roles, sequencing steps, and articulating criteria are all organizing behaviors.

- Organizing behavior is emergent and ongoing [20]. Organizing is an existential set of behaviors that occur naturally in individuals and groups.
- Constraints to organizing originate internally (limited by an individual's experience/expectation or by agreement among members of a group) or externally (formal organizational structure).
- Organizing is a subset of sense-making and when more than one individual is involved, then sense-giving and negotiation of meaning become paramount and pervasive.

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[3] See Kim [14] for a more thorough discussion of the logically necessary temporal sequence of agreements in collaborative or team organizing.

2.1.4 Problems, Tasks, and Constraints

So far, we have specified both problem and task as sources of definitional constraint. In order to actually begin the task, we also need to address functional constraint. Policies, rules, norms, cultures, practices, etc. are all functional constraints on problem solving behavior. Given our assumptions that sense-making, sense-giving and organizing are all natural behaviors mandated by a constantly changing environment, constraints function to *cognitively bind* the individual to the group and the group members to each other as they work to define and eventually act. These restraints are necessary for effective and/or efficient results, otherwise the probability of productive movement would be prohibitively small.

3 Implications

In the following section we will explore the implications of this position on some perennial research foci associated with virtual work to illustrate our conceptual framework. Specifically, we will briefly look at the concepts of teams, leading, and creativity. In addition to addressing implications, we hope to illustrate how this perspective can be viewed as more valid both conceptually and pragmatically. From a systems perspective, these implications will likely not be seen as crucial. However, from an organizational perspective, the implications for linking organizational behavior (managing) to system design is of considerable importance so we include this discussion here to address this pragmatic concern.

3.1 Team

Teams are viewed as the primary working unit within any organization. Following from our argument, teams should emerge from a problem definition because a team is a collection of resources appropriate for a given task. Team composition, "team dynamics," "teamwork," and related notions of "team behavior" all follow from problem definition which works to constrain the naturally occurring behaviors of sense-making, sense-giving and organizing. In other words, defining team absent a specific problem or task is relatively meaningless given the necessary relationship between "a team" and the problem context. In this sense, teaming is a sub-set of organizing behavior.

Thus, attempts to "manage" a team potentially work to interfere with a naturally occurring process centered on *the problem.* In this sense, it would potentially be more beneficial to "manage" the problem as opposed to the people who are naturally making and giving sense as well as organizing. Although subtle, this *shift* in perspective will produce better outcomes than those derived from perspectives focused more on "control," "stability," etc. of *people*. Experience has shown us that controlling people is even more difficult and fruitless than herding cats. (We can't even get people to read the manual!)

For example, research on highly reliable organizations [35] focuses on teams charged with managing specific problems such as nuclear reactors, landing an airplane on an aircraft carrier, and surgery on a patient. They succeed in spite of the high probability for negative outcomes. It is important to note that these tasks are relatively constant over time, enabling a continuous and nuanced refinement of both problem and task definition. Counter to this type of scenario are those that involve a continuously changing problem like those found in any for-profit competitive environment. While many perspectives on "team" and how to "manage" a team suggest that they require a top-down, mandated structure, they often do so in the absence of discussing the centrality of problem. Yet, in such a context, problems are constantly changing or evolving leaving the practitioner in the position of "chasing" the problem with this or that team as opposed to "owning" the problem and allowing individuals to "figure it out."

3.1.1 Leadership

Stemming from the more traditional perspective on teams, leadership is viewed as central, often assuming leadership to be a quality of *an* individual (the leader). As noted above, leading is a sense-making, sense-giving and organizing behavior making it fundamentally similar to all other behaviors associated with a given task. The implication of our perspective is that leading is nothing more than a more pronounced and recognized form of sense-giving although one that is often informed by constraint from beyond the scope of the task (budget, legal parameters, etc.). It is important to note that this behavior can be shared or distributed, as the problem requires. In other words, leading results from the focusing on a common experience and reconstructing it in such a way that others now make different sense of the experience than they did before. This can result in not only differences in perception, but also differences in how the problem is commonly defined. Once this "shift" has been made, appropriate shifts in task definition and organizing will follow. Additionally, the presence of a "leader" becomes less important than the presence of *leading behavior*, regardless of its source.

The implication is that behaviors can be identified that effectively address the perquisites of the problem at hand regardless of whether or not the behavior is performed by a single individual or by a number of individuals. This allows for one team member to have more experience with the problem at hand without necessarily being responsible for all the leading behavior; in essence this allows for more distributed responsibility for leading behaviors. Particularly in virtual environments, this opens up many possibilities for efficient and effective collaborating. An organization's ultimate performance is based on the manner in which the problems that define that organization are addressed rather than by personality-level characterizations of the individuals involved *per se.*

3.2 Creativity

Similar to our conceptualization of leading, creative behaviors are sometimes appropriate for certain problems. Creative behaviors essentially transcend existing constraints that generate potentially useful, if different, steps, roles and sequences of steps in a given problem or task definition. (This is why outside consultants can be very effective). This is especially useful in open-ended tasks or tasks that have changed so much that existing constraints are dysfunctional. We explicitly include creativity because of the need to respond quickly to changing conditions (for example, agile manufacturing, emerging IT) and to avoid carrying over constraints from one problem to the next. Explicitly rewarding creativity as a matter of course improves the probability of a team's efficient and effective problem solving in a manner that is not as limiting as a one-size-fits-all physical yoke.

4 Methodological Discussion

In inquiry, there are "stages" of understanding that have a logically necessary sequence. For example, we must be able to accurately *describe* a phenomenon before it can be *explained.* Likewise, we must be able to adequately explain a phenomenon before we can *predict* it. All too often methods are employed that do not take this logical necessity into consideration and so we see an experiment conducted (probably in order to employ quantitative measures) before there has been adequate description of the basic phenomena. The importance of virtual collaborative work to modern society and organizations is such that we strongly advocate beginning with some robust description. Given how recently the Web was introduced to the public (April, 1995) and the present near-ubiquitous use of it, we feel it especially important for scholarly inquiry to proceed on a firm descriptive foundation based on a clear, coherent conceptual framework. This is especially important for influencing future technology design.

Given that efforts to date have employed terms like the metaphorical "team" without coherent conceptual specification, it seems clear that we must begin with some descriptive studies to better understand specifically what behaviors fulfill sense-making, sense-giving, and organizing functions in effective virtual collaborative work.[4] Similarly, we need to describe specific control mechanisms and the interactions among them to establish the relationships between organizing behaviors and teamwork behaviors. Finally, we need to describe the advantages and disadvantages of different existing information and communication technologies to support the sense-making, sense-giving, and organizing in virtual teamwork.

5 Conclusions

In this paper we attempted to specify the phenomena associated with virtual collaborative work from cognitive and social cognitive perspectives. We put forth a series of definitions that assumes all people are natural sense-makers, sense-givers and organizers; we posited that the collaborative work we observe within both informal (ad hoc teams or communities) and formal (organizational) environments derives from fundamental, ubiquitous social behavior intimately tied to context-specific problems. The paper began by challenging the need to re-define terms like "virtual" in a manner which works to subtly shift the focus of study to "proximal vs. distributed" from the more fruitful "fundamental behavior vs. technological constraints." The paper then presented a framework for virtual collaborative work and discusses its implications on issues related to teams, leadership, creativity and

[4] Please see [36] for an illustration of this kind of methodological approach to generating a descriptive structure suitable for structuring virtual collaboration designs.

the design and use of information technology. We now conclude with some closing thoughts.

The approach put forth in this paper offers a new perspective on collaborative work and suggests that much of what we do as humans is (1) natural and (2) collective. Thus, it would benefit designers, users, managers and "leaders" to align strategies and expectations with these naturally occurring behaviors. While we realize that we are advocating a slight shift in perspective from "people" to problem, we also realize that it is this subtle shift combined with the potential for better outcomes that makes it worth sharing, discussing, and pursuing. It is in this manner that we will be able to align multiple perspectives as they would all be tied to a common problem, common behaviors, and, at a fundamental level, a shared process for understanding any context. Ultimately we believe that this approach will allow us to provide user-based structures for virtual collaborative work in a coherent, effective and efficient fashion.

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About the Authors

Michael D'Eredita is a Professor of Practice at the School of Information Studies at Syracuse University. His research centers on the intersection among human cognition, social cognition and information technology. His work has been published in journals such as Organization Studies, Memory and Cognition and the International Journal of Web Based Communities.

Michael S. Nilan received his Ph.D. in cognitive behavior from the School of Communications at the University of Washington. He has been engaged in a long-term program to develop coherent user-based approaches to creating effective resource organization structures in hyperspace. He is an Associate Professor at Syracuse University's School of Information Studies, the original information school.

4

Conduct, Performance, and Dilemmas of Inter-organizational Virtual Organizing

A Literature Review

Sanjeev Jha[1] and Mary Beth Watson-Manheim[2]
1 College of Business Administration, University of Illinois, Chicago, Illinois, USA, sjha2@uic.edu
2 College of Business Administration, University of Illinois, Chicago, Illinois, USA, mbwm@uic.edu

Abstract. Firms are increasingly embedded in networks of relationships with other organizations that are of strategic importance. An organization's participation in a network may provide access to information, resources, markets, and technologies, or it may lock it in unproductive relationships from which it may be difficult to extricate. Therefore, it is no longer adequate to analyze firms' conduct and performance by examining firms in isolation from their network partners. Strategy research has investigated inter-organizational alliances for some time. However, the primary focus of this research has been to examine the antecedents of network formation and relatively lesser attention has been paid to the implications of alliances and networks on a firm's performance. Since virtual organizations are conceptualized as strategic networks and alliances among organizations, we examined literature on virtual organizations to understand what has been done in inter-organizational context. We found 34 papers out of a total of 117 papers on virtual organization that examined virtual organizing at inter-organizational level. We classified each of the short-listed papers by virtual organizing type (network membership, network structure, tie modality, and time-frame), performance, and dilemmas of virtual organizing. Our analyses showed that inter-organization virtual organizing strategy varied with the goals of virtual organizing. Across the short-listed papers we found a pattern of organizing that depended on whether organizing was for abstract resources (knowledge, skills, competencies, etc.) or for specific goals (outsourcing key components). Virtual organizing for abstract resources tended to exhibit decentralized network structure and collaborative ties with partners, while virtual organizing for specific goals tended to exhibit centralized network structure and opportunistic ties. We found a lack of empirical literature examining the process of inter-organization virtual organizing strategy and its consequences.

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1 Introduction

Firms are increasingly embedded in networks of relationships with other organizations, even across continents, which are of strategic importance. An organization's participation in a network may provide access to information, resources, markets, and technologies, or it may lock it in unproductive relationships from which it may be difficult to extricate. Therefore, it is no longer adequate to visualize and analyze firms' conduct and performance by examining firms in isolation from its network partners [1]. In other words, understanding a firm's conduct and performance may not be complete until one comprehends strategic advantages or disadvantages a firm accrues because of its membership to networks composed of business partners, such as suppliers, customers, competitors, or other entities.

Strategy research has investigated inter-organizational alliances for some time. However, the primary focus of this research has been to examine the antecedents of network formation and relatively lesser attention has been paid to the implications of alliances and networks on a firm's performance [2]. Specifically, how does participation in networks influence firms' conduct and performance?

The view of strategic networks and alliances among organizations has been termed a virtual organization beginning with Davidow and Malone [3]. Thus, it is reasonable to believe that this set of literature on virtual organizations may address specific questions applying to conduct and performance of firms in virtual inter-organizational relationships. Our objective in this study is to understand what previous literature on virtual organization has done in inter-organizational context. Specifically, what does past research say about the conduct and performance of inter-organizational virtual organization? The rest of the paper is organized as follows. First, we discuss the theory behind inter-organizational virtual organizing. In the next two sections we discuss the methods and results of the study. In the following three sections we present the discussion, limitations, and conclusions of this study respectively.

2 Background

Venkatraman and Henderson [4] argue that virtualness of an organization is a strategy and not an organizational structure. The authors emphasize that the term "virtual organization" is an unfortunate term, while the term "virtual organizing" connotes a powerful strategy that focuses on organizing virtually for knowledge and intellect to create business value. They conceptualize virtual organizing to have three vectors and three stages. The three vectors of virtual organizing are: customer interaction (virtual company-to-customer interactions); asset configuration (virtual business to business interactions); and knowledge leverage (virtual sourcing of expertise). The three stages of virtual organizing are at task unit level, organizational level, and inter-organizational level. In this paper, we focus on the third stage of virtual organizing, the inter-organizational virtual organizing (IOVO). This stage is the most challenging because participating organizations may have different aspirations and organizing strategy. However, the rewards are plentiful if networks are managed well as members gain strength from each other's resources. Henceforth, in this paper, we conceptualize an inter-organizational virtual network of relationships as an IOVO strategy. The authors identify performance objectives of IOVO to be sustained innovation and growth.

Apart from the performance issues, the other interesting aspect to examine in case of inter-organizational networks is the dilemmas of organizing strategy. For instance, Dyer and Nobeoka [5] studied the knowledge-sharing network of Toyota and its suppliers to uncover and explain how Toyota managers solved the following three fundamental dilemmas of knowledge sharing: *(1) motivate members to participate and openly share valuable knowledge (while preventing undesirable spillovers to competitors), (2) prevent free rider, and (3) reduce the cost of finding and accessing different knowledge.* It is important to note two important characteristics of Toyota and its suppliers' knowledge-sharing network. First, Toyota is at the centre of the network guiding and managing its suppliers. Second, the knowledge-sharing network is enduring, where the entire network benefits from learning from each other, providing a sustainable competitive advantage against the networks of other automakers.

To the best of our knowledge, only two studies have reviewed literature on virtual organizations: Schultze and Orlikowski [6] and Watson-Manheim et al. [7]. Schultze and Orlikowski [6], in their seminal paper, reviewed practitioner-directed literature on virtual organizing to identify metaphors that characterized virtuality. In the absence of real experience of the new way of organizing virtually, the authors stressed that metaphors convey the characteristics of organizing. To their credit, the authors identified 5 overarching metaphors from the selected 17 articles from 3 of the best practitioner journals. The search terms used to select the articles were: "virtual organizing," "virtual organizations," "virtuality," and "virtual work." Watson-Manheim et al. [7] carried out a literature review to develop a precise understanding of the term "virtual" used to describe changing work environments. The authors proposed a framework to classify changing work environments based on the type of discontinuities involved in the work. The authors used the search terms "virtual work" and "virtual organization" to select past literature.

In this paper, our objective is to take stock of the literature on virtual organization to understand the ways of IOVO organizing (conduct), challenges of IOVO organizing (dilemmas), and whether IOVO organizing mattered or not (performance). In some sense this is an extension of Schultze and Orlikowski [6], wherein the authors identified five virtual organizing types: organizing as platform, as existing in space, as composed of bits, as operating as a community, and as engaging in a network of relationships. Also, as mentioned above, since strategy literature has identified the research gap and stressed the criticality of understanding the conduct and performance of organizational networks, we believe studies on IOVO strategy may guide practitioners and researchers.

3 Methods

The objective of this paper is to understand the conduct, consequences, and dilemmas of IOVO strategy. Accordingly, we searched for published articles, both conceptual and empirical, that examined IOVO. We chose *EBSCOhost* and *JSTOR* databases to look for the articles. The search terms ("virtual organizing," "virtual organization(s)," "virtuality," and "virtual work") were taken from Schultze and Orlikowski [6], which included the two search terms in Watson-Manheim et al. [7]. These search terms resulted in 117 articles on virtual organizations. We manually inspected each of the 117 articles to segregate IOVO papers. Our manual inspection resulted in 34 articles that addressed the issue of virtual organizing in inter-organizational context.

Next, we analyzed each of the 34 short-listed articles according to the framework derived from the objectives of our study. The framework has five components of IOVO: Goals/performance; dilemmas; research approach; context of the study; and organizing type. We discuss five components:

1. Goals/ performance of IOVO strategy: We identify the central objective of IOVO strategy in each of the selected short-listed papers.
2. Dilemmas of IOVO strategy: We identify the challenges of IOVO strategy in each of the selected short-listed papers.
3. The Research Approach: Following are terms used to classify articles based on research approach [7]: Field research, survey; Field research, case study; Conceptual; Theoretical, model building; Simulation; Prescriptive.
4. IOVO Strategy Characteristics: We adapt the characteristics of IOVO strategy from Gulati et al. [1] to understand how organizations conduct themselves in inter-organizational relationships. The authors mention the following first three characteristics of strategic networking strategy and to this list we added the time-frame dimension:

   Network membership: This refers to the composition of the network, which includes complementary resources, sharing of risks, access to market, etc. In this paper we have clubbed skills, competencies, capabilities, technology, capital, etc. as resources.

   Network structure: This refers to the overall pattern of relationships among partners. We have classified IOVO strategy promoting either centralized or decentralized network structure. Centralized network structure is organized around a focal firm [8] and therefore a centralized IOVO strategy has a central firm virtually organizing members around it. Focal firms accrue disproportionate benefits compared to other members in terms of knowledge or financial rewards. In contrast, in decentralized IOVO strategy all members are equal and there is no formal focal firm organizing the activities of members.

   Tie modality: This refers to the rules and norms of virtual organizing. Based on Gulati et al. [1], we classified IOVO strategy as collaborative or opportunistic. In collaborative ties the benefits are distributed fairly among members, while in opportunistic ties members are driven by self-interest and more concerned about their own benefits [9]. Collaborative ties are win-win relationships where imbalances in rewards even out in the long run, while opportunistic ties are those where members are less concerned about the overall benefit of others or in equity in reward sharing. For example, a phrase like "common interests" was classified as collaborative IOVO strategy, while a phrase like "organizing contractually or other means" was classified as opportunistic.

Time-frame: Apart from the above three, we found IOVO strategy also differed by time-frame. Authors in the selected papers put emphasis on the temporality of virtual organizing strategy. Accordingly, we classified IOVO strategy as short-term or long-term. For example, Toyota and its supplier have a stable, long-term strategic alliance, where all the members benefit from each other [5]. We found several papers that have conceptualized IOVO strategy to be short-term for specific business opportunity.

5. Context of IOVO strategy. We identify the context of the field research or conceptual study for better understanding of the consequences of virtual organizing strategy. There is a huge variation in the contexts of virtual organizing: Global Water Partnership [10]; outsourcing of key components [11]; research & design VO; cyber community of teachers [12]; energy industry in Sweden [13]. As Venkatraman and Henderson [4] emphasize, virtual organizing is a strategy applicable to all kinds of organizations; however, the way of organizing may differ.

The five components of the coding of articles were mutually agreed upon after several rounds of discussion. While, one of the authors coded the articles, the other checked the coding to refine the coding. Disagreements helped in further refining the coding of articles.

4 Results

We found only 3 empirical papers out of the 34 short-listed papers on IOVO strategy (see Table 1). Out of these three, Lin and Lin [12] is a case study of a cyber community of teachers. Ahuja and Carley [8] is another case study of a VO engaged in research and design. The third paper, Kraut et al. [11], employed survey methodology to study the linkage between usage of electronic networks and outsourcing of key components. We discuss the results of these studies in the following paragraphs. However, it is important to note that two of the three empirical

Table 1: Research approaches in the selected papers.

S. No.	Research Approach	No. of papers
1	Field research, survey	1
2	Field research, case study	2
3	Conceptual	29
4	Theoretical, model building	1
5	Simulation	1
6	Prescriptive	1
Total		34

Note: The total is less than the column sum because one article matched multiple research approach

papers study non-commercial organizations. In other words, only one of the 34 papers is an empirical study based on commercial organizations. The majority of the papers are still conceptual, discussing the mechanisms, goals, and dilemmas of organizing virtually.

We have classified the short-listed papers into three broad groups: empirical papers (Table 2); conceptual papers conceiving virtual organizing as a long-term strategy (Table 3); and conceptual papers conceiving virtual organizing as a short-term strategy (Table 4).

Table 2: Empirical papers

	Goals/performance	Dilemmas	Network membership; structure; tie modality		Context
	Creating new knowledge, new education	Trust; creation & sharing knowledge	Resources; Decentralized; Collaborative		Cyber community of teachers
	No. of publications	Motivating members to get involved.	Resources; Centralized; Collaborative		Case study of a research & design VO.
	Outsourcing of key components	Opportunism & complexity of transactions.	Resources; Centralized; Opportunistic		Survey of 250 managers in four industries

The first group, of three empirical papers discussed above (presented in Table 2), has three different contexts. Lin and Lin [12] did a case study of SCTNet, a cyber community of teachers, which metaphorically functions as a platform where teachers participate to create new knowledge. Virtual organizing is collaborative to share domain knowledge, short-term, for a specific project, and most importantly VO is decentralized. The dilemmas are teachers' attitudes towards sharing and creation of knowledge. The other two empirical papers, by Ahuja and Carley [8] and by Kraut et al. [11], discuss virtually organizing strategy for number of publications and outsourcing of key components respectively. There is a similarity in their characteristics of virtual organizing as they are both organizing for members' resources; however, there is dissimilarity in tie modality as Ahuja and Carley [8] emphasize collaborative ties among researchers, while Kraut et al. [11] hint at opportunistic ties among members. But unlike Lin and Lin [12], both of these studies have centralized network structure for long-term virtual organizing. Kraut et al. [11] mention that the major dilemmas are the focal firms' vulnerability to opportunism and complexity of transactions, which may force them to produce in-house. Ahuja and Carley [8] mention the challenge of motivating members to identify and involve with the group.

In the second group, we found five conceptual papers that stressed virtual organizing to be a long-term strategy (presented in Table 3). The first set of three papers has goals of creating knowledge assets and dilemmas of dissipation of core competencies and decision-making through consensus in a network of equal partners. For example, Holmberg [10] discusses the case of Global Water Partnership, wherein the members share expertise and experience in water management, but are concerned about swifter and better decision making in the absence of a brokering body. The second set of the last two papers has a manufacturing context. For example, Upton and McAfee [14] discuss how factories can virtually organize to collectively design products, enable suppliers to electronically bid for jobs, and level the field for small and big suppliers. The dilemmas for the focal firm here are creation of conflicting goals, reduced openness, and trust. Both of these sets of papers organize virtually for members' resources, but the key difference is in their characteristics of network structure and tie modality. Organizing for knowledge assets, as in the first set of papers, the authors have conceptualized virtual organizing structure to be decentralized and tie modality to be collaborative; while organizing for production, as in the second set of papers, the authors have conceptualized virtual organizing structure to be centralized with a focal entity overseeing the organizing strategy and tie modality to be opportunistic.

Table 3: Conceptual papers conceiving virtual organizing as long-term

Study	Goals/ performance	Dilemmas	Network membership; structure; tie modality	Context
[28]	Knowledge & skills		Resources; Decentralized; Collaborative	Possible in more developed parts of the society
[29]	Knowledge assets	Dissipation of core competencies	Resources; Decentralized; Collaborative	Forum on technology management
[10]	Knowledge	Politicking; low membership	Resources; Decentralized; Collaborative	Global Water Partnership
[14]	Design products; Bid for jobs		Resources; Centralized; Opportunistic	Virtual factory, a community of factories
[30]	Flexibility, quick response to market	Conflicting goals; openness, trust	Resources; Centralized; Opportunistic	Low level of direct ownership

The third group has 26 conceptual papers, which is more than 76% of the short-listed papers (Table 4). These papers visualize virtual organizing to be short-term and most of them organize primarily for access to members' resources. A few of the papers also discuss the importance of shared risks and access to each other's markets. A careful study of these papers shows that the first 19 of these papers have a conceptualized virtual organizing to have decentralized network structure. Of these 19 papers, only 2 papers profess that members should organize opportunistically to select partners for specific opportunities. The rest of the papers argue for collaborative organizing in a decentralized network structure. Broadly, there are four goals of virtual organizing in these papers: small firms can pose threat to large established firms; exploiting global business opportunities, speed of uniting critical competencies, and flexibility in choosing and removing partners.

The rest of the seven papers in the third group have conceptualized virtual organizing to have a centralized network structure and of these, five papers stress the importance of organizing opportunistically. While, Lynch et al. [15] discuss the success of VOs in the US federal government and emphasize how Cooperative Administrative Support Units (CASUs) virtually organize collaboratively, Fitzpatrick and Burke [16] argue for organizing through formal contractual linkage. Broadly, five of the seven papers discuss virtual organizing in a manufacturing context; the other two are in the context of electronic commerce and the US federal government.

5 Discussion

Need for empirical research: Despite the fact that it has been more than a decade since the idea of IOVO originated [3], little empirical research has been done to understand the conduct, performance, and dilemmas of inter-organizational virtual organizing and still fewer in commercial organization settings. We believe, more empirical research needs to be done to guide organizations appropriately in their IOVO strategy. Specifically, how the conduct (network membership, network structure, tie modality, and time-frame of organizing) influences performance and the dilemmas that organizations need to address for successful virtual organizing.

Although, we found little evidence of rigorous empirical research on IOVO strategy, we believe organizations are increasingly practicing IOVO strategy. We find evidence of this discussed in recent innovation literature emphasizing the importance of organizations' alliances with business partners across the globe to fruitfully engage in solving business problems. A spate of recent practitioner literature attests to the criticality of organizing for innovation beyond organizational boundary: era of open innovation [17]; open market innovation [18]; global innovation process [19]; networking for successful innovation [20]; outsourcing innovation [21]; sourcing innovation [22]; and many others. Two examples of organizations that immediately come to our mind, that have begun networking extensively with business partners are Proctor & Gamble and Boeing. P&G reinvented their innovation business model. A. G. Lafely, the CEO of P&G, set a target of 50% of their product innovations to come from outside and 50% from inside [23]. Boeing, unlike past projects, actively solicited business partners in the innovation process for a new 787 jetliner, the Dreamliner project [24]. In sum, more research is needed to understand the process and consequences of IOVO.

IOVO Strategy: We found IOVO strategy varies with the goals of virtual organizing. Across empirical papers (Table 2), conceptual long-term virtual organizing papers (Table 3), and conceptual short-term virtual organizing papers (Table 4), we found a pattern of organizing that depended on whether organizing was for abstract resources (knowledge, skills, competencies, etc.) or specific goals (outsourcing key components). Barring a few exceptions, virtual organizing for abstract resources had decentralized network structure and collaborative ties with partners, while virtual organizing for specific goals had centralized network structure and opportunistic ties.

The latter kind of organizing for specific goals seems to be more prevalent in practice than any outsourcing relationship [16], as focal firms attempt to be opportunistic and retain most of the powers in the network. However, this kind of opportunistic strategy does not necessarily yield a win-win strategy. Members may leave the network or may not share resources and eventually everybody loses. The dilemmas of organizing (trust, identity, dissipation of competencies, etc.) may doom the networking strategy pre-maturely, especially when compounded with the above challenges and when organizing duration is short-term.

The former kind of organizing seems to be more idealistic, especially if the time frame is short-term. The goals are abstract and the organizing strategy is to have a decentralized structure and collaborative ties among members. Kasper-Fuehrer and Ashkanasy [25] have aptly called this a "Weberian-ideal-type" IOVO strategy. This may be akin to the metaphors identified by Schultze and Orlikowski [6]. However, we do not rule out the possibility of this kind of short-term, decentralized, and collaborative IOVO strategy working successfully in some industry or knowledge work. We submit that more research needs to be done in this area. For now we, along with the authors, wonder how organizations will overcome the dilemmas this ideal type of IOVO strategy pose. For example, flexibility demands substitutable links, while creating new competencies requires stability to harness members' expertise [26]. We believe there is immense scope for doing research in understanding how IOVO strategy impacts performance.

Dilemmas of IOVO: In the beginning of the paper, we mentioned the example of dilemmas of knowledge sharing network at Toyota and its suppliers. Toyota and its suppliers have a knowledge sharing network that is centralized and for the long term benefit of the partners. The major dilemmas that they face are motivating members to participate in the network, preventing free rider, and reducing the cost of finding and accessing different knowledge [5]. The reasons why Toyota has successfully solved the dilemmas of inter-organizational networking seem to emanate from their unique and thoughtful organizing strategy: network structure is centralized (Toyota as a strong focal firm), tie modality seems to be collaborative (Toyota taking interest in the performance of suppliers), and time-frame is long-term. Over a period of time all the network members benefit by making the knowledge-sharing network a success. The only paper that came close to describing this organizing type was Ahuja and Carley [8], though the network is not composed of commercial organizations.

What we find from the short-listed papers is that the IOVO strategy militates against successfully resolving the dilemmas of organizing. For example, Mowshowitz [27] mentions that excessive switching may increase rather than reduce costs and also cause image problems. Although the dilemmas by themselves look similar to that of the Toyota case, the papers have not addressed how IOVO strategy will successfully resolve the dilemmas. How do you resolve the issues of trust (identity, dissipation of competencies, etc.) when IOVO strategy is long-term, centralized, but opportunistic (Table 2, 3); when IOVO strategy is short-term, decentralized, and collaborative (Table 2, 4); when IOVO strategy is long-term, decentralized, and collaborative (Table 3); when IOVO strategy is short-term, centralized, and opportunistic (Table 4)? Future research may examine how IOVO strategy resolves dilemmas of organizing.

6 Limitations

This study has two major limitations. First, we searched for relevant articles from only two major databases (*EBSCOhost* and *JSTOR*). There are other databases like *ABI/Inform*, which we did not investigate, because of paucity of time and also because *EBSCOhost* and *JSTOR* are two of the largest articles databases. We believe we would have gotten more of the same articles rather than different articles from other databases. This also makes us believe that the absence of articles that we may have inadvertently omitted may not have significantly biased our findings. Second, since we focused on only the published articles, we may have also advertently omitted unpublished studies like dissertations, conference articles, or work-in-progress (WIP) articles on IOVO. We conveniently assume that most of the important conference and WIP articles may have been published in journals. However, we do admit that we may have missed some of the unpublished articles. We also want to submit that including all of them is beyond the scope of our study. Despite these limitations, we believe that the 35 articles we chose are representative of the research done with an IOVO perspective.

7 Conclusions

Our analyses show that IOVO strategy varies with the goals of virtual organizing. Across the short-listed papers, empirical and conceptual, long-term and short-term, we found a pattern of organizing that depended on whether organizing was for abstract resources, knowledge, skills, competencies, etc., or for specific goals, outsourcing key components. Virtual organizing for abstract resources had decentralized network structure and collaborative ties with partners, while virtual organizing for specific goals had centralized network structure and opportunistic ties. Virtual organizing for abstract resources seems to be a more ideal kind of IOVO strategy, while organizing strategy for specific goals seems familiar from general network relationships. However, more research is needed to understand the process of virtual organizing and its impact on performance and in addressing the dilemmas successfully, especially since a large proportion of the short-listed papers are still conceptual. Also, as we mentioned above, practitioner literature on innovation has emphasized the importance of strategic networks and some of the large organizations seem to be orchestrating strategic alliances, so more rigorous research is needed to unravel the process of IOVO.

Our contribution lies in classifying the papers by the characteristics of IOVO strategy (network membership, network structure, tie modality, and time-frame), dilemmas, and goals of virtual organizing. To the best of our knowledge no one has classified papers in this way.

Table 4: Conceptual papers conceiving virtual organizing as short-term

Study	Goals/performance	Dilemmas	Network membership; structure; tie modality	Context
[31]	Small firms can pose threat to large firms	Demanding partners & customers;	Resources; Decentralized; Collaborative	VO as a future form of organization
[32]	Small firms can pose threat to large firms	Managerial vacuum geographical & cultural distances	Resources; Decentralized; Collaborative	Six small firms want to create 'virtual web'
[27]	Flexibility & responsiveness lower costs.	Excessive switching between business partners	Resources; Centralized or decentralized; Opportunistic	Consistent with all forms of organization
[33]	To access global business opportunity.		Resources; Decentralized; Collaborative	An industrial virtual enterprise
[34]	Quickly assemble broad ranges of resources		Resources; Decentralized or centralized; Collaborative	Applications of Artificial Intelligence (AI) in VOs.
[35]	Gaining access to new global markets.		Resources; Decentralized or centralized; Collaborative	Pursue a specific global market opportunity
[36]	Flexibility, adaptability, & Efficiency	Economic dependence on partners	Resources; Decentralized; Collaborative	Industrial organization.
[25]	Swiftly coming together to exploit a market	Trust, loyalty, profit sharing, making business strategy	Resources; Decentralized; Collaborative	Weberian-ideal type definition of IOVO
[37]	Exploiting a market opportunity	Trust, common business understanding	Resources; Decentralized; Collaborative	Proposes a theory of trust

Table 4 Continued: Conceptual papers conceiving virtual organizing as short-term

Study	Goals/performance	Dilemmas	Network membership; structure; tie modality	Context
[38]	Speed business solutions	Sharing sensitive information with partners	Resources; Decentralized; Collaborative	Applicable to all industry
[39]	Collectively exploit opportunities	Regions that lack sophistication cannot be tapped	Resources; Decentralized; Opportunitsite	IT enabling agility & global expansion
[40]	Adaptability flexibility, agility, & speed	Loss of control of functions & information	Resources; Decentralized; Collaborative	Parnters quickly link resources & capabilities
[41]	Dynamix business process	Conflict, loyalty, coherent identity,greater alienation.	Resources; Decentralized; Collaborative	Special Issue: Communication proceses Vos.
[42]	Exploit fast changing opportunities.	Managing HR: staffing, rewarding, assigning work	Resources; Decentralized; Collaborative	Importance of HR in the success of Vos,
[43]	Speed growth, flexibility, profitability		Resources; Decentralized; Collaborative	New business model
[26]	Flexibility and responsiveness. Knowledge.	Inhibit flexibility and change, autonomy	Resources; Decentralized; Collaborative	VO in an electronic market environment.
[44]	Market quickly, increased product improvements		Resources; Decentralized; Collaborative	Agile practices, chemical industry
[45]	Adaptability, flexibility, react quickly to changes	Management coordination may become an issue.	Resources; Decentralized; Collaborative	Agile practices, chemical industry
[46]	Leveraging on shared competencies, shorten devlopment times	Commitment, identity, & trust. Sharing info.	Resources; Decentralized; Collaborative	Bio Region, Biotechnology industry
[47]	Efficiency & responsiveness		Resources; Centralized; Opportunistic	Vos in context of electronic commerce.

Table 4 Continued: Conceptual papers conceiving virtual organizing as short-term

Study	Goals/performance	Dilemmas	Network membership; structure; tie modality	Context
[48]	Global competitiveness. Local responsiveness	Coordination costs Traditional	Resources; Centralized; Opportunistic	Strategies & transnational organization.
[16]	Strategic flexibility, Cost efficiency, competitiveness	Not all firms may successfully organize virtually	Resources; Centralized; Opportunistic	Discusses two forms of Vos
[13]	Access global markets. More complete product.	Difficulty in managing towards final goal	Resources; Centralized; Opportunistic	Two VOs in energy industry in Sweden.
[4]	Competitive advantage, Sustained innovation & growth	Managing competition & cooperation.	Resources; Centralized; Opportunistic	Powerful concept applicable to all organizations.
[15]	Responsive, competitive, & flexible.		Resources; Centralized; Collaborative	Success of VOs in the US Federal Govt.
[49]	Organizational & product flexibility to respond to changes.	Trust, information privacy modularity may weaken ties	Resources; Centralized; Opportunistic	Supply chain management.

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About the Authors

Sanjeev Jha is a Doctoral Student in the Department of Information & Decision Sciences in the College of Business Administration, University of Illinois at Chicago (UIC). His research interests are innovation management, virtual organizing, knowledge management, organizational learning, information technology (IT) adoption, and strategic information systems (IS). He has published articles in journals such as Knowledge and Process Management, Research-Technology Management, Communications of the ACM, Information Resources Management Journal, and IEE Engineering Management. His co-authored papers have been presented at conferences such as Academy of Management (AOM), International Conference in Information Systems (ICIS), Organizations and Society in Information Systems (OASIS), Americas Conference in Information Systems (AMCIS), Workshop on e-Business (WEB), and ISOneWorld.

Mary Beth Watson-Manheim is an Associate Professor in the Information & Decision Sciences Department and Director of the Center for Research in Information Management in the College of Business Administration at the University of Illinois, Chicago. She obtained her Ph.D. in Information Technology Management from Georgia Institute of Technology. Her publications have appeared in journals such as MIS Quarterly, Journal of Management Information Systems, IEEE Journal of Systems, Man and Cybernetics, Information Systems Journal, MIS Quarterly Executive, Information Technology and People, and Group Decision and Negotiation and others. Prior to obtaining her PhD, she worked in the telecommunications industry for approximately 10 years. She is involved in research on issues related to the integration of information and communication technologies (ICT) and organizational work, and ICT-enabled organizational change. Her research has been funded by Intel Corporation, IBM Corporation, Lotus Development Corporation, and various university centers.

Section 3

Process Issues to Achieve Virtualization

5

Structuring Virtuality

A User-Based Example for E-Commerce

Michael S. Nilan[1] and Anuradha Mundkur[2]
1 School of Information Studies
330 Hinds Hall, Syracuse University, Syracuse, New York
Phone: 315 443 1878
mnilan@syr.edu
2 School of Geography, Population and Environmental Management
Faculty of Social Sciences, GPO Box 2100, ADELAIDE SA 5001
anuradha.mundkur@flinders.edu.au

Abstract. The purpose of this paper is to provide an example of an empirical procedure for generating user-based cognitive and social cognitive models of tasks/problems/contexts that can be employed to create readily navigable link structures for virtuality-mediated communication and collaboration purposes. Employing a natural language, user-based method, this study describes patterns found across 128 interviews where respondents were describing their cognitive movement in the form of steps taken during an interactive E-Commerce situation. Employing these patterns, we analytically develop a model of E-Commerce as a series of logically necessary steps over time. The resulting model illustrates the utility of individual cognitive and social cognitive patterns to structure virtuality as a series of interactive links associated with particular tasks/problems/ contexts. Logical structures derived in this manner have the additional strength of requiring no "training" of users because they already recognize the inherent linguistic, temporal and functional relationships. As an added benefit, the model of E-Commerce generated in this study has concrete practical implications for web site design and evaluation.

1 Introduction

Over the last decade or so the Web has become a significant hub of communication and collaboration activities. We know from past research on the diffusion of innovations [25] that there is a tendency to use new technology the same way we use the technology it is replacing until we figure out what the capabilities of the new technology are so we can take full advantage of it. This would lead us to

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suspect that virtual activities on the Web, like E-Commerce, are being structured by their technological predecessors. To a large extent, we can see that E-Commerce entrepreneurs have adopted structures like printed catalogs and shopping carts to structure the interaction between purveyors of goods and services and their customers [17]. This seems like a mixed metaphor with virtual catalogs coming from their print technology predecessors but shopping carts coming from in-person shopping behavior. In this paper, we raise the question of whether it might be possible to employ structures derived from sources other than immediate technological predecessors in order to take better advantage of the Web's *tabula rasa* hyperspace potential for virtual communication and collaboration. There have been calls for structuring virtuality according to human cognitive and social cognitive perspectives [6] where constraints for structuring the Web's hyperspace are derived from actual human behavior associated with specific tasks/problems/contexts rather than from the technology itself or from managerial logic practiced in non-virtual contexts [15, 1, 28, 19]. Following D'Eredita & Nilan [6], we believe that natural, ubiquitous collaborative processes exist and suggest that it is upon these processes that the design or "structuring," of new technological environments should be centered. This paper reports on one such effort focusing on E-Commerce interactions as a context to illustrate this approach.

2 Conceptual Framework

First we need to define the notion of "structure." Here we intend structure to indicate constraints to random human action that *facilitate* movement in a direction appropriate for a given task/context while, at the same time, *inhibiting* movement in an inappropriate direction. Constraints to human behavior/action/movement come from a range of sources including: genetic inheritance (the "nature" side in the long running nature vs. nurture debate); culture, (beliefs and value systems); society (laws); organizations (policies, reward structures); technology, (interfaces, telecommunications protocol); etc. Some of these constraints or structures are the result of survival pressures that represent lessons learned across centuries and millennia; some are more temporary, almost ephemeral. Some of these structures are almost Darwinian in their appropriateness for human survival [5] while many associated with virtuality are the well-intentioned products of software programmers that rely more on technological constraints, which are often alien to users. Some of these constraints are learned without conscious effort and some of these constraints are imposed by man-made caprice. Much of the design of current systems requires users to read a manual or to pursue training in order to take full advantage of the system/software/technology. This illustrates how far designed solutions to human problems have strayed from the human baseline. From a practical point of view, we can't get users to read the manuals anyway

To clarify what we mean by "structuring virtuality," we begin by defining a "system" as 'a series of steps designed to help solve a human problem.' Thus, man-made structures (the designing referred to above) constrain (either facilitate *or* hinder) people's movement through time and space as people move to address situations, make decisions, solve problems, etc. based on the selection of steps (which steps out of all possible steps) and sequencing of specific steps (what order if any, are optimum for success).[1] Structuring virtuality then refers to collections of hyperspace links that function as constraints to guide human activity on the Web in a particular context.[2]

We chose E-Commerce to illustrate this conceptual approach to structuring virtuality because of its pervasiveness on the Web today. Existing E-Commerce structures are clearly intended to facilitate purchasing behavior. We searched the literature in a number of fields to try to find out what models of purchasing behavior have been employed in state-of-the-art E-Commerce sites. A very useful review [16] developed a taxonomy for consumer characteristics and their online shopping behavior. This classification reveals that thus far empirical studies have focused on:

- *Demographics*–Despite evidence that across time/space variables (specifically, characteristics of the individual that don't change or change too gradually) are poor predictors of behavior [9, 20], a large number of studies have tried to explain online shopping behavior in terms of demographics. For example, one study found that demographics might influence whether or not people are online in the first place; however, once people are online whether they buy or not and how much they spend cannot be explained by demographics. Even life style characteristics explain only a small proportion of online shopping behavior [2].
- *Personal characteristics and attitudes towards online shopping*–Similar to demographics, some studies emphasized other across/time space predictors such as Internet knowledge and acceptance of the Internet as a shopping channel, need specificity, disposition to trust, the extent to which they would like to share values and information with others, the extent to which they like being first to use new technologies, and tendency to spend money on shopping, cultural environment and perceived risk, as influencing online shopping attitudes and behaviors [16]. However, like demographics, these characteristics are known to be poor predictors of behavior [9, 20].
- *Hypothetical behaviors*–These studies looked at customers' willingness to buy and to return for additional purchases and customer loyalty. This willingness is judged on answers to questions covering likelihood of returning to a store's website, the likelihood of purchasing from the store within the next three months, the likelihood of purchasing within the next year, and in general the likelihood of ever purchasing from a particular store again [13]. However, intentions are hypothetical behaviors that are also known as poor predictors of actual behavior.

Together the above studies describe consumers as persons rather than our desired focus on purchasing behavior. While these studies are no doubt valuable to

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[1] "Technology" is seen as comparable to "system" although it is often employed as sub-routines in a larger system logic. However, the essential intent is, like "system," to facilitate realization of human goals through imposition of constraint.

[2] The notion of context is essential here because all steps are for a purpose or are taken to reach a goal—even seemingly trivial steps have a goal of reducing boredom. Likewise, design constraints are "for" some purpose. The extent to which design constraint purposes and human goals align is the issue.

expanding our understanding of people who shop online, they do not describe actual purchasing behavior and provide little direction for improving the design of E-Commerce websites.

Other studies have focused on extremely narrow factors outside the control of the consumer such as:

- *External environment*–This is often understood as the influence of contextual factors such as legal framework, third party certification bodies and numbers of competitors. These studies found that the existing legal framework and third party certification bodies are positively associated with consumers trusting online stores [16].
- *Vender/Service/Product Characteristics*–These studies look at the products these stores sell and the service they provide to support the transactions [16].
- *Website Quality*–These studies have largely focused on impact of perceived ease of use and perceived usefulness [10]; user satisfaction and dissatisfaction with a website [34] and transaction support [17].

These studies provide us with valuable insight into how the market works and the economics of E-Commerce. However, they once again fail to provide us with insights into actual user purchasing behavior that we can use to generate requirements for E-Commerce website design.

Our perspective on human behavior, specifically, step taking, demands that information systems not be seen as problem solvers but rather as providing users with a means to manage their own problems—a support mechanism [1]. Thus, we need to pay attention to why users have entered the system, how and what kind of step taking they employ. Therefore, for studying step taking per se, the unit of analysis should be the problem rather than the individual user. The user is central to the information situation—influenced by not just the system but also the state the user is in, how the user understands his/her purpose, the nature of the resource needed which is dependent on the use to which the information will be put. These foci will help generate a system that will respond to the user's actual situation or problem as opposed to the user needing to be taught to better adapt to a system [33].

Existing virtuality structures seem to be following the default described by Diffusion of Innovation researchers [25] or else seem to have been deliberately carried forward from earlier communication and collaboration technologies. Most design is currently dominated by aesthetic expert logic derived from the capabilities of technology itself or simply carried over from expertise developed in the Industrial Age of manufacturing and marketing (as opposed to deriving from Information Age conditions). In spite of "user-friendly" rhetoric, users are seldom substantively involved in design. We set out to see if we could identify structural features, specifically steps and sequences of steps that derive from human purchasing behaviors as opposed to those that currently dominate E-Commerce design.

We employed Dervin's notion of cognitive movement from her Sense-Making approach [7, 8] to conceptualize the dynamic process of purchasing. Cognitive movement is a metaphor for how people experience life—as if they are moving through time and space—as a series of events or steps over time. A central aspect of life is that we are constantly faced with uncertainty or gaps in our understanding of our environment. Dervin [7] employed a "situation → gaps → uses" model to describe sense making where a person focuses on a context or situation, which has a goal or desired end state, and takes steps to reach that goal. Along the way the person inevitably encounters aspects of the environment and/or his/her movement that are not clear (being beyond existing experience, uncertain or undetermined). The term "cognitive" refers to perceptions associated with the context/situation/environment as well as the person's movement through space and time.

It is important to note that this method explicitly elicits respondents' step taking descriptions in natural language in the form of open-ended responses, following the respondents' time order. Subsequent content analytic procedures and descriptive data analyses preserve as much of the natural language features as possible. Thus, even the appellation of steps and step sequences are user-based as opposed to technology- or aesthetic-based.

Dervin's approach has been successfully employed to describe a wide range of behaviors from a user perspective, for example, public spheres [27] media systems [29], public information campaigns [4], and nursing practice [30].[3] Other recent work in virtual communities [23, 24] that employed similar conceptual frameworks have provided insight into other dynamic sequences of behavior associated with Web-based collaborative phenomena. In the context of E-Commerce, we see purchasing as collaboration between consumer and vendor through the medium of a web site where the web site "stands in" for the vendor's side of the collaborative interaction. An ideal E-Commerce web site would address the range of step taking needs of the customer in an effective AND timely fashion. This is our rationale for wanting a complete description of purchasing behaviors.

Our goal was to elicit a series of descriptions of consumers' cognitive behaviors associated with purchasing on the web in order to look for patterns in those behaviors across a wide range of E-Commerce situations—we were looking for similarities in steps and similarities in the sequencing of those steps. If there are patterns in what people do then we can be confident that web site design features based on those patterns will likely be useful to consumers. Further, since these patterns represent similarities of user descriptions of step taking, consumers will need little, if any, "training" to navigate structures designed according to these patterns. If a web site has a complete set of features associated with purchasing that are perceived as useful by consumers, then we may be able to increase the likelihood that the consumer will not only purchase from that site, but that he/she will say good things about the site to others and will return in the future, because, for example, they will develop loyalty.

Our research questions for this study were quite modest: What are the cognitive behaviors (steps) that consumers articulate when they describe online purchasing experiences? Are there any patterns of behavior in their descriptions? Are there any patterns in the sequences of behaviors over time in their descriptions?

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[3] See Dervin & Frenett [8] for a range of examples of the application of this approach.

3 Methods

We chose face-to-face interviews for an elicitation technique because we were describing a relatively common yet unknown sequence of behaviors. We chose an adaptation of Dervin's [7] TimeLine method where respondents described a recent online purchasing experience as a series of events or "steps" (operationalized as "something that you did, someone else did, or things that just happened"). "Step" is our operationalization of cognitive behaviors that represent the respondent's experience where each "step" is associated with a unique point in time and space such that steps are time/space specific, and is preceded or followed by other steps in the respondent's experience. Note that most accounts of experience recounted between people take this same form given the linear nature of language—we start at the beginning and unfold our description in temporal order until we get to the end (often called a "story"). The set of steps (recorded on 3" by 5" index cards) was taken as a respondent's account of one E-Commerce interaction. Finally, demographic information was collected from the respondents in order to describe the study sample.

We conducted 128 interviews where respondents described two online purchasing situations which produced a total of 1526 steps articulating behaviors describing online purchasing experiences as a series of respondents' cognitive movements or steps. We employed a randomizing sampling strategy geared towards getting as wide a range of descriptions of online purchasing as possible. Most of our respondents were students (graduate and undergraduate) at a medium-sized Eastern university. We believe that students are an appropriate population for this study because they are familiar with Web technology, have ready access to it, have disposable income to spend—in short, they are the E-Commerce consumers of the immediate future. The average age of the respondents was 27 years. Most of the respondents were in the age group of 21-30 years (78.13%). Of the respondents, 55.47% were Caucasian, 21.09% were Asian, and the rest were African American, Native American, or Hispanic/Latino. In terms of gender we had almost an equal number of males and females.

4 Data Analysis and Results

Given the descriptive nature of our data (mostly open-ended responses), we employed standard inductive content analytic procedures, the most complex of which (described in more detail in [21]) was employed to search for patterns in the steps describing purchasing behaviors. We (literally) laid out the 3" by 5" index cards for each respondent's purchasing description in a horizontal line, one description below the next, one respondent below the next. Then, by sliding the index cards left or right (always maintaining the respondent's time order), we attempted to align similar behaviors or steps in vertical columns. There were certainly differences in the amount of detail articulated between different respondents, however, we were able to document two distinct types of patterns: first there were several types of step that virtually all respondents mentioned; and second these steps were mentioned in the same time order.

Table 1. Frequency and percentage of events described by respondents maintaining respondent articulation order (n = 1526)*

Description of events*	n	%
Realization of want/visiting a website	313	20.54
Browsing/Searching – online and offline	246	16.14
Comparing products/prices/website features	72	4.72
Researching/observing/finding information general	220	14.44
Selecting products/links/features/vendors	270	17.72
Purchase/no purchase/complete purchase/purchase offline/order confirm	247	16.21
Enter information general	109	7.15
Stop	33	2.17
Save data	12	0.79
Other (not related to purchasing)	2	0.13
Grand Total	1524	100.00

* Missing data = 2

** Inter-judge coding reliability coefficient (Percentage Agreement Index) equals .9235 or 92.35% agreement between two coders.

Table 1 describes the results of this process, listing eight types of step in time order. This is a model of the specific E-Commerce behavior synthesized from respondents' natural language descriptions. The most common first event articulated by respondents was categorized synthetically as "Realization of want/visiting a website," which represents both serendipitous and known-item search as an initiation of an E-Commerce interaction. Of the 1524 valid responses (two responses were missing), 313 (20.54%) described this as their first step. For instance, we were told, "I knew I needed more memory and speed on my computer," or "I saw this interesting DVD on the web site," or "I wanted to buy a gift." Other common events included browsing (as a search strategy in a less directed context) and searching (both online and offline) (n = 246, 16.14%); researching/ observing/finding information (n = 220, 14.44%); selecting products/links/features/ vendors (n = 270, 17.72%) and making/not making the purchase (n = 247, 16.21%). Table 1 summarizes the frequency and percentages of how respondents described the steps when they went online to engage in E-Commerce. Note that we maintained the time order of respondents' articulations with two exceptions described next.

Steps that individual respondents mentioned in between "Realization of want/visiting a website" and "Browsing" (for example) were virtually always elaborations of the same movement although at a higher level of detail. Such "detail" steps were incorporated into the immediately subsequent step. Using this same example, detail steps between "Realization of want/visiting a website" and "Browsing/Searching" were incorporated into "Browsing/Searching." Note that there was another pattern in the steps that respondents articulated that did NOT follow a time order: "Stop" and "Save data." We found that many respondents described this kind of step but it was reported at many different points in the sequence of steps describing purchasing. This is logical given the computer's role in web-based phenomena.

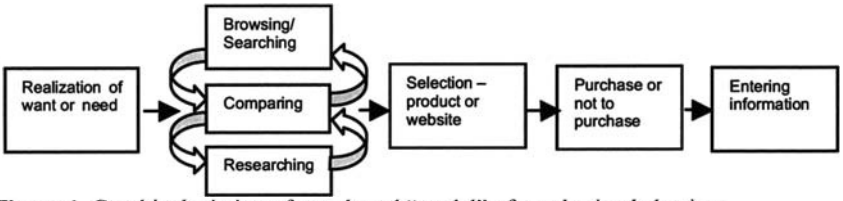

Figure 1. Graphic depiction of user-based "model" of purchasing behaviors.

This "model" of the patterns in respondents' descriptions of their purchasing situations had one other feature that is extremely noteworthy: A "loop" of behaviors (indicated by brackets in Table 1) that were often repeated by respondents (including "Browsing/Searching", "Comparing", and "Researching" steps), once for type of product, again for color of product (for example), then for other specific features of the product, service, warranty details, etc. By including this as an iterative loop, we were able to significantly simplify the complexity of our description of respondents' purchasing behaviors and still retain the overall time order of respondents' articulations.

Figure 1 shows a conceptual, time-sequential "schematic" of the cognitive steps describing purchasing behaviors presented in Table 1 with the iterative loop that dramatically simplified our representation of the patterns associated with "purchasing" for our sample. The loop is basically a pre-selection product/service feature information seeking sequence. The loop was evident in respondent's descriptions anywhere from once to several times depending on the complexity of the feature set that the respondent wanted to address before he/she felt confident in selecting or deciding on a particular product (regardless of whether the respondent subsequently purchased from the same website/vendor where he/she was looking) OR selection of a website (if s/he subsequently purchased on another website/vendor).

5 Summary and conclusions

One reliable empirical generalization we can make from thirty five-plus years of eliciting respondents' descriptions of their situations/problems is that researchers have ALWAYS found three types of patterns [7, 8, 21]:

- Respondents' descriptions are characterized by similar behaviors (including similar perceptions and feelings);
- Respondents do these things in a similar time order; and
- There is a finite range in resources respondents need to "move" through their situations/problems.

Our use of a content free method[4] for respondents' descriptions of their perceptions of a meaningful behavioral sequence as a series of steps provided us with a coherent and reliable basis for describing purchasing experiences across respondents. We argue that the pattern in the functional types of steps and the sequence of steps represents a recurring aspect of life, in essence a structure known to/recognized by everyone, about which people collaborate and about which they talk and refer to as "purchasing." We think that "purchasing", or more generally, "trading" represents a very basic and embedded behavioral sequence in human nature - probably developed socially over the last two hundred thousand years. This is clearly a more enduring structure than those ephemeral structures somewhat arbitrarily "designed" into many existing systems, including the vast majority of sites engaging in E-Commerce as currently practiced. The socio-cognitive structure reported here is a generalization across 128 people about the similarities in how people think and talk about purchasing online. We believe that if the functional and temporal relationships found here were employed to structure Web-based E-Commerce design it would improve the utility to both customers and vendors who collaborate around or through E-Commerce web sites. Our socio-cognitive model can be employed to facilitate or structure and inform interaction. Although we looked at B2C (business to consumer) experiences, we feel that the embedded nature of the perceptions modeled here would be helpful for Web-based B2B (business to business) interactions as well.

The model presented in Table 1 and in Figure 1 represents a sequence of logically necessary behaviors that customers expect from E-Commerce web sites literally in spite of the well meaning aesthetic design constraints currently employed to structure those sites. The observed patterns in steps were evident regardless of the specific E-Commerce context. That we found such patterns in respondents' descriptions strongly suggests that web sites which are designed to constrain user movement which accommodate these expectations will be both more "successful" with regards to purchases but will also likely be perceived as more useful by customers—a "win-win" situation.

Nilan and D'Eredita [22, 6] have argued for a social cognitive perspective [32] to be applied to the communicative and collaborative vision of structuring virtuality beyond this individual cognitive perspective. The implications of this move are that the passive roles associated with human beings having only "receiver" roles in "top down" mass communication media (publishing and broadcasting) have inhibited our ability to see that people have many other roles vis-à-vis those media—people are also conversants in a communication context even though the "other" does not listen very well nor respond appropriately—so far. The Web is a horizontal, small group to small group medium where the conversant role is (or should be) MUCH more evident. Our data would suggest that the effectiveness of the "other" in our professional design efforts could be much more natural and responsive to users'

[4] By "content free" here refers to the manner in which the conversation between the researcher and respondent unfolds. The researcher's structure is steps over time, similar to how people tell each other stories and according to Dervin's [7, 8] cognitive movement metaphor. However, the types of steps, their temporal order, etc. are details supplied by the respondents.

natural movements. While we know from the research into diffusion of innovations [25] that people tend to 'do what we are used to doing but on the new technology' when we are initially dealing with new technology like the Web (and it has been just over eleven years since the Web's introduction to the public in April, 1995) it should be obvious to us that enduring human cognitive structures like the patterns presented here will be effective on the Web in spite of still unknown or arbitrary technological constraints.

We believe that our model illustrates that there are readily observable human structures that will allow designers to take better advantage of the unique aspects of the Web. These approaches require the researcher or professional to learn to listen to the user/customer more effectively and to cast the users/customers in a more responsible and natural interactive role [22]. This will facilitate the design of true "interactive" web sites appropriate for global electronic network environments.

As an example of the utility we see in this study for improving the design of E-Commerce web sites, the iterative resource seeking loop indicates that users invariably seek insight into product features salient to them, yet most existing sites do not provide information about competing products. If users are leaving an E-Commerce site to access this kind of resource, you are increasing the chances that the user will purchase elsewhere. This is somewhat ironic since the Web is so well suited to providing information resources. Haubl and Trifts [12], even though they are clearly within a "rational" model of consumer behavior, noted that customers routinely make product feature comparisons across web sites. However, it appears that because E-Commerce web site designers have carried over traditional marketing logic (which says you don't talk about competitors' products except to criticize them) onto the Web, they "build in" encouragement for users to go elsewhere and potentially lose the customer in the process. Our model clearly shows that web sites *should* address customers' natural predilection to get information about competing products/services BEFORE they actually reach a product selection step. For the most part, price as a feature that distinguishes one web site from another would seem to be an Industrial Age logic while how a site treats a customer by providing what the customer needs, for example, would seem to be a viable Information Age logic. It seems clear to us that giving customers what they clearly say they want is a viable strategy for getting customers to not only stay at your E-Commerce site but to return in the future.

Current E-Commerce web site design really only addresses the last two steps in the model presented here. Attention to potential customers' needs and predilections in the antecedent steps would seem to be a powerful strategy for keeping a customer at a site and encouraging that customer to return next time s/he has a desire for a similar product. Although we can envision E-Commerce web sites that are markedly different from the current catalog-plus-shopping-cart variety, we believe our purchasing model provides insight into other aspects of a human-to-human purchasing interaction that could be acknowledged and addressed in web site design. If the resources at E-Commerce websites are sending customers elsewhere to get their questions answered, this only increases the chances that customers will buy elsewhere. Customer loyalty is likely to be related to how easy the E-Commerce website makes the purchasing process.

The web interface is a way of organizing resources (computing functionalities and links or referrals [21]). There are two approaches to designing interfaces. Researchers who studied text-editing systems concluded that users needed training to enhance their understanding of the editor [11]. Other researchers emphasized understanding user behavior rather than attempting to change it through training, for example [18] and demonstrated how user suggestions were utilized in the development of the Apple Lisa interface [31]. Further, a recent survey by Zona Research found that 33% of the people surveyed indicated having difficulty locating products and 62% indicated giving up looking for merchandise items because they could not find them [3]. The importance of designing an interface that mirrors patterns of user behavior (including resource use) can be seen from the assertion that interface limitation is seen as one of the top six key obstacles to E-Commerce [26].

Table 1 and Figure 1 suggest one way in which information can be organized and sequenced on an E-Commerce website that follows what human beings already expect. Web designers can use the abstract model of E-Commerce developed by our study (which is based upon the way that people perceive and talk about their experiences of going through an E-Commerce purchasing problem) as way to organize information on their websites. Thus, using the abstract model as a base on which to build the website design will help customers to navigate to the point in the E-Commerce process where they want to be without any training at all! They already "know" this process. Further, if the appropriate resources are organized in accordance with the model, then not only will people be able to find what they need but they could also bring new resources to the website and "place" them in the logical location. Note that this would facilitate keeping the site up-to-date at little or no expense to the vendor! The first level of the interface could be a representation of the steps (in time order) in the user-based purchasing model. This would enable customers to immediately locate where they are with their own purchasing situation at the present moment and where they want to go. The second level of the interface would present the resources needed in order to navigate though a specific event or step. As Nilan [21] suggested, "The relationship between the first and second levels is that the first level allows for a crude orientation to the system but on user terms, and the second level allows users to cognitively navigate through the problem space to more specifically define their functional needs."

We believe that the study reported here provides a good first example of employing cognitive and social cognitive approaches to deriving insight for structuring virutality which in turn can provide valuable practical insights for website designers. By illustrating the not-so-complex cognitive process involved in E-Commerce purchasing, this study can lead E-Commerce web site designers to reexamine the current two-step model of E-Commerce on which their designs are based (basically an online catalog and a shopping cart). At a higher level of abstraction, we believe this study supports a shift from controlling users (characteristic of Industrial Age marketing logic, for example) through a methodological focus on individual differences to collaborating with users through a methodological focus on shared similarities in cognitive orientation to specific tasks/problems/contexts. In other words, we believe that researchers and designers should shift from aesthetical and/or technological constraints to functional constraints associated with a specific task/problem/context [6].

One of the weaknesses of the study lies in the inductively developed coding schemes, which could have been tighter. This especially true for the schemes developed for describing events mentioned by the respondents and the types of questions they had. However, we would argue that a user's interpretation of the steps is served by this over-generalization in much the same way that the flexibility of language allows for myriad ways of constructing utterances/ sentences. Individual terms in the model presented here are not interpreted in isolation but rather in terms of the entire model, so the generalized terms chosen for representing the different steps in the model would seem to be adequate for communication and navigation purposes. The biggest strength of the current study is that, by focusing on what the user does rather who the user is, it provides web designers with rich data on cognitive process involved in E-Commerce as well as an understanding of the kinds of resources needed to navigate through the process.[5]

One final note: The approach illustrated here employed a strategy based upon empirical research. However, the current Web technology suggests that the kind of data collected here could be done quite economically in real time, all the time (rather than every now and then through expensive research). An example would be the use of discussion group type functionality that is designed deliberately to facilitate user/vendor communication as opposed to an add-on feature. Not only is the global economy being changed by this technology, relationships between vendors and their customers are changing as well. This approach provides a way of thinking about and employing virtual relationships to mutual advantage through respectful interaction with both "sides" contributing valuable insights to further communication and collaboration [22].

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[5] In this study we also elicited respondents' information needs at each step but due to space limitations, we were not able to include these results in this report.

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About the Authors

Michael S. Nilan received his Ph.D. in cognitive behavior from the School of Communications at the University of Washington. He has been engaged in a long-term program to develop coherent user-based approaches to creating effective resource organization structures in hyperspace. He is an Associate Professor at Syracuse University's School of Information Studies, the original information school.

Anuradha Mundkur is an Adjunct Lecturer and Research Fellow in the School of Geography, Population and Environmental Management and Flinders Institute of Public Policy and Management, Flinders University, Adeliade, Australia. Her research interests are in information and communication policy making in development, information technology in governance, and gender and ICTs.

6

Competency Rallying Processes in Virtual Organizations[1]

Bernard Katzy[1] and Kevin Crowston[2]
1University BW Munich, Center for Technology and Innovation Management, Munich, Germany
bernhard.katzy@cetim.org
2 Syracuse University School of Information Studies
Syracuse, NY 13244 USA
crowston@syr.edu

Abstract. Firms face an environment changing at an increasingly rapid pace. Unfortunately, the speed at which organizations can adapt their strategies and competencies to exploit such opportunities remains limited. In this paper we weave together an external perspective on market-facing with an internal perspective on competency development and marshalling to describe the organizational activities necessary for firms to cooperate within a virtual organization. We argue that firms can address their individual limitations through a systematic process that we call "competence rallying," with which they can access market opportunities and additional needed competencies. Specifically, we present a local process theory of how one network of firms reliably engineers and delivers manufacturing projects using an inter-organizational process that works to meet short-term market opportunities. Our theory is grounded in the experiences of the *Virtuelle Fabrik* project, an organized network for regional cooperation in the manufacturing industry around the Bodensee in Europe. The success of manufacturing projects in a

[1] The Virtuelle Fabrik project was started by the Institute for Technology Management, University of St. Gallen. Financial support was provided by The Swiss Commission for Scientific Research (KwF) and the Virtuelle Fabrik partner companies. The Virtuelle Fabrik project team included Günter Schuh, Bernhard Katzy, Kai Millarg, Thomas Zehnder, Stefan Eisen, and Åsa Göransson, as well as managers from the partner firms. The authors thank all of the participants in the Virtuelle Fabrik for their contributions and in particular, for the many discussions that led to the concepts discussed in this paper. The authors take sole responsibility for the work presented here. This paper has benefited greatly from discussion with Paul van Fenema, Steven Sawyer, Ping Zhang, Robert Heckman, Barbara Kwasnik, and Gisela von Dran.

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virtual organization is predicated on specific organizational activities in four phases of the competence rallying process: 1) identification and development of competencies, 2) identification and facing of market opportunities, 3) marshalling of competencies, and 4) a short-term cooperative effort.

1 Introduction

Firms face an environment changing at an increasingly rapid pace. Market opportunities in particular can arise and disappear again in a short time. However, the speed with which organizations can adapt to changes remains limited. We refer to this situation, where the environment changes more rapidly than organizations can adapt, as a "turbulent environment" [1]. Turbulent environments re-pose two central questions addressed by theories of the firm: How does the firm behave in its market, and how is work organized?

In stable environments, the answers provided to these questions distinguish two broad types of theories of the firm. In the first type of theory, markets are assumed to determine the organization of work and it is the role of management to craft deliberate strategies to translate industry realities into appropriate organizational structures and processes. In the second type of theory, existing structures or "core competencies" [2] internal to the firm are used to explain its market behavior. Competencies are valuable, rare, inimitable, and embedded in the organization and thus define a resource barrier that provides a source of sustainable competitive advantage. As a result, strategies emerge from organizational structure and culture as long-term patterns of behavior [3].

While both types of theories deliver fruitful explanations of the nature of a firm in stable environments, the two questions point to opposite ends of a paradox for firms in turbulent environments. On the one hand, the insight of the first type of theory—that deliberate strategy is necessary—remains true even in the face of short-term market opportunities. However, time constraints make it impossible for firms to adopt appropriate organizational structures and routines to ensure performance for each change in the market. On the other hand, the insight of the second type of theory—that competencies inside the firm are a source of competitive advantage—holds true especially for short-term market opportunities. The more valuable a competency is, the longer it takes to develop (often a decade or more [2]), so competing firms cannot readily develop competencies to meet short-term opportunities. However, the unpredictable nature of market opportunities in turbulent environments increases the risk that necessary competencies may be missing and that existing competencies may become irrelevant or outdated. In short, turbulent environments make appropriate strategy and competencies simultaneously more important yet seemingly less attainable.

We suggest that one way for firms to resolve this paradox is by addressing these conflicting theoretical insights as distinct phases in a process that unfolds over time and across a virtual organization of cooperating firms [4]. In particular, we suggest that one way for firms to address their individual limitations in meeting short-term market opportunities is to cooperate with other firms for access to temporarily needed competencies they cannot build themselves. We use the term "rallying," meaning, "to rapidly reunite for concentrated effort" [5], to describe *the process of developing and bringing together in temporary cooperation a network of firms with the competencies needed to satisfy a newly-identified market opportunity*. In this paper, we describe the process of competency rallying for successful short-term projects in a particular virtual organization.

Aspects of the competency rallying process have been discussed before, of course, and these prior discussions provide some of the building blocks for our theorizing. For example, the role played by market recognition and competency recombination is evident in the Prato region of Italy [6], where many small textile manufacturing firms specialize in various aspects of textile and apparel production, such as weaving, dying, sewing, etc. These small companies are not able to identify worldwide customers, nor do they offer a complete range of desired services. Instead merchants, *impannatores*, provide access to the highly volatile fashion market opportunities for the entire industrial district [6] and temporarily bring together numerous small companies to fill the requirements for each particular contract. Similarly, Prahalad and Hamel [2] note that to develop competencies, they must be used and re-used in many different markets and contexts, as we suggest happened in our case setting. However, our theory is novel in the way that it weaves together an external perspective on market-facing with an internal perspective on competency development and marshalling to describe the overall process of competency rallying.

While the potential value of such cooperation is becoming more widely accepted, the details of competency rallying are little understood. The contribution of this paper is the development of a process theory of competency rallying that meets the demands of turbulent environments. The process theory is grounded in a detailed action research study of one successful virtual organization called the *Virtuelle Fabrik*.

2 Methodology

Following a grounded theory approach to theory building [7], we carried out a research project to develop a relatively full description of competency rallying in a specific setting. This description suggests further research that could be carried out in other settings to develop a more general description of competence rallying (as we will discuss in the conclusion of this paper). In this section, we describe the particular research setting, overall research methodology, and data collection and analysis approach. In the subsequent section, we describe the general structure and each phase of our proposed process theory in turn.

2.1 Research Setting: The *Virtuelle Fabrik*

Our study was conducted at the *Virtuelle Fabrik* (the "Virtual Factory"), an organized network for regional cooperation in the manufacturing industry in the Bodensee (or Lake Constance) region of Germany, Switzerland, Liechtenstein and Austria. The virtual organization started in 1996 and still operating today, routinely engineers and manufactures new products by recombining the competencies of its members to meet short-term market opportunities. Members of this virtual organization (ranging from small and medium enterprises to divisions of large multinationals) have cooperatively produced dozens of products, from simple parts to a complex module for a letter-sorting machine.

2.2 Research Approach: Collaborative Action Research

The research project was carried out as a four-year collaborative action research case study [8]. To be able to study the process of cooperation between the project organizations, the core partners assumed the role of active promoters. Researchers acted partly as change agents in the firms and partly as observers of the change processes, "alternating the change agent and researcher roles" [9, p. 420].

Susman and Evered [8] describe a five-phase cyclic process for action research, consisting of 1) diagnosing, 2) action planning, 3) action taking, 4) evaluating, and 5) specifying learning:

1. **Diagnosing** includes identification of the primary problems that underlie the organization's desire to change and leads to the development of working hypotheses about the state of the organization. In this phase, action researchers can use techniques similar to organizational ethnography as a way to develop thick descriptions of the dynamics and processes of the organizations involved in the project (the methods used are described below).
2. In the next phase, **action planning**, researchers and practitioners collaborate in determining organizational activities to address the problems identified. This planning is based on the theories and models brought to bear by the researchers as well as the knowledge of the practitioners. In other words, the research is both theory-driven and theory-building.
3. In the **action-taking** phase, the planned changes are implemented. Being part of the change process requires the researchers to be participant-observers in the processes being studied.
4. After the actions are taken, researchers and practitioners collaborate in **evaluating** the outcomes, including determining whether the actions had the theoretically expected effects and if they were effective in relieving the problems, a form of theory testing.
5. In the final phase, **learnings** from the actions and results are formally specified. This phase distinguishes action research as research rather than simply a type of change effort. Baskerville and Wood-Harper [10] suggest three audiences for the learnings. First, the participant organizations can be restructured to reflect the new knowledge gained in the interaction. Secondly, where the change was not fully successful, the learnings may lead to a new round of diagnosis and action planning. Finally, the test or building of the theoretical framework in practice contributes to the development of scientific knowledge.

In this project, each cycle began with a diagnosis of the current state of the *Virtuelle Fabrik* project inspired by the data and literature. Then to see if this diagnosis could be supported, the project organizers developed an action plan that was cooperatively implemented by the researchers and managers. The results of the intervention were observed and evaluated to see if the predictions were supported. These evaluations led the researchers to explore complementary perspectives and facets of the process of competency rallying. As the priorities of the project shifted, we modified or maintained each inference about the process. Informal discussions and formal reporting of the project led to specification of the learning and to the next round of action learning. Finally, we wrote up our inferences about the various aspects of the process, adding conceptual arguments, additional examples, and citations to relevant literature.

2.3 Data Collection

There are significant similarities between action research and other kinds of qualitative research in the modes of data collection. The evidence guiding our descriptions of and inferences about the process of competency rallying is divided into seven general categories:

1. **Semi-structured interviews with company managers**. The researchers conducted nearly 100 semi-structured interviews to diagnose a variety of topics with company managers. Interviewees included company directors and managers and employees involved with in- and outsourcing at all levels and departments. Each round of interviews lasted three to four days and resulted in a report describing the situation of the firm.
2. **Project plans**. The project was co-funded by the participating companies and the Swiss Commission for Scientific Research (KTI). The project plans showed the results achieved in the prior year, lessons learned from this work, and the specification of concrete actions for the year to come.
3. **Project meetings with partners**. Regular meetings were held among the partners to plan and take actions. Smaller formal meetings were held for parallel development work. Researchers attended many meetings as change agents or to follow the developments.
4. **Results of interventions**. The action interventions produced both intended and unintended results. Some of these results even appeared in parts of the partner companies remote from the project interventions.
5. **Observations of projects**. Partner companies executed numerous manufacturing projects, about fifteen of which were directly observed by the researchers. The researchers followed the interventions, progress, and difficulties encountered in these manufacturing projects to feed the observation back to the partner companies as lessons learned.
6. **Informal discussions**. As part of the ethnographic data analysis process, researchers were participant-observers in the network for four years and constantly had informal conversations with managers and employees of the participant companies. These ranged from brief interactions to long discussions over group dinners (known among participants as the "virtual

dinner", as discussed below). Researchers talked informally with employees at all hierarchical levels from all participant companies.

7. **Formal reports**. The researchers and managers regularly wrote up project results, which were defined as sub-projects from teams and work-packages. In 1998 a book was published in German reporting the project results in general [11], though not including the model presented in this paper.

2.4 Data Analysis

Action research uses much the same data analysis techniques as other kinds of qualitative research. Because our goal was developing theory, we followed the general approach of grounded theory [7, 12]. A variety of more specific data analysis techniques were used for different data and at different points in the action research cycle and in the project lifecycle. A primary approach was content analysis of the text for example, from interviews or observation) to develop insights on the development of manufacturing projects among the partner firms. By comparing the process of multiple manufacturing projects, regularities in the development processes could be induced. By using multiple sources of evidence, findings could be triangulated to improve our confidence in their reliability. The validity of the findings could be tested by checking with project participants and by using them as the basis for designing, implementing and testing helpful interventions.

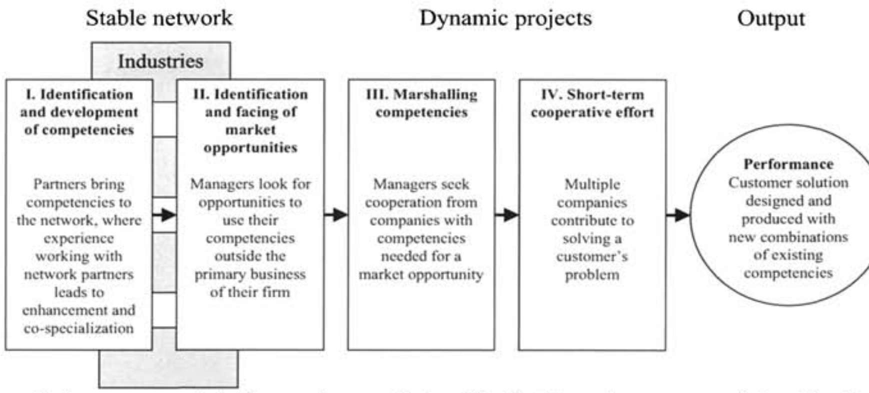

Figure 1. A process model of competency rallying. The first two phases are carried out in all member firms across multiple industries; the final two phases are carried out for the specific projects identified in Phase II.

3 A Process Theory of Competency Rallying

In this section, we present the process theory of competency rallying induced from the analysis of the collected data described above. Our analysis suggests that successful competency rallying involves four related sets of organizational activities, specifically: 1) identification and development of distinctive competencies in network members, 2) identification and facing of short-term market opportunities,

3) marshalling competencies from network partners for a particular market opportunity, and 4) a short-term cooperative effort. These stages of the process theory are shown graphically in Figure 1. The first two phases are performed on an on-going basis within the relatively stable network of firms taking part in the *Virtuelle Fabrik* project. These phases draw on competencies and market opportunities from a variety of industries, as indicated symbolically by the grey boxes. The final two phases are performed dynamically for each individual product developed by the *Virtuelle Fabrik.*

3.1 A Process Model of Competency Rallying

The data from our case study suggests that successful design and manufacture of products by the *Virtuelle Fabrik* required the successful performance of four sets of activities: competency creation, market facing, competency marshalling and cooperative effort. For example, consider the development of the electric retraction device for a steering wheel, a product engineered and built within the *Virtuelle Fabrik.* The manufacturing project started when one of the network members, Wiftech, was approached by a customer and asked if they could provide the part. Wiftech itself did not have the capacity to build the part but offered instead to take the project to the network, an example of **facing a market opportunity**, which would have been impossible without the project. Wiftech passed the project on to a project leader from another firm, with whom they were acquainted from various project meetings. The project leader evaluated ten different technologies from ten independent firms in the network for technological feasibility and for their cost in the effort to design the part, an example of **marshalling competencies** ("to arrange things in an appropriate order so that they can be used effectively"). While ten companies were involved in the search for a technical solution, only three were involved in designing and manufacturing the first prototypes. The joint work of these companies at this stage is an example of a **short-term cooperative effort**. Final production required different partners, as the order quantities did not fit the one-of-a-kind manufacturing philosophy of the prototype manufacturers. Unstated in this example, but clearly necessary, were the on-going processes for **developing and maintaining the competencies** necessary to design and manufacture such a part in the first place. In the remainder of this section, we present the four phases of our process theory and the evidence for each phase.

Phase 1: Identification and development of competencies. The network rallies competencies that are provided by independent partner firms in the *Virtuelle Fabrik* project. These firms can provide competencies from their various industries (as indicated symbolically by the grey boxes in Figure 1) that are potentially valuable yet not exploited in other industries. This view corresponds with the stream of literature on the resource-based view of the firm, which describes firms as collections of resources that can be deployed to establish competitive positions in multiple markets with heterogeneous products [13].

Through the course of the project, the conception of "resources" gradually evolved and expanded. Initially, the view was quite limited: the original goal of the project was to increase machine utilization, so resources were machines.

Descriptions of these machines across the industries were based on the generally accepted classification scheme and terminology from the DIN 8580 standard, which defines all machining operations. Defining resources makes direct comparison across business or industry boundaries possible. It also led, in some cases, to a rethinking of the meaning of resources. For example, two member companies considered themselves experts in grinding in their respective industries, but when one contracted work to the other, they discovered that one was much cheaper than the other, a fact the companies could not have discovered through benchmarking only within their own industry. This discovery led to a revision in thinking about resources. Rather than viewing them as undifferentiated commodities (for example, tool machines), the view shifted instead to competencies: something one firm was better at doing than others. The second, more expensive company was forced to reconsider its competencies and determined that they lay in grinding smaller-sized parts and to more precise tolerances, which made them more expensive, in the particular case, but able to do work that the other firm could not. As this example shows, in order to participate in the network, firms had to clearly identify what competencies they could contribute. A second important benefit of the project was that experiences with the *Virtuelle Fabrik* contributed to the further development of competencies within the partner firms. This development occurred because workers within the companies faced requirements from a range of different industries and customer projects, which stretched their existing skills. Managers began to refer to this stretch as the "jogging effect," meaning that the little time they spent manufacturing for the network led to an increase in the fitness of the firm.

Experiences of cooperative manufacturing also revealed capabilities that were not linked to machine tools but which were needed to design and engineer complete customer solutions and thus equally important for successful projects. Examples included assembly, quality inspection and testing, project management and certification for ISO conformity. Unlike simple machining operations, the competencies discovered in this way were to a great extent intangible. There were no generally accepted definitions (such as DIN 8580) that could be used to describe the distinctive competencies the network could bring to bear on customer problems.

As well as within the individual member companies, competencies were developed at the level of the *Virtuelle Fabrik* as a whole. From experiences with joint manufacturing projects, stable sub-networks of partners emerged, which as a group proved to have competencies for applications in medical technology or precision machinery (for example). In building these sub-networks, the *Virtuelle Fabrik* project contributed to a trend of co-specialization of the partners. Some firms decided to give up certain technologies, for which they found reliable partners in the network, and to concentrate on other competencies, which proved to be competitive over a wider range of industries.

In summary, the *Virtuelle Fabrik* relied upon member firms' competencies, which were conceptualized as something one firm can do better than others. In order to contribute to the virtual organization, companies had to first clearly identify and further develop their competencies.

Phase II: Identification and facing of market opportunities. The *Virtuelle Fabrik* provided member firms with market opportunities beyond their core businesses and industries, again as indicated symbolically by the grey boxes in Figure 1. The conception of identifying and facing market opportunities evolved through the course of the project. Initially, the understanding was simply market access, an important element in other networks where companies are not equally situated in terms of access to profitable opportunities. However, market opportunities do not present themselves neatly labeled as such. Instead, accommodating short-term market opportunities requires active entrepreneurial creation of business on the level of the partner firms as well as on the level of the network. We refer to these activities together as "market facing" (based on the concept of market orientation, [14]).

Penrose [15] argues that the market opportunity of a firm "comprises all productive possibilities that its 'entrepreneurs' see and can take advantage of." Her central argument is that the growth of the firm is limited by the managerial services (for example, "fundraising ingenuity," "ambition," or "entrepreneurial judgment") available for creating market opportunities. Such managerial services were particularly limited for the partners in the *Virtuelle Fabrik*, who were either internally oriented production departments or small and medium-sized firms, where highly specialized management resources are particularly scarce.

Explicit market facing activities took time to develop. The majority of manufacturing projects in the first two years of the project were carried out for customers from inside the network. Some manufacturing projects had served external customers, but these usually occurred by chance or were initiated by the customer. The research project worked nearly exclusively on how to organize work in the network, so market-facing activities were a matter for the individual partner firms. However, experience and early success in manufacturing projects showed that the *Virtuelle Fabrik* was also successful with products that were not fully specified and for which the firms could use their engineering capabilities. To take advantage of these competencies, the project leaders promoted facing markets outside the network. Advances from the inward orientation to outside marketing were made in the third year of the action research project.

Organizational routines for facing market opportunities on the level of the network were initially developed as an adoption of existing product marketing techniques for the marketing of production competencies. For example, purchasing criteria were identified that could be used to signal the uniqueness and the buyer value of competencies from the virtual organization. Mapping these purchasing criteria on market segments and customers resulted in a number of target segments for which sub-networks of firms developed marketing plans. Exposure to new business opportunities raised awareness of market facing among the managers involved. A saying became common among them: "Market opportunities are like trains that run again and again through the station. To catch the train, you have to practice jumping on trains, not construct new stations."

In summary, identification of market opportunities provided member companies with access to applications for their manufacturing competencies in businesses beyond their traditional industry boundaries. Membership in the network exposed the firms to ideas and demands they would otherwise not have seen, with beneficial effects for the development of their competencies. Selecting business opportunities, as we have seen from the action interventions, requires more than simply picking them off the shelf. Instead, it is necessary for managers to be able and willing to perceive opportunities to stretch competencies beyond their primary business.

Phase III: Marshalling competencies. In the structure of the process theory, developing competencies and facing market opportunities represent two necessary preconditions in the network of firms. However, they are not in themselves sufficient to address a customer's need. Central to the success of projects in turbulent environments is the quick combination and recombination of the competencies necessary for a particular market opportunity. In order to meet this need, members of the *Virtuelle Fabrik* developed routines for marshalling competencies, that is, for determining what competencies from which partner companies are required to satisfy a specific customer's need. Development of these marshalling capabilities was necessary to permit companies to address opportunities that could not be handled by any single firm.

Again, the conception of marshalling evolved over the course of the project. Initial activities were based on literature suggesting that markets would be an efficient means of allocating resources to evolving market opportunities without hierarchical overhead or central management [16]. For example, Miles and Snow [17] suggest that market mechanisms will become more important for marshalling competencies with the use of information systems that reveal the status of potential trading partner (a so-called full-disclosure system). A shift towards market coordination through computer systems also fits predictions based on transaction cost economic analyses [18]. In accordance with these suggestions, a full-disclosure information system, called the "Technology Capacity Bourse," was developed in the early stages of the project. This database provided descriptions of the machine tools available in each of the member companies. The goal of the system was to reduce the cost of searching for partners and specifying competencies.

The system served its purpose until the partners attempted to include real-time capacity information to automate competencies marshalling. At that point, action reflection revealed that managers of the partner companies were not prepared to make sourcing decisions solely based on information from the database. This was especially true for many of the intangible competencies developed in the network that could not be described as succinctly and unambiguously as the physical resources (for example, engineering or integration competencies). Because of the difficulty of describing such competencies, a simple database was out of the question in any case.

Instead of relying on technology, organizational routines for marshalling competencies were developed. The researchers analyzed early experiences of manufacturing projects to identify problematic situations. Small teams of managers and researchers then developed what the project partners called the "rules of the game." Each rule was presented to all *Virtuelle Fabrik* project partners and a formal vote taken on adding it to the set of guidelines for collaboration. These guidelines eventually covered the entire lifecycle of a co-operative manufacturing project, for example, how partners are selected, how prices are calculated co-operatively, a checklist of how to specify customer products, and a standard contract. In addition, the researchers drew on literature to describe the complementary roles and positions of cooperating partners. Consideration of these functions led to the specification of a set of roles to ensure that the competencies needed for a successful manufacturing project were available. One firm might fill different roles (or even multiple roles) for different manufacturing projects, as long as it was clear who was responsible for a role and all were filled.

Apart from those explicit guidelines, mutual site visits and experiences from joint production projects contributed to shared knowledge about the competencies and priorities of individual partner firms in the network. Frequent informal social contacts, such as the "virtual dinner," provided the relationships needed for marshalling competencies on a self-organized, ad hoc basis. This body of shared knowledge formed what some have called a knowledge market [19]. Based on the mutual knowledge of partners' competencies acquired during the project meetings and site visits, managers chose to use personal contact to directly settle technical issues. Other authors have documented similar networks that seem to operate without a central design agency, such as industrial districts in Italy [20] and the film industry in Hollywood [21]. These cases are similarly reported to have culturally embedded restructuring mechanisms independent of any central institution.

In the end, the database in the Technology Capacity Bourse was regarded more as a means to establish a first contact (yellow pages), while placing orders was based on personal contact. Kumar et al. [20] similarly report the failure of an information system for transaction management in the Prato region, which they attribute to a mismatch between the economic rationality of the system and the need of the managers to build trust and a relationship with the companies with whom they interacted.

Phase IV: Short-term cooperative effort. Rallying competencies requires that multiple partners temporarily unite to combine their forces in a concentrated effort to create a new solution for a customer. The fourth set of organizational activities in the process addresses the question of how management can facilitate and elicit "the willingness of individuals to contribute force to the cooperative system" [22, p. 83]. There were several issues that had to be addressed.

First, the project leaders had to address the development of cooperative processes to allow companies to give and take business at a reasonable cost. Evaluation of initial projects showed that the additional coordination among independent firms led to roughly 30% higher cost than would have been the case for a manufacturing project performed within a single firm. Clearly such a cost disadvantage could not be tolerated. Firms therefore engaged in the reengineering of firm-boundary-spanning processes to make cooperation within the network as efficient as in-company processes. Duplicate activities—such as repeated quality inspection each time a part crossed a firm's boundary, filling out a full set of shipping papers and purchase orders, or work preparation and entering the workload in the next firm's electronic planning systems—were traced and eliminated. Of course, elimination of these activities also removed an important set of safeguards against mistakes and opportunism by partners. For this type of cooperation to work, expectations for the performance of the work moved from control at the transaction level to controls at the level of the network. Companies had to agree to follow the procedural guidelines that the project leaders derived from experiences with earlier manufacturing projects.

Second, direct communication was established between the involved operators in the *Virtuelle Fabrik,* avoiding chain-of-command communication. For example, partner companies created dedicated liaison positions with the ability to by-pass normal business processes for network business or allowed an outsourcing firm to contact machine operators directly. Consequently, expectations of what individual employees would do changed. For many machine operators, work for the *Virtuelle Fabrik* included external contact for the first time, forcing them to build skills in communication or conflict resolution. Of course, empowering production staff to accept work for the firm has the potential for conflict between their decisions and the traditional hierarchical control of the company and work processes, and these conflicts had to be resolved.

Third, in the course of the project, short-term cooperation increasingly shifted towards substantial arrangements. The established guidelines, for example, covered the context of cooperation, for example, the process of acceptance of new partners by the network, the process of specifying customer products, the process of calculation of cost, reward systems, and the communication processes in the network. On the other hand, direct procedural arrangements to control transaction were declined by the partner firms. For example, after the discussion of several proposals, it was decided that a guideline for the allocation of resources within partner firms was not required. Instead, the managers agreed that work could be delegated within the network, but not the responsibility for its quality, timeliness and cost. In other words, rather than having a rule for how to allocate resources, it was the explicit agreement of the managers to leave open how commitments were met, as long as they were.

This focus on substantial rather than procedural cooperation resembles the particularities of the craft industrial mode. As Piore and Sabel [6] explain with the example of the construction industry, manufacturing projects are too short-lived, firms too unstable and employment too ephemeral for time-consuming process of grievance arbitration. Moreover, individual customer-defined projects vary too much to justify the establishment of arbitration systems that are unlikely to have any bearing on the facts of future conflict. Unlike mass production, this mode of working requires the collaboration between workers and managers. Since the work is always based on a unique design, problem solving is a trial and error process based on the craftsman's experience. It is therefore not surprising that organizational units are small and supported by personal leadership. Improvements are based on the ingenuity and creativity of the individual and his technical excellence, which is challenged by the customer's desire.

In summary, our data suggest that competency rallying involved four related sets of organizational activities, specifically: 1) identification and development of distinctive competencies in network members, 2) identification and facing of short-term market opportunities, 3) marshalling competencies from network partners for a particular market opportunity, and 4) a short-term cooperative effort. Our data suggest that the successful performance of these activities in the *Virtuelle Fabrik* was necessary (though not sufficient) for the design and development of manufacturing projects that met emerging customer demand in a turbulent environment.

4 Discussion

Two characteristics strike us as key to understanding the success of the *Virtuelle Fabrik*, although further research would be valuable. A first characteristic is the nature of the manufacturing projects carried out in the *Virtuelle Fabrik*. The project started with the goal of trading commodity manufacturing, but it turned out that it performed best for products requiring intensive engineering for which intensive interaction between customer and designers and among designers is necessary. In short, the process summarized in Figure 1 worked best for cases where marshalling of competencies and cooperation mattered. On the other hand, for standard, off-the-shelf products, the degree of customized effort represented in this process is probably inappropriate. Instead, for these products an electronic market might be useful to lower transaction costs and enable customers to locate low-cost suppliers. A possible research question then is how companies can develop procurement processes and criteria to decide when to purchase from an electronic market and when to seek the specialized services of a virtual organization.

Second, the partners in the *Virtuelle Fabrik* operated in turbulent environments, meaning that the environment, and in particular the demands of the market, changed more rapidly than the strategies and competencies of the companies could change. In part these changes were endemic, due to increased competition and the companies' strategies of innovation, and in part they were due to participation in the *Virtuelle Fabrik*. Because of the turbulence of the market, it was necessary for these companies to search for new market opportunities where they could apply their competencies and to be able to marshal collections of competencies, including competencies from other firms, in order to satisfy rapidly-emerging market opportunities. Turbulence is characteristic of industries where market demand is uncertain or where technologies are rapidly evolving. Jones et al. [23] have identified demand uncertainty, task complexity, human asset specificity and frequency as factors leading to the need for network governance. Describing Silicon Valley, Saxenian [24] showed how production networks among computer systems companies spread the risks of developing new technologies. Similarly, in the Hollywood film industry, agents provide access for actors to new films [21].

In a more stable environment, where innovation is less critical, some of the activities we have described may well be unnecessary. For example, in Prato, where the production processes are well understood, explicit marshalling of competencies seems to be less necessary. *Impannatore* reportedly do not need to know the details of the production chain; instead, they pick an initial firm, which can in turn place further work. However, we speculate that even in stable environments the processes we have described may be useful. Miles and Snow [25] point out that dynamic networks—likely arenas for competencies rallying—offer firms additional strategic options. Competency rallying makes firms more agile and able to respond quickly to customer requests. Organizations that are practiced at the process we have described should be able to change very rapidly since they are constantly changing anyway. In other words, competency rallying seems to be an important "dynamic capability" [26]. An important research question here is to identify and describe appropriate control mechanisms for firms that are constantly on the edge of instability.

Finally, consideration of the case suggests some important preconditions for its success. For example, the project leaders spent considerable time discussing and refining reward mechanisms for participation in the *Virtuelle Fabrik*. Other factors are not yet fully understood and or under the control of the project leadership. Some of these were implicit in the industrial district and created and reinforced by other means, such as common training, past interactions, etc. Other researchers have documented empirical evidence for such processes in industrial districts such as Prato [20] or the watch industry in Switzerland. In these areas, extensive socialization mechanisms have been developed, for example, professional schools, professional associations, institutions, governance structures and traditions [6]. In other words, while the manufacturing projects undertaken by the *Virtuelle Fabrik* are only short-term, commitment to the *Virtuelle Fabrik* and the industry is long-term. The failure of other networks may be attributable in part to an absence of these factors, which led to suspicion and mistrust among the partners, disinterest and eventual disintegration of the network [27]. Further research might consider what factors are necessary for the success of a cooperative venture such as the *Virtuelle Fabrik*, and how these factors are realized. Many of these factors seem to be regional and specific. Given that information technology makes cooperation possible on a global scale, future research might consider how (or indeed, if) absence of local factors can be overcome and cooperation extended globally.

5 Conclusion

In this paper, we developed a process theory of competency rallying, that is, of *the process of developing and bringing together in temporary cooperation a network of firms with the competencies needed to satisfy a newly identified market opportunity*. Our process theory hypothesizes that competency rallying consists of four related sets of organizational activities, specifically: 1) identification and development of distinctive competencies, 2) identification and facing of short-term market opportunities, 3) marshalling competencies from network partners and 4) a short-term cooperative effort. Some of the basic building blocks of our process theory have been discussed before, but our process theory is novel in the way that it weaves together an external perspective on market-facing with an internal perspective on competency development and marshalling to describe the overall process of competency rallying. The purpose of an action research study such as the one reported here is to guide and inspire new ideas and practices rather than systematically testing existing theories. Our process theory of competency rallying suggests that performance of firms in turbulent environments should be studied by considering both how these firms face the novel market opportunities and how they marshal competencies to attack these opportunities. In doing so we build on research on entrepreneurial behavior of individuals [28] but shift the level of analysis to the organization.

The study of rallying processes advances another existing but so far distinct research stream by generalizing the concept of agility [29] of virtual organizations beyond its origins in the reallocation (or switching) of mainly physical resources [30-32]. While reallocation or switching has been accepted as an important mechanism to achieve agility, our process theory offers a richer description of how it is undertaken. Competency rallying offers an organizational perspective on the reallocation process within a network of firms. As such, it also contributes to research on the concept of dynamic capabilities [26, 33] that sustainable firm performance can be based on the mastering of organizational routines of resource reconfiguration. More specifically our local explanation of competency rallying in turbulent environments, summarized in Figure 1, contributes empiric evidence "that dynamic capabilities are not tautological, vague, and endlessly recursive" [26, p.1116]. It is our hypothesis that competency rallying provides a structured set of common and specific dynamic capabilities that can be observed in other settings, despite the high degree of idiosyncrasy of dynamic capabilities and path-dependency in their emergence.

The extent to which our local explanation of competency rallying in turbulent environments, summarized in Figure 1, develops into a more general theory depends on how well it works in other settings. For example, Crowston and Scozzi [34] successfully used the process theory to analyze cooperation in Open Source Software development projects. One of the first questions for future research is whether or not the process of competency rallying in other settings resembles our model, or whether the model is unique to the *Virtuelle Fabrik.* A possible approach to answering this question is to apply well-known theory-testing techniques. For example, a large-scale survey of networks could be attempted to statistically replicate this model. A problem with this approach is the difficulty of identifying functioning networks, since unlike firms they do not appear in directories with contact addresses, ready to be sampled. Another approach would be a meta-analysis of existing case descriptions of networks, although there are obvious difficulties with this approach also.

For an action research project, it may be more meaningful to ask how the experiences of this project can influence further action. In this sense, replication of the *Virtuelle Fabrik* project is already underway, as other groups are building similar networks in their own regions and industries. One such example can be found in the construction industry in Switzerland. Four other networks in precision machining are operating or planned in the regions around Bern and Basel, Switzerland and Augsburg and Aachen, Germany. One of these groups has already informally reported a significant backlog of orders for the network. These groups have adopted the *Virtuelle Fabrik* processes and, though independent, are working with the *Virtuelle Fabrik* project research team. Clearly, the interest of these groups in replicating the *Virtuelle Fabrik* is an indication of its success in changing peoples' mindsets about the value of such cooperative networks. Their experiences will be a valuable replication of our results.

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About the Authors

Bernhard R. Katzy started his professional career with an apprenticeship as car mechanic and later earned master degrees in electrical engineering and business management. He holds a PhD in industrial management from University of Technology (RWTH) Aachen in Germany and a second Ph.D. (habilitation) in general management and technology management from University of St. Gallen, Switzerland. He currently is professor at the University BW Munich (D) and Leiden University (NL) and director of CeTIM–Center for Technology and Innovation Management. His research interest is about entrepreneurial management of fast growing high-tech firms and the management of strategic change in the transition to the information age.

Kevin Crowston is a Professor in the School of Information Studies at Syracuse University. His research focuses on new ways of organizing made possible by the use of information and communications technology, including in particular virtual teams and organizations. He approaches this issue in several ways: empirical studies of coordination-intensive processes inhuman organizations; theoretical characterizations of coordination problems and alternative methods for managing them; and design and empirical evaluation of new kinds of computer systems to support people working together.

7

Spatial and Temporal Boundaries in Global Teams

Distinguishing Where You Work from When You Work

Jonathon N. Cummings[1], J. Alberto Espinosa[2], and Cynthia K. Pickering[3]
1 Fuqua School of Business, Duke University
jonathon.cummings@duke.edu
2 Kogod School of Business, American University
alberto@american.edu
3 Information Services and Technology Group, Intel Corporation
cynthia.k.pickering@intel.com

Abstract. While spatial boundaries include the geographic differences among team members (different cities), temporal boundaries include the workday differences among team members (different time zones). In global teams members have to deal with both spatial and temporal boundaries since their co-workers are often located in cities within and across time zones. For global team members with high spatial boundaries and low temporal boundaries (those in different cities in the same time zone), synchronous communication technologies such as the telephone and instant messenger provide a means for real-time interaction. However, for global team members with high spatial boundaries and high temporal boundaries (those in different cities in different time zones), asynchronous communication technologies, such as e-mail and web software, provide a way to interact intermittently. Using social network data from 625 team members (representing 5986 pairs) across 137 global teams in a multi-national semiconductor firm, we explore the impact of spatial and temporal boundaries on coordination delay. We also illustrate how member awareness can reduce coordination delay, thus increasing the likelihood of better global team performance.

1 Introduction

A wide range of terms—including distant, proximate, dispersed, collocated, and virtual—evoke the spatial boundaries inherent in distributed work. Global software

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development, information technology offshoring, and just-in-time manufacturing are a few of the business practices that rely on employees in different geographic locations. Spatial boundaries, defined as geographic differences where people are located, are fundamental to the study of distributed work [1]. Prior research has linked an increase in relatively low spatial boundaries (different hallway vs. different floor vs. different building) to a reduction in work outcomes such as task communication [2], collaboration likelihood [3], and teamwork quality [4]. As work continues to become more globally distributed across different cities and countries, spatial boundaries will undoubtedly overlap with temporal boundaries [5]. Temporal boundaries, conceptualized as the amount of non-overlapping work time (8am to 5pm Pacific Standard Time vs. 8am to 5pm Greenwich Mean Time), have the potential to be as disruptive as spatial boundaries. Unfortunately, empirical research has not kept up with theorizing about temporal boundaries in distributed work [6-9].

To illustrate the distinction between spatial boundaries and temporal boundaries, consider a product development team with members split between sites in Northern and Southern California. Though members on the team reside in different geographic locations, they share the same hours in a workday. Thus, if members encounter an urgent problem or need to coordinate their work in real-time, they have access to synchronous communication technologies (the telephone or instant messenger) throughout the workday. Now consider a separate product development team with members split between sites in Northern California and India. Because of the 13.5-hour time difference between sites, members will likely experience a one-day delay in solving their problems and coordinating their work through asynchronous communication technologies (e-mail or web software). In both product development teams, the members encounter high spatial boundaries. However, in the first team, the temporal boundaries are low, while in the second team, they are high. The purpose of this paper is to explore the differential impact of spatial and temporal boundaries on coordination delay and global team performance.

1.1 A Boundary-based Model of Coordination Delay

Coordination has long been considered an important aspect of joint work since people have to manage task dependencies and integrate their work towards a common goal [10-12]. For members working on a project across different sites, coordination is even more critical as it can take longer to resolve issues, clarify communication, and rework tasks [13]. These time lags in coordination, or coordination delay, are costly to organizations due to the additional hours of time spent by project members [14]. Practitioners and academics alike have been optimistic that various communication technologies will be able to help team members overcome distance to coordinate effectively [15-17]. Although there are documented examples of software development teams that successfully "follow-the-sun" and product development teams that do an excellent job of designing in the West (the US, Europe) and producing in the East (India, China), it is unclear if these are exceptions or the norm. Furthermore, the coordination delay issues that global team members face have not been linked to different combinations of spatial and temporal boundaries, and there has not been empirical evidence regarding which communication technologies are best suited for managing these boundaries.

Spatial boundaries, such as being located in a different city from other team members, impact the likelihood of face-to-face contact, spontaneous communication, and shared social settings [18]. It follows that coordination delay should increase with spatial boundaries when informal and unplanned interactions are required [19]. Temporal boundaries, such as being located in a different time zone from other team members, impact the likelihood of synchronous communication, real-time problem solving, and workflow availability [8]. That is, the resulting communication across high temporal boundaries will be largely asynchronous, leading to longer response and issue resolution times. Thus, coordination delay should increase with temporal boundaries since there are fewer overlapping hours within which to work [7]. Global team members who work across spatial and temporal boundaries face even greater consequences for coordination delay. Not only do team members have to work harder to create opportunities for informal interaction, but they also have to be more aware of the work hours of other members. Therefore, we propose that:

Hypothesis 1a: *Holding constant temporal boundaries, an increase in spatial boundaries (same city vs. different city with overlapping workday) will be associated with an increase in coordination delay for pairs of global team members.*

Hypothesis 1b: *Holding constant spatial boundaries, an increase in temporal boundaries (same workday vs. different workday in different cities) will be associated with an increase in coordination delay for pairs of global team members.*

Hypothesis 1c: *An increase in spatial boundaries will be more strongly associated with an increase in coordination delay when there is also an increase in temporal boundaries for pairs of global team members (same city with overlapping workday vs. different city with overlapping workday vs. different city with non-overlapping workday).*

Communication technologies allow team members to communicate at a distant through the use of audio, video, text, graphics, and other features. Researchers have categorized communication technologies according to whether they are used synchronously or asynchronously, as well as whether they are used in the same place or in different places [20, 21]. For example, telephone communication is synchronous and is often used when two people are in different places, while e-mail communication is asynchronous and is often used when two people are in different places. In teams separated by high spatial boundaries, face-to-face communication is not a regular option, given that members are not in the same place. Therefore, members are less likely to bump into one another in the hallway, see each other in the lunchroom, or encounter one another in meetings throughout a workday. As a result, they will have less mutual knowledge about team members in other locations, including contextual information such as work schedules, time commitments, and other task constraints [22]. Opportunities for informal communication, which give team members a chance to update one another on progress and develop mutual knowledge, are more difficult to create. Similarly, synchronous communication, such as talking on the phone, is less likely to occur naturally when team members are spread across spatial boundaries given the need to be available at the same time. Developing common practices for dispersed coordination is difficult, and requires aligning the effort of all parties involved [23]. When team members are in different geographic locations, but have time overlap in their workday, both informal communication and synchronous communication should reduce the likelihood of coordination delay. We hypothesize that:

Hypothesis 2a: *An increase in informal communication will decrease the negative impact of spatial boundaries (different cities) on coordination delay for pairs of global team members who have low temporal boundaries (overlapping workday).*

Hypothesis 2b: *An increase in synchronous communication will decrease the negative impact of spatial boundaries (different cities) on coordination delay for pairs of global team members who have low temporal boundaries (overlapping workday).*

For team members separated by high spatial boundaries and high temporal boundaries, informal communication and synchronous communication are even less likely to happen by chance. One way for members to mitigate this challenge is through active awareness of when others are working (in order to make an early morning or a late-night phone call for example). Through transactive memory, members can build awareness of who is doing what, and try to forecast when interaction is necessary [24, 25]. Team members with greater awareness of other members should be in a better position to connect when needed [26]. An alternative to interaction outside of the typical work day is through asynchronous communication such as email. Research suggests that managers prefer email for a wide range of activities, and it can be used to share information, coordinate work, and create a shared identity for the group [27, 28]. Other technologies, such as WebEx and Groove, allow team members to share a desktop, on which they can save files, leave messages, and interact asynchronously (or synchronously if both people are available at the same time). Given the advantages of member awareness and asynchronous communication, we expect the following:

Hypothesis 3a: *An increase in awareness of when other members are working will decrease the negative impact of spatial boundaries (different cities) on coordination delay for pairs of global team members who have high temporal boundaries (non-overlapping workday).*

Hypothesis 3b: *An increase in asynchronous communication will decrease the negative impact of spatial boundaries (different cities) on coordination delay for pairs of global team members who have high temporal boundaries (non-overlapping workday).*

Finally, we argue that the overall performance of global teams, such as completing work on time, working well within budget, and meeting final product requirements [29], is impacted by the coordination delay among pairs of members. When workflow coordination does not proceed smoothly among members who depend on one another for knowledge and expertise [30], we anticipate that performance will suffer. It follows that:

Hypothesis 4: *An increase in coordination delay for pairs of members will be associated with a decrease in global team performance.*

We test the above hypotheses using survey data from 625 members of 137 global teams in a Fortune 500 corporation. Our boundary-based model of coordination delay is displayed in Figure 1. It summarizes the linkages between spatial and temporal boundaries, coordination delay, and performance. We identify potential moderators of spatial boundaries and coordination delay (informal communication and synchronous communication), as well as temporal boundaries and coordination delay (member awareness and asynchronous communication).

1.2 Analysis Strategy

Given the co-occurrence of spatial boundaries and temporal boundaries in the case of team members spread across the world, we highlight our strategy for analyzing where and when people work. In hypotheses focused solely on spatial boundaries, we hold temporal boundaries constant by examining N=2911 pairs of team members who are in the same time zone (and thus have an overlapping workday). In hypotheses that address temporal boundaries and the difference between an overlapping workday and a non-overlapping workday, we hold spatial boundaries constant by only looking at N=3746 pairs of team members who are in different cities. Finally, for the combination of spatial boundaries and temporal boundaries, we create a 3-pt scale that captures N=5986 pairs of members who are in (1) the same city with overlapping workday, (2) different cities with overlapping workday, and (3) different cities with non-overlapping workday. In our dataset, a traditional statistical interaction is not appropriate because there are no pairs of members in the same city with a non-overlapping workday.

Hierarchical Linear Modeling (HLM) is used to analyze the pairs of team members. HLM takes into account the non-independence of observations, and adjusts the degrees of freedom to account for pairs of members nested within teams (see [31] or [32] for additional discussion about the use of multi-level models). For the analysis of member pairs, coordination delay is the dependent variable, and spatial boundaries (H1a), temporal boundaries (H1b), and spatial and temporal boundaries (H1c) are the independent variables. The moderating variables (following the approach recommended by [33]) include informal communication (H2a), synchronous communication (H2b), member awareness (H3a), and asynchronous communication (H3b). Ordinary Least Squares (OLS) regression is used to analyze the association between coordination delay and team-level performance (H4).

2 Method

2.1 Sample

Participants from a large, semiconductor manufacturing firm were solicited to participate in a study of team effectiveness. Roughly 4,000 randomly sampled managers from several large business units in the company were asked to provide the name of a project they led in the prior 6 months along with the project start/end date and project description. Of these managers, 380 provided project information. Then, the same project managers were asked to complete an online survey that included asking them to add the names of other people on the project, how much communication they had with each person on the project, and how well the project performed. The online survey was dynamic, so once the project manager added people, they were automatically sent an email message inviting them to participate and complete the survey.

Of the managers providing project information, 300 of them provided the names of other people on the project. From the projects, a total of 2,318 names were generated, and 1,311 of them completed the survey, for a response rate of 57%. Out of the completed responses, we distinguish between the 1,039 responses from project managers or project members (the "core" members), and the 272 responses from project advisors, outside experts, stakeholders, or others affiliates (the "non-core" members). For purposes of our analyses, we only examine data from the core members. We reduce the sample further by only including data from 625 respondents (representing 5,986 pairs of core members) who were on a project with at least one other core member who responded. This ensures that we have at least two assessments of team performance by core members.

Respondents in the sample worked in 54 locations across 23 countries (Belgium, Brazil, Canada, China, Costa Rica, Denmark, France, Germany, India, Ireland, Israel, Japan, Malaysia, Mexico, The Philippines, Poland, Russia, Singapore, South Korea, Taiwan, The United Kingdom and the United States). Over half of the respondents were from engineering or IT, and worked on hardware or software projects. The typical project length was over a year and a half. Around 70% of the respondents were male, and the average age was 38 years old. Respondents had, on average, over ten years of industry experience and about five years of experience in the company. We developed survey questions through pilot testing with employees in the company.

2.2 Variables

- *Spatial boundaries.* Survey respondents were asked whether each team member was located in the same room, same hallway, different hallway, different floor, different building, different city, or different country. In cases where data were missing—some respondents did not know where other members were located—we used company database records to determine the location. Because pairs of members in different buildings are always in the same time zone, we used city as the cut-off for spatial boundaries (0=same city, 1=different city), since members in different cities could be in different time zones.

- *Temporal boundaries.* Almost 90% of the sample reported working between 9-11 hours a day, arriving 7-9am local time and departing 5-7pm local time. Therefore, we based the measure of temporal boundaries on the time zone difference between cities where members worked (0 = during a 9 hour workday, there was at least 1 hour of overlap, 1 = during a 9 hour workday, there were no hours of overlap). For example, there are only four time zones in the continental United States, so all pairs of project members there have an overlapping workday. However, for pairs of project members working in the United States and India, the time zone difference is at least 10.5, so they have a non-overlapping workday.
- *Spatial and temporal boundaries.* The extent to which two members are separated by spatial boundaries and temporal boundaries (1=same city with overlapping workday, 2=different city with overlapping workday, 3=different city with non-overlapping workday). As mentioned above, this variable was used because there were not any members located in the same city with a non-overlapping workday.
- *Core size.* The number of core members on the project (project manager and project members).
- *Time shifting.* For the roughly 10% of team members reporting workday hours outside of 7am to 7pm, we created a dummy variable to account for possible shifting of their work time (0=no time shifting, 1=time shifting).
- *Years known.* For each core member, the respondent reported the number of years knowing the other person (1: < than 1 year; 2: 1 to 3 years; 3: 3 to 5 years; 4: 5 to 10 years; 5: more than 10 years).
- *Member interdependence.* Average of a 3-item scale measuring the extent to which team members depended on one another (tasks this person performed were related to tasks I performed, this person depended on me for information or materials needed to complete their work, I could not accomplish my tasks without information or materials from this person; 1: not at all; 3: sometimes; 5: very much). Cronbach's α=0.90
- *Coordination delay.* Average of a 3-item scale measuring the extent to which there were delays in coordination (typically it took a long time to get a response from this person, our communications required frequent clarification, we often had to rework tasks beyond what I would normally expect; 1: disagree; 3: neutral; 5: agree). Cronbach's α=0.79
- *Synchronous communication.* Core members were asked on a 5-pt scale (1: Rarely, 2: Monthly, 3:Bi-weekly, 4: Weekly, 5: Daily) "Please mark how often, during the past six months, you communicated with this person via... (a) Voice Communication (telephone or voice conference). Note that though we collected data on Synchronous Text Communication (instant messenger), we exclude it from our analyses because it was used infrequently.

- *Asynchronous communication.* Core members were asked on a 5-pt scale (1: Rarely, 2: Monthly, 3:Bi-weekly, 4: Weekly, 5: Daily) "Please mark how often, during the past six months, you communicated with this person via... (a) Asynchronous Text Communication (e-mail)."
- *Informal communication.* Core members were asked on a 5-pt scale (1: Rarely, 2: Monthly, 3:Bi-weekly, 4: Weekly, 5: Daily) "Please mark how often, during the past six months, you communicated with this person by phone, electronically, or face-to-face . . . through informal or unplanned encounters."
- *Member awareness.* Core members were asked on a 5-pt scale (1: disagree; 3: neutral; 5: agree) to indicate their awareness of other members with the item "I always knew when and where to find this person."
- *Team performance.* Average of a 3-item scale that asked "Overall, to what extent do you disagree or agree with the following . . . we completed the work on schedule/on-time, we completed the work well within budget, the final product met requirements (1: disagree; 3: neutral; 5: agree)." Cronbach's α=0.81, and Intra-Class Correlation (ICC)=0.19, $p < .01$, indicating that responses within teams were more similar than those between teams, suggesting the team level of analysis is appropriate for this variable.

3 Results

The following two control variables were significantly negatively correlated with coordination delay: years known ($r = -0.14$, $p < .001$) and member interdependence ($r = -0.21$, $p < .001$), and remain significant throughout the HLM models (which are available from the authors). In support of hypothesis 1a, when pairs of members were in the same time zone, there was greater coordination delay for those in different cities compared with those in the same city ($B = 0.11$, $p < .01$). In support of hypothesis 1b, when pairs of members were in different cities, there was greater coordination delay for those with non-overlapping workdays compared with those who had overlapping workdays ($B = 0.12$, $p < .01$). In support of hypothesis 1c, when pairs of members were in different cities and had non-overlapping workdays, there was greater coordination delay than those with an overlapping workday in the same city and those with an overlapping workday in a different city ($B = 0.11$, $p < .01$).

We did not find support for hypotheses 2a or 2b. Informal communication ($p = .66$) and synchronous communication ($p = .38$) did not negatively moderate the relationship between spatial boundaries and coordination delay. In addition, we did not find support for hypotheses 3a or 3b. Member awareness ($B = -0.28$, $p < .01$) and asynchronous communication ($B = -0.23$, $p < .01$) were negatively associated with coordination delay, thought they did not negatively moderate the relationship between temporal boundaries and coordination delay. Rather, there was a positive interaction effect for member awareness ($B = 0.05$, $p < .01$) and asynchronous communication (Email: $B = 0.07$, $p < .01$). This indicates that pairs of members with non-overlapping workdays derived significantly fewer benefits than pairs of members with overlapping workdays who had greater member awareness and asynchronous communication.

Finally, we found support for hypothesis 4. In an OLS model available from the authors, coordination delay was negatively associated with performance at the team level of analysis ($B = -0.31$, $p < .05$). Even after controlling for the same variables used in the HLM models, we did not find a direct relationship between spatial or temporal boundaries and team performance.

4 Discussion

We contribute to the literature on distributed work by conceptually and empirically distinguishing between the impact of spatial boundaries and temporal boundaries on coordination delay in global teams. While years known and member interdependence are generally helpful for reducing coordination delay, there does not appear to be a silver bullet for pairs of members separated by spatial and temporal boundaries. Although we control for the amount of dependence one member has on another member, one possible explanation for lack of interaction effects is that pairs of global team members are engaging in non-communication activities to coordinate their work, such as pre-established schedules, division of labor, and work routines [34]. We also have not examined other factors that prior research has identified as being important for distributed work, such as changes in technology use over time [35-36], conflict among team members [37], general levels of trust [38], and other forms of diversity in global teams [39].

We believe that focusing on pairs of members in global teams can provide insight that aggregating to the team level does not allow. Though members work together as part of a team, much of the work is done alone or with another member. Rarely does an entire global team work on the same task at the same time. Therefore, by disaggregating the team into pairs of members, we are able to better understand what factors predict coordination delay within the team. By further demonstrating that coordination delay is linked to overall team performance, we were able to develop a full model of global team effectiveness that incorporates inputs (spatial and temporal boundaries), processes (coordination delay), and outputs (team performance) [40, 41]. It is important to highlight that spatial and temporal boundaries do not directly affect team performance, but rather they do so indirectly through processes such as coordination delay.

4.1 Limitations and Future Directions

In exploring global teams in a single organization, we limit the generalizability of our results to large, multi-national organizations that have operations in many parts of the world. Smaller companies, or firms with only a few geographic locations, may face other issues not described in this study. We also realize that spatial boundaries could be conceptualized as the number of miles between team members, and temporal boundaries could be conceptualized as the number of time zones between team members. However, in our dataset, the number of miles and number of time zones within pairs of members were correlated r = .95, making a comparison of this alternative conceptualization of boundaries infeasible. We encourage other researchers to look for ways to further tease apart the impact of spatial boundaries and temporal boundaries, for example, by examining teams with members in North America and South America so that the spatial boundaries are greater yet the temporal boundaries are still restricted. In our sample, most team members where either in the same country (separated North-South) or were in different countries (separated East-West).

We also find the issue of time shifting very interesting, even though in our study only about 10% of respondents reported working outside of a typical workday (and it was not associated with coordination delay). In-depth qualitative analyses and field interviews may shed more light on the advantages and disadvantages of working during the middle of the night, or shifting the workday to better overlap with team members in other geographic locations. There may also be cultural differences in how team members in different countries control their use of time, for example, members in the US and India may differ in norms of what is acceptable communication outside of typical business hours. There is also the issue of transportation time, since in Europe it takes much less time to travel from one country to another than it does to travel from the US to a country in Europe. In some parts of the world, members can be in different cities, but have more opportunities to hold face-to-face meetings and discussions at critical points in the global team lifecycle (for example, at the beginning and middle of a project).

Along with exploring differences in spatial and temporal boundaries and how time shifting affects global team effectiveness, there are a number of other avenues for exploring "virtuality." Following the lead of Griffith et al [42] and Kirkman and Mathieu [43], we need to learn more about the extent to which team members are supported in their use of communication technology, as well as how members are supported when they are apart from other members. For example, project managers who travel a lot may have access to different levels of technology (broadband Internet access vs. dial-up Internet access). Similarly, the technical support for communication tools may be greater in some regions of the world than others, depending on the number of employees at a particular site or the resources available to employees. There are certainly an increasing number of technologies available to help team members communicate across space and time, though it may take awhile for them to achieve the critical mass of e-mail and the telephone.

4.2 Managerial and Technological Implications

There are many ways to manage a global team. Our results suggest that the use of communication technology with team members who are spread across spatial and temporal boundaries provides limited help with the problem of coordination delay (with the exception of email). Other aspects of the working relationship, such as how long members have known one another and how aware they are of when and where others are working, can be beneficial for reducing coordination delay. While member awareness can be encouraged, team members who have just met on the team for the first time will need additional support for building relationships.

Interestingly, the more members depend on one another, the less likely there is to be coordination delay, which suggests that team members with greater interdependencies can become more effective at working out problems. However, even with an increase in all of the above factors, the impact of spatial and temporal boundaries on coordination delay *does not disappear.* The findings from the interaction effect of member awareness and asynchronous communication on temporal boundaries also suggest an unintended consequence: pairs of members with fewer temporal boundaries benefit from awareness and asynchronous communication significantly more than pairs of members with greater temporal boundaries. To reduce coordination delay, managers might consider including members on global teams who have at least some overlap in their workday (for example, for team members in the US and India, having members in Europe who can help coordinate workflow).

While many technological tools are available to team members, they each require an investment of time and effort to learn the features, in addition to making sure other members are also using the tools. Certainly e-mail and the telephone are preferred in many situations, but we believe the next generation of tools will help teams coordinate their work without relying so heavily on communication. Training team members to better partition work, plan for dependencies in the task, and synchronize the hand-off of individual pieces will facilitate work when members do not have overlapping workdays, but need to be involved in the project together. Technology that helps with task organization, rather than simply communication, should enable global teams affected by spatial and temporal boundaries to overcome coordination delays. Explicitly embedding information about when and where people are working on a global team is a step in the right direction.

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About the Authors

Jonathon Cummings is an Associate Professor at Duke University's Fuqua School of Business. His current research focuses on social networks and teams in organizations, and the role of knowledge sharing in work distributed across different geographic locations.

Alberto Espinosa is an Assistant Professor of Information Technology and UPS Scholar at the Kogod School of Business at American University in Washington DC. His current research focuses on understanding how technical teams bridge geographic boundaries to coordinate their work and achieve high levels of performance.

Cynthia Pickering is an Intel Principal Engineer with the IT Innovation and Research group. She is director of the IT Collaboration Research Lab, called Collaboratory, based in Chandler Arizona. The Collaboratory has a primary focus on global team collaboration: comprehending people, process, and technology interdependencies. Cindy's research combines needs assessment, new concept development, emerging usage models definition, and enabling architecture and technologies exploration.

8

Coordinating Global Software Development Activities

Requisite Variety in Information Systems as a Dependent Variable

Gambel O. Wiredu
Univeristy of Limerick
Limerick, Ireland

Abstract. In this paper, I explain how globally distributed software development subunits can coordinate their activities with information systems (IS). The basis of this explanation lies in the contemporary proliferation of global software development (GSD) activities that suggests an unexplained reality: organizations practicing GSD are somehow regulating their IS to cope with increasing and varied uncertainties. Through an empirical example of an organization's subunit's regulating and coping, I make the case that requisite variety in a subunit's information systems is a dependent variable for managing uncertainties leading to optimal coordination. In this example, I show varied uncertainties that faced the subunit, and I explain how variety in its information system was requisite for managing the uncertainties satisfactorily. Based on these explanations, I suggest four characteristics of variety in IS that will be requisite for managing uncertainties in GSD: developers' agility; developers' continuity and traveling; high frequency of communications; and varied communication modes and technologies.

1 Introduction

It is well known that the increased virtuality of global software development (GSD)–exemplified in the global-distribution of developers, of development processes, of information and of technology–induces new organizational challenges [1, 2, 3, 4, 5, 6, 7]. Usually, this knowledge is derived from comparisons with collocated software development in which resources are not distributed. Thus, although virtual communications are implicit in any modern software development

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activity, virtuality becomes more pronounced in the face of distribution that engenders spatial and temporal distances.

In software development, as in many other types of work, interdependencies can engender uncertainties [8, p. 565, 9], and uncertainties can undermine interdependencies. This is often the case in GSD in which developers in different locations depend on each other mainly for information because "uncertainties" is, fundamentally, a characteristic of information. Managing uncertainties is, therefore, essential for managing interdependencies; and coordinating GSD activities is, fundamentally, an information processing exercise aimed at managing uncertainties.

New coordination challenges in GSD are implied in the intuition that greater technology-based information processors, due to the pervasiveness of advanced communication technologies, are increasing and varying uncertainties that ironically need more behavior-based information processors for coordination. In other words, software development, an epitome of research and development (R&D), is uncertain and complex enough, wanting for more organismic or behavior-based information processing [10, 11, 12, 13]; yet more software organizations are drawing upon technology-based information processors to globally-distribute their software development activities [1, 7].

This trend constitutes a puzzle that raises awareness to the unexplained reality that many software organizations' subunits are regulating their information systems (IS) to cope with increasing uncertainties that accompany development tasks and their global-distribution. It also suggests that in spite of increased mechanization of information processors through virtualization of GSD, such subunits are somehow able to blend technology-based mechanisms with behavior-based processors to deal with uncertainties within and without development subunits. How do they do these? Stated differently, how do globally distributed subunits make their information systems more capable of coordinating their GSD activities? How they accomplish these is yet unexplained in the IS development literature, hence the puzzle. This paper aims to demystify this puzzle by showing that matching varied uncertainties facing a GSD subunit with varied IS is essential for coordinating activities. I show how Gamma[1] (a subunit of a multinational information technology organization) matched the varied uncertainties facing it with its varied IS to coordinate its activities optimally.

Although a concise definition of an information system has not yet been settled upon by scholars of the IS field [14, 15], there is general agreement within the field that an information system is not just a technical system but rather an interactive and teleological relationship between hardware, software, information, people, and communications – that is, between a technical and a social system [16, 17]. Lee's [17, p. 11] description of this relationship, in particular, is lucid:

> In addition to the information technology comprising the technical system, there is also the organization comprising the social system. Just as there are information requirements

[1] A pseudonym. All names related to the empirical example have been disguised to hide the identity of the organization.

> that the social system poses to the technical system, there are organization requirements that the technical system poses to the social system. . . .
>
> Once the technical system is designed and implemented so as to provide the information required by the social system, the technical system itself would be changed, where the change would then trigger new and different organization requirements for the social system to satisfy. Then, once the social system is designed and implemented as to deliver the organization required by the technical system, the social system itself would be changed, where the change would then trigger new and different information requirements for the technical system to satisfy. These mutually and iterative transformational interactions can be expected to continue without end. Hence whatever results from them is not determinate but emergent.

Using Lee's description interactions, between the various technologies, types of information, modes of communications, and types of developers, denote the IS in Gamma's GSD activities. Based on this denotation, I provide explanations of how varied uncertainties in Gamma's activities were managed by its varied information system with the aim of espousing the idea that a major dependent variable for optimal coordination of GSD activities is requisite variety in information systems.

According to the law of requisite variety "the variety within a system must be at least as great as the environmental variety against which it is attempting to regulate itself" [18, p. 495]. This implies that the variety in IS in a subunit must at least be regulated to match the variety in uncertainties in its internal and external environment. The basis for matching lies in managing IS' capacity to sense, register and respond to the subunit's environment accurately [19, pp. 188-193]. Thus, the requisite variety in IS subsumes their optimal technology-based and behavior-based capacities for dealing with varied information processing requirements within and without the subunit's environment [20, 12, 9]. To avoid an axiomatic treatment of requisite variety [21, p. 307], I premise my explanations on evidence of its characterization of Gamma's IS. Then, I use my explanations to discuss characteristics of requisite variety in information systems and associated coordination functions in GSD. This paper contributes to filling a gap in our understanding of the relationship between coordination challenges in GSD and information systems requirements.

2 Uncertainties, Information Processing, and Coordination

Organizational research literature is replete with constructs of coordination that espouse insights about the problem notably in terms of dependencies [22], interdependencies [23, 19], uncertainties [24, 25, 13] and mechanisms [26]. In spite of the diversity of these insights, coordination can be perceived from two broad perspectives—*processes* and *mechanisms* that are used to manage uncertainties and interdependencies.

Coordination processes denote the pure human and non-physical arrangements and actions. They are conceptualized as "coordination by feedback" by March and Simon [27] and as "coordination by mutual adjustment" by Thompson [23]. Coordination mechanisms are the reified, standardized or crystallized versions of the processes, and they are conceptualized as "coordination by programming" by March and Simon [27] and "coordination by plan" or "coordination by standardization" by Thompson [23].

Mechanisms are formalized, impersonalized, and standardized versions of processes in the form of "pre-established plans, schedules, forecasts, formalized rules, policies and procedures, and standardized information and communication systems" [13, p. 323]. This suggests that coordination processes and mechanisms are closely interrelated because repetitive and recurring processes can easily be transformed into mechanisms while the breakdown of mechanisms leads to the reformulation of new processes or the amendment of old ones. The manifestations of these transformations and reformulations would reflect the varied uncertainties confronting an organization or its subunit.

Tushman and Nadler [9] argue that uncertainties in an organizational subunit come from three main sources: the subunit's task characteristics, its task environment, and the task interdependencies between itself and other subunits in the organization. They proposed that information processing, "the gathering, interpreting and synthesis of information in the context of organizational decision making" (614), is the means for managing uncertainties. Their emphasis on task-related or work-related sources of internal and external uncertainty suggests that the nature of work (analyzability and variety) and how it is affected by environmental factors (internal and external) are determinants of the nature of information processing and hence of coordination [see also 28, 29, 12, 30].

Task variety refers to the amount and frequency of exceptional events in work while analyzability refers to the amount of exceptional actions and of time required by workers to deal with work exceptions. Thus, tasks which are characterized by low analyzability and high variety would engender greater uncertainties, and therefore require more behavior-based information processing (human-based communications) while highly analyzable and lowly variable tasks would engender less uncertainties and require more technology-based information processing. Software development, an epitome of R&D, is characterized by low analyzability and high variety, as witnessed in the high emphasis on teamwork, high reliance on developers' intellect, less routineness, and high degrees of coordination by feedback and by mutual adjustment. This signifies that the sources of task uncertainties would be greater and, perhaps, more diverse in software development [10, 12].

The task environment of software development is also a source of task uncertainty because it is an area that lies outside the control domain of the software development subunit. Customers' requirements and feedback on prototypes as well as requirements for integration of a final product into a bigger application are typical sources of task-environmental uncertainties. The more dynamic the task environment, the greater and more diverse the uncertainties faced by the development unit.

Closely related to the task environment are inter-unit interdependencies that constitute another source of uncertainties because an organizational subunit's software development outcome normally has to be integrated into a larger application. Because other units' development outcomes also have to be integrated into the application, inter-unit interdependencies are pervasive [12]. When the focal software development subunit depends on other subunits to get work done, the greater the degree of instability on the part of the other units the greater and more diverse will be the degree of task uncertainties.

This understanding of the nature of software development uncertainties, based on Tushman and Nadler suggests that a subunit's task characteristics, its environment and inter-unit interdependencies are all predominant sources of uncertainties in software development. Against this backdrop, Tushman and Nadler proposed "as work-related uncertainty increases, so does the need for increased amounts of information, and thus the need for increased information processing capacity" [9, p. 616]. Furthermore, they argued in harmony with Perrow [29], Van de Ven and colleagues [30, 13] and Daft and McIntosh [28] that greater work-related uncertainties required more organismic or behavior-based coordination modes, as compared with a less work-related uncertainties scenario in which mechanistic or technology-based modes of information processing and coordination would suffice.

The problem with the logic behind the need for more behavior-based coordination modes seems to contradict the reality of GSD because GSD organizing largely displaces the behavior-based information processing required for dealing with increased work-related uncertainties. For example, research on distributed organizing in general and GSD in particular is replete with distribution-related and virtuality-related problems such as inadequate mutual knowledge [31, 32, 33], attribution errors [34, 35], mistrust [36, 37], and ethnocentrism [38], to mention the most notable. The manifestation of any of such human-centered problems in a GSD activity is likely to worsen uncertainties because it will engender conflicts and undermine interdependencies between distributed team members. These problems, nonetheless, allude to a fourth source of uncertainties–*intra-unit (cross-site) interdependencies*–and confirm the logic that greater and more varied uncertainties are prevalent in GSD.

In spite of these, distributed organizing and GSD are proliferating [39, 1, 7]. Given this contradiction between existing logic and the reality, one can believe that in spite of increased and varied uncertainties, GSD subunits are somehow managing them satisfactorily. In other words, even though more technical systems are deployed to support social systems' information requirements [17], the organizing requirements that technical systems pose to social systems are being managed somehow.

The theoretical challenge facing GSD research, however, is that this belief is yet unjustified in terms of nuanced analyses of how the increased and varied uncertainties in GSD activities are being managed satisfactorily. In short, the global-distribution or increased virtualization of software development embodies a puzzle. This paper aims to demystify the puzzle. Through my analysis of the Gamma case, I provide explanations of how requisite variety in IS facilitates the management of increased and diverse uncertainties in GSD. It is hoped these explanations, will contribute to demystifying the puzzle and justifying the belief.

3 Research Setting and Methods

From early March to early September 2006, Gamma, a globally distributed team or subunit within Bork (a multinational information technology organization) upgraded a data mining application (also called Gamma) for remote data collection from its customers' servers. This application contributed to the broader application, Supporter, that at the business or organization level, was aimed at supporting Bork's services to its customers. Several other subunits in Bork, called Release Partners (RPs), were involved in Supporter development, and together they constituted a bigger meta-unit called GammaServ.

Bork aimed to reduce the cost of warranty on its hardware products–4% of 2005 revenue was put in the pot for warranty. Thus, driving down warranty cost was a priority, and supply chain cost and delivery costs had to be managed in this cost reduction. It was hoped that this cost reduction would be achieved through remote connectivity in which automated proactive data mining and diagnosing will manifest in customers' servers. It was also hoped that cost reduction would be achieved by relying on Bork's expertise around the world and on information technology to develop software. Such reliance manifested in the composition of globally-distributed teams in GammaServ with the expectation that developers would engage in both intra-team and inter-team technology-mediated communications to accomplish their tasks.

Gamma was made up of twelve engineers headed by the project manager (PM). Three developers and one Architect were based in Kerry, Ireland. One support person and one developer were based in Watertown, South Dakota (SD), USA. The Technical Lead (TL) and four developers were in Bloomington, SD, and one product release manager was based in San Francisco, California, USA. All twelve engineers reported to the PM who was also based in Kerry in the same work area with the other four. Also, all twelve had been working as part of the Gamma team on earlier versions of Gamma before my empirical study. In April 2004, the team was formed specifically to develop the Gamma application. Thus, during the period of my study, all its engineers had been working together since the team's inception.

The time difference between Kerry and SD is 7 hours, thus there were few overlapping hours of work between the two locations. Gamma's very frequent project meetings were usually held between 3.30pm and 6.00pm Kerry time. When the PM had to interact with SD developers, he usually worked from home (late in the Kerry day) to make use of more overlapping hours. The SD developers were more experienced in developing remote connectivity applications and in agile development than the Kerry developers.

With theory development in mind [40, 41], I adopted an inductive and interpretive approach to my empirical study and analysis. My empirical study focused on understanding how GSD activities are coordinated in the face of uncertainties that are engendered by increased virtualization. I aimed to collect qualitative evidence on the various uncertainties facing Gamma development and ascertain how the subunit managed these uncertainties through its information systems. Because this study was idiographic and required an in-depth analysis [42], it was necessary for me to produce qualitative evidence. That is, the continuity and richness of qualitative evidence was deemed crucial to the validity of the study outcome.

Thus, I collected data through observations (or silent participations) in virtual meetings conducted by the Gamma team, through document and e-mail analyses, through short conversations, and through one long face-to-face meeting with the PM. All the evidence was collected at the Kerry site for the entire application upgrade period (approximately six months). The long face-to-face meeting came first, followed by all of the document analyses, observations, and short conversations concurrently in twenty days out of the six months. These methods were mutually complementary and contributed to collection of rich qualitative data.

3.1 Varied Uncertainties Facing Gamma Development

Note that although these empirical results are categorized under sub-headings to make reading easier, in reality they are less categorical and even overlapping.

Task Characteristics: Gamma development was characterized by complexity, that is, by low analyzability and high variety. On the one hand it was characterized by high variety and a high degree of exceptions and non-routineness, which is attributable to the iterative nature of the software development process. On the other hand, Gamma development was lowly analyzable because developers needed more thinking time and had to depend on the Bloomington developers who had greater experience in remote connectivity applications development. The Gamma team also had to collaborate collectively, in pairs, in threesomes, and so on, to be able to deal with the exceptional character of Gamma. Typical of people working on a R&D task, Gamma developers were usually uncertain about knowable outcomes of the non-routine development process, signifying complexity [8, 13].

Task Environment and inter-unit interdependencies: The PM witnessed that one source of the unstable task environment facing Gamma was the continuous changes in customers' demands. Such changes continuously induced changes in business requirements, and this affected Gamma as well as other RPs because such requirements served as inputs for development. As the PM stated, "business requirements baselines are changing continuously in Bork." This unstableness in business requirements further engendered problems in Gamma's interdependent relations with its RPs. Thus, Gamma's inability to predict the changes in the state of business requirements was a typical instance of task-environmental uncertainty; and this translated into uncertainties in inter-unit interdependencies.

According to the PM, inter-unit interdependencies:

> between Gamma and release partners (RPs) [was] not that good; each partner [had] a different motive; commitment from them [was] not certain; engagement with them [was] continuous but the business requirements [could] be changed by a RP arbitrarily; there [was] competition for shared resources by RPs; interdependencies [were] not smooth at all.

It is also interesting to note that these release partners were operating from locations such as India, Brussels, parts of the USA outside of South Dakota, and Britain. The spatial and temporal distances between them worsened the unsmooth interdependencies between Gamma and its RPs. Unsmooth inter-unit interdependencies constituted an instance of unstableness (uncertainties) in the source of inputs for Gamma development: the developers' coding had to align with other RPs' coding to facilitate smooth integration of their efforts to make Supporter a success.

A significant variation that was related to constantly changing requirements in Gamma concerned the highly critical nature of eleventh-hour changed requirements. In the early days of development, changing requirements were easier to deal with because there were enough time resources at developers' disposal. On the contrary, when the release was approaching, it was more difficult to deal with changing requirements because of the obvious time limitation. This means that the uncertainty engendered by the changing requirements for Gamma development was more critical when the release was approaching.

Intra-unit Interdependencies: Exceptional actions in resolving Gamma problems manifested in intra-unit interdependencies as witnessed in the numerous one-to-one, one-to-many and many-to-many communications (for example, teleconferences) among Gamma developers. Intra-unit interdependencies that occurred between Kerry and Bloomington developers were predominant because of the differences in experience between both sets of developers and because each developer was working on some specific component that was interlinked with what others were doing. This difference and need for continuous mutual awareness, combined with spatial and temporal distance between these sets, translated into continuous uncertainties on the part of both sets of developers.

In view of these varied uncertainties facing Gamma, the key question is: to what extent was its information system varied, and how requisite was this variety for managing the uncertainties?

3.2 Explanations for Requisite Variety in Gamma's IS

Uncertainties engendered by task characteristics required more collective thinking time and dealing with higher levels of developer expertise. Gamma's response to collective thinking time requirements was to draw on the 7-hour time difference between Kerry and SD to engage in serial analyses of particular problems. The following scenario reflected serial analysis. Kerry developers would work on aspects of the problem while SD developers would be sleeping. When Kerry developers closed from work, SD developers would take over actions on the problem. Then Kerry developers would go to sleep and return to the problem the next day. This continued until the problem was resolved. Thus, the needed time to deal with exceptional actions was enhanced by the temporal distance between Kerry and SD because it facilitated continuous actions on lowly analyzable and highly variable problems. The so-called round-the-clock or follow-the-sun development [39] was in typical display in such scenarios.

Since the source of task uncertainties engendered by inter-unit interdependencies was external. To deal with them required high agility on the parts of Gamma developers. The PM's witness corroborated my observation that developers' response was in drawing upon their agility to deal with these variations. This increase was largely facilitated by the Bloomington developers who were more experienced in agile development. Although Bork's regulations demanded Gamma's adoption of formal methods that entailed less operational costs, Gamma's challenges, and its capacities for agile development within operational cost limits was crucial for dealing with such uncertainties.

Although the increasing criticality of frequently changed requirements close to release time required high agility levels, the challenge also required high degrees of mutual understanding between Gamma's distributed developers. In this respect, the developers' continuous relationship building, since the beginning of Gamma development, had resulted in high mutual understanding, which they exhibited to deal with eleventh-hour changed requirements. Only two Bloomington developers had met the Kerry developers face-to-face, so relationship building, mainly within technology-mediated communications, was the foundation for developing this mutual understanding. Developing mutual understanding is essentially a learning process. For example, the PM lamented about "guys making assumptions" in the early days of the project; and the three Kerry developers added later that they had learned continuously about the preferences of Bloomington developers.

In instances where higher levels of development knowledge were required from remote experts in other Bork subunits, Gamma developers relied mainly on e-mailing, telephone calling, and/or instant messaging to source knowledge to deal with the lowly analyzable problems. The communication mode depended on the nature of the problem and the explicitness of the information required. Typically, developers used instant messaging for very short queries, they used telephone calling for queries that required more time for interactions, and they used e-mailing when the explicitness of the expert's response demanded a corresponding explicit query.

Uncertainties engendered by intra-unit interdependencies required more frequent technology-mediated interactions between the sites. Gamma developers, thus, relied heavily on technology-mediated communications to achieve mutual awareness of the state of the task at all times. Very frequent teleconferencing by all Gamma developers (including the PM), conducted in virtual rooms with desktop sharing and instant messaging, were the predominant mode of such communications. This was complemented by e-mailing, telephone calling, and instant messaging. These communication modes were applied in various times to match parameters such as the detail of information needed; the reckoned length of the communication; whether the communicator wanted the communication to be obtrusive or unobtrusive; the necessary number of people who needed to get the information being communicated; whether the information needed to be stored or not; and whether the communicated issue required an immediate or delayed response.

Teleconferencing was predominantly used because it supported rapid notification of changing requirements, mutual awareness of others' tasks, reduced information overload, and reduced communication redundancy.

The varied measures and facilities that dealt with varieties in uncertainties are distilled partially to show varieties in people, information, technology, and communications–the parts that define the interactive and teleological relationships of Gamma's IS (see Table 2). The presumption underlying this distillation is that variety in each of the parts signifies variety in the information systems they constitute.

Table 1. Various characteristics of communications, information, and technologies

	Obtrusive	Unobtrusive	Persistent	Ephemeral	Asynchronous	Synchronous
One-to-one	• Telephone • IM	• e-mail	• e-mail	• Telephone • IM	• e-mail	• Telephone • IM
Broadcast	• Instant Messenger (IM)	• Teleconference • e-mail • Bugzilla	• e-mail • Bugzilla (bug management e-mail)	• Teleconference • IM	• e-mail • Bugzilla	• Teleconference • IM
Unobtrusive			• e-mail • Bugzilla	• Teleconference	• e-mail • Bugzilla	• Teleconference
Obtrusive				• IM • Telephone		• Telephone • IM
Persistent					• e-mail • Bugzilla	
Ephemeral						• Telephone • IM • Teleconference

Varieties in people were reflected in three main capacities. First, the Bloomington developers' greater remote connectivity application development experience and greater experience in agile development proved invaluable in dealing with the high degree of exceptional actions requirements that were associated with the low analyzability characteristic of Gamma development. In particular, the experience in agile development was invaluable in dealing with exceptional actions demands that were associated with continuously changing business requirements. Second, variations in people was also exemplified by the developers' continuous relationship building and mutual learning leading to high degrees of mutual understanding over time. Note that continuous relationship building was achieved mainly through technology-mediated learning, and this facilitated their handling of the highly critical requirements change when release was looming large. Third, traveling across the Atlantic even by few engineers was very important both for sustaining high levels of understanding in cross-site interactions and for enhancing team cohesion and collective decision-making.

Varieties in communications were signified by the different communication modes adopted by Gamma developers to facilitate, for instance, their agility. Because variations in communication modes embody variations in people, information and technology, a complete distillation is an almost impossible task. Thus, much of my explanations of varieties in communications and the parameters underlying those varieties would apply to varieties in information, technology and people implicitly. In Gamma development, I discerned four main parameters that defined the varieties in technologies: synchronicity, obtrusiveness, information exchange mode, and information life. Synchronicity is about whether or not communication is concurrent in terms or sending and receiving information. Obtrusiveness is about whether or not communication prompts (aurally and/or visually) the interlocutor about the arrival of information. Exchange mode is about whether communication is one-to-one or broadcast. Information life is about whether information exchanged is persistent or ephemeral. Examinations of each of these parameters with each other produce six 2-by-2 matrices (see Table 1) that help in explicating the characteristics of variations in communications, information and technology used by Gamma for dealing with uncertainties.

The matrices plus the varieties in people's capacities are matched against the varied uncertainties facing Gamma to develop Table 2 which is a precursor to the explanations of requisite variety in IS in the following section.

Table 2: How varied information systems matched varied uncertainties in the internal and external environment

		Uncertainties facing Gamma		
Information Systems Requirements		**Task Characteristics** Task variety Immediacy of query response Availability of interlocutor Traceability of communication Spontaneity of communication Formality of communication	**Task Environment and inter-unit interdependencies** Changing requirements Eleventh-hour requirements	**Intra-unit (cross-site) interdependencies** Varying Communication preferences Mutuality of awareness and knowledge Mutuality of understanding
Part	**Variety**			
People	**Agility and experience**	• Agility and experience address task variety	• Experience increases expectation; agility facilitates resolution of changing requirements • Experience increases expectation; agility facilitates resolution of 11th-hour requirements	
	Continuity and learning	• Continuity and learning increase informal interactions	• Continuity and learning enhances collective agility •Learning enhances more efficient and effective ways of resolving 11th-hour requirements	• Awareness of others' communication preferences • Continuity and learning facilitate mutual understanding through relationship development

Table 2 Continued: How varied information systems matched varied uncertainties in the internal and external environment

Communication Mode (including information and technology)	**Teleconferencing** • Synchronous • Ephemeral • Broadcast • Unobtrusive	• Clarifies task variety • Facilitates immediate response to queries • Induces informal communications • Induces informal interactions	• Facilitates notification and collective discussions to resolve changing requirements • Facilitates task allocations to resolve 11th-hour requirements	• Also has instant messaging, and document sharing and editing facility that facilitates various communication modes • Facilitates task verifications • Brings all engineers to the 'same page' more efficiently
	Normal e-mailing • Asynchronous • Persistent • 1 – 1 and broadcast	• Clarifies task variety • Facilitates problem solving that requires delayed responses • Addresses non-availability of interlocutor • Facilitates traceable communications • Facilitates formal communications	• Supports broadcast of teleconferences scheduled to resolve changing requirements • Facilitates task allocations for resolving 11th-hour requirements in the absence of teleconferencing	• Facilitates mutual awareness at both personal and collective levels • Brings all engineers to the 'same page' less effectively
	Bug management e-mailing (Bugzilla) • Asynchronous • Persistent • Broadcast • Unobtrusive	• Task variety: Broadcasts new bugs, priorities, severities, and assignments • Addresses non-availability of interlocutor • Facilitates traceability • Facilitates formal interactions		• Facilitates mutual awareness of bug fixing, priorities, severities and assignments • Formalizes bug-related information through categorizations; facilitates sorting by categories
	Instant messaging • synchronous • ephemeral 1 – 1 and broadcast • Obtrusive	• Facilitates immediate response • Notifies availability • Potentially facilitates traceable communication • Facilitates spontaneous communications		• Facilitates personal-level mutual awareness • Facilitates personal-level mutual understanding
	Telephone calling • Synchronous • Ephemeral • 1 – 1 • Obtrusive	• Facilitates immediate responses to queries • Facilitates spontaneous communications		Facilitates personal-level mutual awareness Facilitates personal-level mutual understanding

4 Discussion

How can globally distributed subunits make their information systems more capable of coordinating their GSD activities? I discuss answers to this question by evoking, from the above explanations, four characteristics of variety in IS and associated coordination functions that depict their requisite coordination capabilities in GSD environments (see summary in Table 3.

First the *agility of developers* would always ready them for dealing with uncertainties that are engendered by continuously changing requirements and by eleventh-hour changed requirements that are critical. Developers are integral in the social system of a globally distributed subunit's information systems, and their agility will facilitate information systems' responsiveness to such uncertainties. Gamma had an agile capacity because it was constituted by a globally distributed team of developers most of whom were experienced in agile software development. However, bearing in mind that Bork was a large multinational organization that was bent on reducing costs by insisting on formal methods, Gamma developers' agility was not absolute. Rather, agility was exhibited amid the discipline in Bork's required formalisms such as adherence to plans and processes that were key to the organization's cost-reduction strategy. In short, agile development must be balanced with the required discipline [43] to achieve responsiveness to customers' changing requirements and organizational formal requirements.

Second, the *continuity of developers*, in the same development team over a long period, coupled with developers' traveling across sites is fundamental for their mutual learning and understanding and to their relationship building. Mutual understanding is crucial in the GSD context where communications aimed at problem resolutions are technology-mediated. Technology-mediation normally slows down mutual understanding between people, and the process takes a relatively longer period to manifest satisfactorily. Thus longevity of developers in a GSD team will help in achieving high degrees of mutual understanding needed, especially when dealing with eleventh-hour changed requirements. Furthermore, high degrees of mutual understanding will continuously ease communications between distributed developers and enhance their agility, and hence increase the social system's capacity for responding to problems through technology-mediated interactions. Together, these are essential to information systems' capacity for responsiveness to emergent and eleventh-hour requirements.

Third, *high frequency of communications* by distributed developers is necessary for continuous mutual awareness. On the presumption that distributed developers will use various modes of communications to match various contexts and information needs, high frequency of technology-mediated communications will facilitate information systems' accurate sensing of its environment. Accurate sensing is the basis for accurate registration and responsiveness, and these capabilities of a subunit's information systems are particularly necessary when dealing with intra-unit uncertainties between globally distributed developers. The high frequency of communications between Gamma's distributed developers contributed significantly to continuous mutual awareness and responsiveness in the subunit.

Fourth, *varied technologies and communication modes* that will facilitate all obtrusive/unobtrusive communications, broadcast/one-to-one communications, synchronous/asynchronous responses, and/or persistent/ephemeral information are necessary for two main reasons: they represent flexibility in technical systems of information systems, a flexibility in technical systems will enhance developers' (social systems') natural flexibility, and make information systems more capable of sensing and registering accurately the subunit's internal and external environments. In Gamma, these varieties were clearly manifest, and they helped the developers obtain the right information in the right format from SD and elsewhere.

Table 3. Characteristics of IS variety and their coordination modes

Characteristic of IS variety in GSD	Coordination function
Agility of developers	Responsiveness to changing requirements and eleventh-hour changed requirements
Continuity of developers	Facilitates developers' relationship building and enhances their agility
High frequency of communications	Accurate registration of task variations in the internal subunit environment
High variety in technologies and communication modes	Accurate registration of variations in technology preferences in the internal and external environment

4.1 Implications

The preceding analysis and discussion show that the variety in Gamma's IS was requisite for matching the varieties in uncertainties in its internal and external environment. They also show the predominance of uncertainties borne of intra-unit (cross-site) interdependence. Their predominance obviously reflects the fact that distance (spatial and temporal) does matter [44]. Interestingly, most of the literature on information processing in R&D does not give any significant consideration to intra-unit interdependencies because previous research has largely dealt with collocated R&D [10, 45, 46, 9]. For example, Tushman and Nadler's [9] very notable information processing model suggests subunit task characteristics, subunit task environment, and inter-unit interdependencies as sources of uncertainties. However, as my explanations in this paper show, it is important to regard intra-unit interdependencies as a main source of uncertainty in GSD and integrate it into their model. Giving regard to this source of uncertainty will make information processing theory more relevant and valuable for analysis of information processing in distributed R&D activities.

One feature of Gamma that distinguishes it from other GSD teams discussed in the mainstream GSD literature is the insignificant cultural differences between Kerry and SD developers as the two sets largely shared the English language and Western values. In the mainstream literature, most GSD teams are constituted by globally distributed developers who have perceived significant cultural differences. There are arguments about what specifically constitutes culture, which is typical in the low-paradigm sociology and psychology fields, and these will undoubtedly affect any discussion of culture. Nevertheless, my analysis and discussion of the usefulness of continuity of developers and mutual learning and understanding for relationship building is applicable to GSD teams with significant cultural differences among distributed developers. It is applicable in the sense that such relationship building processes have to be accentuated in such contexts to reduce uncertainties and conflicts.

The discussion also suggests that other uncertainty-related problems apart from socio-cultural differences in the virtualization of software development through global-distribution can be more dominant. Many socio-cultural problems have been talked about in the GSD literature [1, 4, 7]. Therefore, this discussion brings to ongoing research on GSD the instance of constantly changing requirements from globally distributed release partners as a dominant source of uncertainties. It also confirms two issues about agile development that are being increasingly advocated for GSD by some researchers [47, 48]. First, it is a dependable source of managing uncertainties related to constantly changing requirements because it enhances learning. And second, since the total agility of a subunit depends on continuity of developers and soundly built relationships, it may not satisfactorily manifest in subunits where relationships are not soundly built or are slower to build (for example, when socio-cultural differences are more dominant).

There is, nonetheless, a caveat in the generalizability of requisite IS variety that pertains to the fact that Gamma was a subunit of a large multinational organization. Thus, the nature of uncertainties and hence of information systems in small- and medium-sized enterprise (SME) would, most likely, exhibit different characteristics and functions. For example, SMEs are less likely to afford the variety of technologies that Gamma could afford. They are also less likely to retain staff to enjoy the economies of continuity. Contrarily, developers in SME's are likely to exhibit or embrace greater agility because they are, naturally, more flexible than large multinational organizations. My theorization of requisite information systems variety is, therefore, more applicable to globally-distributed subunits in large software organizations. However, aspects of the characteristics and functions will be useful to smaller organizations.

5 Conclusion

The purpose of this paper was to conceptualize how and why requisite IS variety constitutes a dependent variable for coordinating GSD activities. In the steps to achieve this purpose, and in my aim to avoid treating requisite variety as an axiom, I have shown that global distribution of Gamma's software development activities entailed a variety of uncertainties, that these uncertainties required variety in information systems to manage, and that Gamma's information system entailed the requisite variety. Beyond these steps, I have also shown four characteristics of variety in an IS that are requisite for managing uncertainties in GSD activities, and have drawn a few theoretical and practical implications from these characteristics. This is just one explanation of how subunits can make their information systems more capable of managing varied uncertainties. Future research in this area will be needed to fully justify the belief that satisfactory management of uncertainties in GSD is a reality and a significant cause of GSD proliferation these days.

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About the Author

Gamel O. Wiredu holds M.Sc. and Ph.D. degrees in Information Systems from the London School of Economics. His current research concerns are the coordination challenges posed by spatial and temporal distances, as well as socio-cultural differences in global software development. Gamel can be reached at gamel.wiredu@ul.ie.

9

The Tension Between Expectations of Availability and the Reality of Availability in Hybrid Teams

A Reflection by a Hybrd Team of Academic Practitioners

Rosalie Ocker, Haiyan Huang, Eileen Trauth, and Sandeep Purao
The Pennsylvania State University, College of Information Sciences and Technology
{rocker, hhuang, etrauth, spurao}@ist.psu.edu

Abstract. The demands of the global world increasingly dictate that people travel in order to conduct work. Oftentimes, this means that team members are neither strictly here nor there. Teams such as these are hybrids, where members alternate between co-located and distributed contexts. The pervasive nature of information and communication technologies, however, continues to impose an expectation of availability on the team members even as they travel. In this paper, we take a reflexive research stance to inform our understanding of the complexities of accomplishing knowledge work within a hybrid team configuration. An illustrative case highlights issues and outcomes associated with member availability that arose during the writing of a research paper. Categorical reasons for member unavailability are identified and contrasted with the expectation of availability. We suggest that the issues and conflict we experienced may be traced to the ambiguous nature of the task and the early project phase requiring problem formulation.

1 Introduction

Advances in information and communication technology (ICT) have changed the way that teams collaborate. ICT enables work to be accomplished by virtual teams – teams that conduct work predominantly via computer-mediated communication (CMC) [1]. Thus, teams can be composed of members distributed across space and time.

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However, ICT has also impacted the way that co-located teams conduct work. While continuing to meet in the traditional face-to-face (FtF) manner, ICT allows members who share the same physical work location to also collaborate electronically. Arguably, there are few traditional teams that work strictly via FtF interaction. While there is a wealth of research focused on traditional teams, and a growing body of research focused on virtual teams [2-4], there is a need to understand the collaboration complexities of teams that straddle both domains, where both traditional FtF and virtual contexts prevail. We will refer to teams operating with this mixed configuration as hybrid teams.

Knowledge work involves "accessing data, using knowledge, employing mental models, and applying significant concentration and attention" [5]. In this paper, we begin with the premise that the efforts of conceptualizing and crafting a research manuscript constitute knowledge work. Informed by research on virtual teams and knowledge work, we take a reflexive research stance [6-8] to examine our experiences in working as a hybrid team to write a research paper.

This paper is organized as follows. Section 2 presents an account of knowledge work by a hybrid team writing a research paper (the authors of this paper). In section 3, a retrospective analysis of key issues relating to team member availability and unavailability are identified. Reflections on availability are discussed in section 4, informed by the literature on virtual teams and knowledge work. The paper culminates with conclusions in section 5.

2 An Account of Knowledge Work in a Hybrid Team

We use our own experiences, in a manner similar to Mathiassen and Purao [8] and Naur [6], drawing on the account of a specific case that consists of a series of episodes. A retrospective analysis of the case follows along with a comparison of surface-level findings against those derived from prior research.

2.1 Illustrative Case

We describe the activities of a hybrid team and individual members of the team as it engaged in the process of formulating a research paper. Table 1 includes a timeline of the key events.

The four authors of this paper, whom we will refer to as A, B, C and D, were colleagues in the same department in the same university in the same country (U.S.). They decided to collaborate on a research paper for an upcoming conference. While A, B, and C had worked together for many months and were an established team, D was a relative newcomer to the group. However, over the course of the three months prior to this undertaking, the four individuals had various face-to-face (FtF) meetings, ranging from the entire group to different combinations of triads and dyads, to discuss potential research activities. Additionally, all had exchanged numerous emails with one another. In short, the group had an established working rapport.

For this specific manuscript, the group met for an initial FtF meeting to brainstorm. After actively exchanging and discussing ideas, they agreed on a direction and core message of the paper. The topic for the manuscript would be at the intersection of global software development (GSD) and ubiquitous organizations. As they began to plan their work, it became evident that two members would be traveling during the time period leading up to the submission deadline. First, B would travel to Asia to attend a research conference, and before B returned, A would travel to Australia to give a keynote address at a research conference and to conduct field research.

Realizing that they would not be able to meet FtF very often before the deadline, the group developed an action plan and assigned responsibilities to members. By the close of the meeting, they felt good about their efforts; they had a productive meeting and were off to a good start on this project.

A, C and D remained co-located while B traveled to Asia. The three co-located members conducted electronic brainstorming, in an effort to include B, as the next step in the development of the paper. A drafted a rough outline of the paper and emailed it to the group, stating that A would reconnect with the group in early December (2 ½ weeks later). Several days later, just prior to B's return, B sent an email to the group with some modifications to the paper outline. This was the only communication from B during B's trip to Asia.

B returned a few days after A's departure. B and D had several impromptu FtF meetings, after which B, C, and D had a scheduled FtF meeting. In this meeting, new concerns and issues surfaced. The ensuing discussion resulted in a key revision of the paper's core message. B devised a high-level outline for the paper and D agreed to write an initial draft given the revised core message. Over the next two weeks, the draft went through four written iterations, as B and D took turns developing it. During this period, D notified the group, via email, of this change in direction. Neither A nor C responded (A was in Australia; C was co-located with B and D).

B continued to work on the paper and sent a second iteration of the revised core message during the Thanksgiving holiday break. At the end of the holiday weekend, A established contact with the group via email. However, neither C nor D responded. After the holiday break, D emailed the group, explaining that a family emergency was the reason for D's lack of contact. A group meeting was scheduled for later in the week. Meanwhile, C updated A on the group's progress during A's absence.

A few days later, A, B, and D had an impromptu hallway encounter where A expressed confusion over the change in the direction of the paper. Also, A was concerned as to whether they could meet the deadline for paper submission. While B and D were under the impression that the group had the next six weeks to work on the paper (submission deadline was mid January), A expressed availability over the next ten days and a desire to complete the paper before the end of the semester (mid-December).

Over the next two days, B and D sent out two more iterations of the revised core message. Later that week, the group scheduled its second FtF meeting, where all members were available to meet FtF. But, as luck would have it, B's child became ill, requiring participation in the meeting via a conference call.

Table 1. Timeline of key events

Date	Players	Key Events	Activity
10/30	All	FtF Kick-off Meeting	brainstorm ideas for paper; agree on core message of paper; availability of individual members discussed and order of authors determined
11/6	B	leaves for Asia	attends research conference
11/8	A	email to group	attaches outline of paper; will re-connect with group in early December
11/10	C & D	meeting	discuss paper; divide responsibilities for paper sections
11/11	B	email group from Asia	connection very slow; adds some content to A's outline
11/12	A	leaves for Australia	keynote speaker at research conference; conducts field research
11/15	B & D	FtF informal encounter	status update
11/15	C & D	FtF meeting	give feedback on each other's drafted sections
11/16	C & D	FtF meeting	give feedback on each other's drafted sections
11/19	B, C & D	FtF meeting	agree that core message 'not working'; agree to revise core message of paper; prepare outline for paper
11/22	D	email to group	attaches draft of revised core message; specifically draws to A's attention that core message has been revised; asks A to acknowledge
11/22	B & D	FtF informal encounter	B gives feedback to D; they discuss some ideas in-depth; they are in agreement on revised core message
11/25		Thanksgiving Holiday	
11/26	B	email to group	attaches 2nd iteration of revised core message
11/28	A	email to group	first contact since 11/11
11/29	D	email to group	D explains that was out of contact for several days due to family emergency
11/29	B & D	FtF informal encounter	group will hold off on next FtF meeting until D can catch up
11/30	A & C	FtF meeting	C updates A on status of paper
12/1	A, B & D	FtF informal encounter	A confused over core message; concerned whether group can meet deadline; A available to work on paper over next 10 days; B&D thought everyone available until paper deadline in mid January

Table 1 Continued: Timeline of key events

Date	Players	Key Events	Activity
12/2	D	email to group	attaches 3rd iteration of revised core message
12/3	B	email to group	attaches 4th iteration of revised core message
12/3	All	FtF and phone	Discuss draft of revised core message; revise work-plan
12/9	A	email to group	attaches 5th iteration of revised core message
12/9	D	email to group	Suggests need to address struggle/conflict
12/19	All	FtF meeting	Second FtF meeting of all four members; discuss paper

At the meeting, as D tried to explain the chain of events leading to the morphing of the paper's core message, A and C relayed ideas from their meeting earlier in the week. Clearly, the group was not 'on the same page'–*two different conceptualizations* were being developed. B had to disconnect from the conference call early, due to parenting needs. The climate became uneasy as the three FtF group members attempted to reach an understanding regarding the focus of the paper.

The meeting ended with a newly revised work-plan; A volunteered to take the lead in writing the next draft of the paper. Although the three-some tried to repair the meeting and end on a positive note, there was an unspoken distance between them as they left the meeting room. Six days later, A distributed the draft of the research paper via email and asked members for feedback, especially in terms of 'holes or issues that were not identified,' preferably before their scheduled FtF meeting the next day. Within several hours, D sent an email with the following message:

> As I've been thinking about what has transpired since our initial FtF meeting, I believe we need to address the struggle/conflict we've experienced in reaching a shared understanding on the message of this paper . . . .While people traveled and found themselves unavailable (technology infrastructure not much help; mentally focusing on other work), others met FtF and also shared work electronically. The message of the paper developed, as deadlines required. However, when we all found ourselves back in the same location, we evidenced a division in direction.

Within moments, A responded electronically, asking D to revise the draft to incorporate these thoughts. By that evening, D distributed a modified draft of the research paper. B and C were not heard from during this exchange. The following day the four members gathered for what was the second meeting where all members were actually present. The atmosphere in the room was quite tense as the meeting began.

3 The Multi-faceted Nature of Availability and Unavailability

A surface analysis of the account above showed that the group experienced several key issues that exist in virtual teams, including member unavailability, expectations of member availability, difficulty maintaining a shared understanding, and group conflict.

3.1 Unavailability

The group experienced difficulties associated with members' availability to work on the paper. Below, five reasons pertaining to unavailability are identified.

1. *ICT Unavailability*: While B was at a conference in Asia, the difficulty related to connecting with the group was traced to the slowness and intermittent nature of the Internet connection. From the conference, Internet access to people and websites within that country was superb; the problem was Internet access to the rest of the world due to legal and/or regulatory barriers.
2. *Social Unavailability*: A was a keynote speaker at the conference in Australia. After the speech, discussions with interested colleagues clearly took precedence over getting to the bank of computers for email. Thus, the availability of the technological infrastructure was hindered by the need to be socially present with conference attendees.
3. *Physical Unavailability*: Sometimes, even when the underlying technological infrastructure could be navigated, time differences across the globe made team members physically unavailable. For example, when B was overseas, significant time differences (close to eleven hours) made synchronous collaboration impossible. Furthermore, receipt of asynchronous communication was delayed, as emails sent from the U.S. were 'received' when B was asleep, and sent by B when the other team members were asleep.
4. *Mental Unavailability*: When in Australia, A found it necessary to focus on conducting field research and could not devote the mental energies needed to collaborate with the team during that time. Competing demands on time meant C could also not be mentally available to the group for extended periods. Thus, the problem of mental availability was unconstrained by location–distant team members, as well as co-located members, required periods of uninterrupted time.
5. *Emotional Unavailability*: When the group was once again co-located and attempted a FtF meeting, parenting duties and a sick child made B emotionally unavailable to the group. Furthermore, due to cultural observances, while half of the group celebrated a national (U.S.) holiday, they were emotionally unavailable as they took time off from work to spend with family and friends.

3.2 Expectations of Availability

Although members discussed their travel schedules at the initial FtF team meeting, no explicit mention was made regarding members' lack of availability.

There was an unspoken expectation that individuals would remain available to the group.

ICT Availability: Due to the pervasiveness of ICT, distant members were expected to remain in contact with the group. During both A and B's travels, co-located members emailed both and anticipated a response. Co-located members also used email to communicate with each other, even though they worked in very close proximity (some within 20 feet of each other), and expected a response.

Physical Availability: Expectations of the physical availability of co-located members were high. For example, A, C and D scheduled a FtF meeting while B was traveling, and B and D had a series of FtF meetings while A was traveling. Meetings of the entire group were schedule when all members were co-located.

Mental Availability: Due to their shared work experience, it was tacit knowledge that group members were working on other projects as well. However, no one made their work commitments explicit. The implicit expectation of other work commitments did not supersede the expectation that members would devote the mental energy required to remain aware of and responsive to developments in the group's paper. For example, when the paper's direction changed as a result of interaction between B and D, A was performing field research in Australia. D sent an email to A describing the changes, expecting that A would remain up-to-date as the paper developed.

Emotional Availability: When members were co-located, they were expected to be available to meet during normal business hours, within the usual confines of work schedules. However, B, who was unable to attend a critical FtF meeting due to an unforeseen family situation, was expected to participate anyway.

3.3 Consequences of Mismatch Between Availability and Unavailability

Difficulty maintaining a shared understanding: Even though the group established a direction for the paper at their initial meeting, they experienced difficulty maintaining a shared understanding. The core message of the paper evolved as different dyads and triads of co-located members worked on it. Over time, the core message fractured such that two conceptualizations were pursued in tandem.

Group conflict: As the weeks passed and the paper deadline approached, the elusiveness of developing a single core message led to increased levels of tension and conflict within the group. What began as a concerted effort by four motivated colleagues resulted in a less-than-satisfying group outcome.

4 Reflections Informed by Prior Research

Based on the key problems identified, in this section we reflect upon and interpret the group's experiences informed by the literature on virtual teams and knowledge work.

4.1 Awareness and Availability

It is commonly accepted that working in a virtual team is difficult [2-4]. Research suggests that establishing and maintaining an awareness of members is important to the success of virtual teams [10, 11]. Awareness refers to an understanding of others' activities and provides a context to interpret behavior [12, 13]. Weisband [10] describes five types of group awareness: *self awareness* is information about another's activity at a specified time; *activity awareness* is knowledge of others' project-related activities; *process awareness* is knowing what tasks fall within project phases; *social awareness* is knowledge about others outside the context of work; and *availability awareness* is knowing whether others are available to meet or participate in an activity. To date, activity awareness has received the most attention [14].

However, Panteli [15] draws attention to the importance of availability. She articulates three states of availability: present availability, absent unavailability, and silenced availability. Present availability refers to an individual's time availability and commitment during a project. Absent unavailability refers to an individual's temporary unavailability for project work due to non-work related reasons. Silenced availability refers to an individual keeping silent when participation is expected.

Awareness in virtual teams is conceptualized from the perspective of the group, usually in terms of how information regarding members pertains the to team's progress and performance. However, the illustrative case demonstrates the importance of viewing availability awareness from the perspective of individual members. ICT can have dual effects: the supportive and intrusive effects of anywhere/anytime communication, and knowledge sharing [16, 17]. Schwarz, et al. [18] use the term 'work boundary' to refer to 'the increased need but also increased difficulty to create, maintain, negotiate, and manage boundaries, both at work and between work' in virtual environments. They suggest that knowledge workers need to constantly negotiate their position within the sphere of work (how active, reachable, and available one wants to be at different times), in order to maintain an uninterrupted space to be able to effectively manage and balance between various work responsibilities [18]. In our case, during the trip to Australia, A set up boundaries to protect high priority work activities from interruptions from other activities. Such uninterrupted space is critical for the individual knowledge worker. First, it serves as a reflective space to enable the individual to be more concentrated on the priority tasks at hand. Second, such boundaries are constantly negotiated and reset to reflect the organizational needs and one's own needs.

Schwarz, et al. [18] point out that it is the shift in social and cultural expectations about speed in response and availability that can convert the technical potential of advanced ICT into social requirements. For example, when working under a deadline, interruptions are inevitable, necessary or even urgent. Therefore, sometimes there are conflicts between individual needs and social requirements.

4.2 Managing Competing Demands: the Expectation of Availability vs. the Need to Hide-out

The collaboration of knowledge workers is often characterized by the portion of individual work that team members conduct. While some part of this work may require interactions with others, other parts of the work may require uninterrupted time to think, reflect, and reconfigure. This time for reflection can become a casualty of expectations about electronic availability brought on by the availability of ICT. A team member may find herself constantly interrupted by email messages or phone calls requiring immediate responses, which can take her away from the reflection in which she was engaged. After responding to the interruption, she may not be able to get back into her earlier 'flow.' The solution to this predicament, for the knowledge worker, is to 'get away from it all.' This form of remoteness has been termed 'hiding out' [16] or 'islanding' [18] and necessitates cutting off interruptions from people, technology (cell phones, emails) and other potential disturbances.

4.3 Dialectic Progress in Hybrid Teams

Dialectic refers to the notion of conflict [19] among team members and the manner in which this conflict is resolved to reach a higher level of shared understanding that can facilitate progress towards the project objective. In the account provided, it was necessary that the group reach a common understanding regarding the direction and focus of the paper.

Typically, for co-located teams, a series of FtF meetings occurs in order to reach a shared understanding of the problem to be solved. In this manner, the problem is formulated and reformulated as new knowledge is shared and ideas explored [20]. For virtual teams that cannot engage in a series of FtF interactions, reaching such understanding can prove to be a difficult proposition. In practice, a series of FtF meetings is often impractical or impossible if team members are distributed across substantial distances, or, as in the case study group, if member availability does not permit. Purportedly, the next best solution is to have a single FtF kick-off meeting, where the group can establish enough common ground [21] to carry it forward after it is dispersed. The imperative of the initial meeting is not only to reach an agreed upon understanding and direction to guide the group's work, but also to deal with logistical concerns such as establishing group processes, member roles and responsibilities, and communication norms. For most groups, this is not readily achievable in a single meeting.

In theory, hybrid teams have the ability to meet regularly–at least more than once. However, availability issues can make it difficult for all members to meet. As highlighted by the case, although all members were available some of the time, rare was the case when all were available at the same time.

As our illustrative case shows, the members of the group found themselves in a conflict situation, even though they conducted an initial FtF meeting and seemingly reached a shared understanding on the direction of the paper. Furthermore, they mapped out responsibilities and a work schedule with milestones. However, although they discussed their pending travels, they did not foresee the availability problems they would encounter partly because members found themselves unexpectedly without the technology to communicate with their group. This was partly due to non-ICT related availability reasons and partly due to different expectations concerning member availability. With the paper deadline fast approaching, the group needed to resolve their conflict situation. Although the four members had never worked together as a group, they had built up some social capital over the previous months. Their trust of, and mutual respect for, each other helped to mitigate the conflict. Electronic communication proved helpful in providing the distance and precision in words to surface the conflict (for example, D's email to the group) while a FtF meeting of all group members proved essential for working through differences.

5 Conclusions

If the group had adhered to the direction and core message of the paper as originally conceptualized in its kick-off FtF meeting, perhaps many of the problems stemming from availability could have been avoided. However, this is not a realistic expectation, particularly for groups engaged in the early, problem formulation stage of problem solving activities. For non-routine problems, problem formulation is an unstructured and ambiguous activity that consists of both divergent and convergent thought processes [22], and as such provides a rich opportunity for creativity [23-25].

Problem formulation *evolves over time* into a stable conceptualization. Due to these characteristics, knowledge work occurring at the front-end of problem solving can be quite challenging. Performing this knowledge work in a hybrid team, where members were not continually available, hindered the group's ability to maintain a shared understanding of the direction of the paper. Researchers suggest managerial strategies such as front loading projects with FtF kick-off meetings and scheduling intermittent face-to-face meetings in an effort to build and maintain a shared understanding among team members [26-28]. However, our experience indicates that even with established relationships that include mutual trust and respect, accomplishing ambiguous work in a hybrid team is quite difficult.

ICT provides the means to conduct work virtually. However, as our illustrative case indicates, a social structure that sanctions such communication still needs to be cultivated and maintained [28-32]. Advancements in technology will, no doubt, address issues such as ICT availability and the richness of electronic communication. However, our experience indicates that much of the promise of ICT to support ambiguous, unstructured knowledge work may remain largely unrealized. Even with increases in the availability of ICT, the *social*, *physical*, *mental*, and *emotional availability* of knowledge workers is, and may well remain, a dilemma. Add to this the conflict and its effective *resolution* that is prevalent in, and important to, realizing the creative benefits of teams working on unstructured problems, and the stumbling block resembles more of a boulder.

There is a real need to focus research efforts on the study of issues of availability, especially in terms of the softer, social aspects. Understanding these issues in terms of the complex reality of hybrid teams is a fruitful area for future research.

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About the Authors

Rosalie J. Ocker is an Instructor in the College of Information Sciences and Technology at the Pennsylvania State University, University Park. Dr. Ocker's research interests include virtual teams, partially distributed teams, and group creativity and innovation. She has studied creativity in virtual teams in a series of experiments that spans ten years. Dr. Ocker has investigated personality, status effects, linguistic content, and interaction influences on virtual team creativity. Supported by a grant from the National Science Foundation, her most recent research is centered on the study of subgroup dynamics and leadership in partially distributed cross-cultural teams. Dr. Ocker has published in various journals and conference proceedings, including the Journal of Management Information Systems, IEEE Transactions on Professional Communication, Decision and Group Negotiation, Hawaii International Conference on System Sciences (HICSS) and Decision Sciences.

Haiyan Huang is currently a PhD candidate in the College of Information Sciences and Technology, at the Pennsylvania State University, University Park. Her research interests include global software and information systems development, offshore outsourcing, virtual teams, knowledge management, and computer supported cooperative work and learning. She has published several articles on the topic of distributed work teams, managing global IT workforce, knowledge management, and diversity. She is currently involved in several projects related to global information systems development and global IT workforce diversity.

Eileen M. Trauth is Professor of Information Sciences and Technology and Director of the Center for the Information Society at The Pennsylvania State University, University Park. Her research is concerned with societal, cultural and organizational influences on information technology and the information technology professions with a special focus on the role of diversity within the field. As a Fulbright Scholar in Ireland, Dr. Trauth investigated socio-cultural influences on the emergence of Ireland's information economy and published. The Culture of an Information Economy: Influences and Impacts in the Republic of Ireland. She has continued that research by investigating cultural, economic, infrastructure and public policy influences on the development of information technology occupational clusters in the U.S. In 2000 Dr. Trauth began an investigation of the under representation of women in the information technology professions by researching women in Australia and New Zealand. She has continued that research with grants from the National Science Foundation, Science Foundation Ireland and a Fulbright Distinguished Chair in Gender Studies. She is editor of the Encyclopedia of Gender and Information Technology, Associate Editor of Information and Organization and serves on the editorial boards of several international journals.

Sandeep Purao is an Associate Professor in the College of Information Sciences and Technology at The Pennsylvania State University, University Park. His research focuses on the design and evolution of complex socio-technical systems. His work has been published in several journals including Information Systems Research, ACM Computing Surveys and IEEE Transactions on Systems, Man & Cybernetics among others. He was the research program co-chair for IEEE Service-oriented computing conference 2005.

10

A Process Maturity Model for Geographically Dispersed Software Sustenance Operations

Rajeev Sharma[1], and S. Krishna[2]
[1]XLRI School of Management, Jamshedpur- 831 00, Jharkhand, India
[2]Indian Institute of Management Bangalore, Bannerghatta Road, Bangalore - 560 076, Karnataka, India.

Abstract. An increase in demand for software services has led to development of software from different dispersed locations. This has brought in complexities to managing software projects. This research work focuses on the development of a process maturity model that balances different perspectives in one organization that is carrying out software sustenance work from geographically dispersed locations.

1 Introduction

The development of tools and processes using information technology for coordinating the activities of geographically dispersed team members is not the only challenge that is being faced by many software organizations. The biggest challenge is to create an organization that can increase the benefits for all its stakeholders. This necessitates the improvement in processes and tools while at the same time retaining a balance among competing demands of diverse stakeholders.

Over the last few years, there has been an increase in studies that try to understand process maturity in software organizations. The Software Engineering Institute (SEI) has developed a comprehensive model predicated on a set of software engineering capabilities that should be present as organizations reach different levels of process maturity. To determine an organization's current state of process maturity, a five point grading scheme is used. The grading scheme determines compliance with Capability Maturity Model (CMM), which defines key activities required at different levels of process maturity. This model deals with the process maturity for a specific location, but in the current environment, when the work has become

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geographically dispersed, we also need to look into how organizations are managing this transition. Therefore, we have built a process maturity model for geographically dispersed projects. This model has four different stages: Initial, Localized, Sensitized, and Synchronized. Transition from one stage to the next takes place over a period of time.

We also see that to successfully synchronizing software sustenance activities from dispersed locations, organizations need to strike a balance among different competing requirements of its stakeholders. We propose a framework for developing a better understanding of this process to achieve a balance among these competing needs.

2 Research Design

To build a theory about process maturity in geographically dispersed software sustenance activities, we decided to adapt grounded research design [1]. The following paragraphs justify the choice of the qualitative approach and describe the methods adopted. There are three main reasons for adopting a grounded research based qualitative research methodology [2] for this study:

- At present there is no theory that explains the process maturity that happens over a period of time in a geographically dispersed software sustenance organization. Hence, we wanted to explore this phenomenon in its natural setting to gain fresh insights into this type of work arrangement.
- At the same time research literature on co-located software and non-software development teams shows there are a number of factors that have an influence on how the work gets done. Though there are a large number of theoretical and empirical studies, there is no clear understanding about the phenomenon of process maturity in a geographically dispersed software sustenance operation.
- As this is a first attempt at process maturity in an era marked by the development of various web-enabled tools and processes, we adopted grounded theory based methods to describe the phenomenon in greater detail.

The above-mentioned conditions presented us with a unique opportunity for conducting a grounded theory, approach-based study in its natural setting [1].

We collected data in the form of interviews, visits to the worksites, documents, etc. The primary source of data for this study is transcripts of interviews with the employees of different software sustenance organizations. For conducting the interviews, a brief interview guide was prepared to facilitate the interviewing process as well as facilitate the comparison of the data collected from different sources.

The questions mainly dealt with the business, technology, and operations aspects of the software sustenance activities. At the senior level the questions covered the business and operation aspect of the development; at the junior level the questions were restricted to operations and technical aspects of development. Through these questions we also tried to find out the difference between what really works and the standard operating procedures in different situations faced by the developers. We also tried to check the consistency of the answers given by the senior and junior employees by cross checking their responses.

Beyond transcripts of actual interviews, the study is also informed by interview notes, notes on site visits, company documents, and project files (when they were made available). When possible we tried using these data sources to cross check our deductions about the operations of an organization.

All the interviews were conducted at the project sites, and on average, each interview lasted for more than an hour. Going to the development sites also helped the researcher understand the work environment at these organizations. Some of the interviewees also showed some electronic documents, which would not have been possible otherwise. To maintain the confidentiality of the organizations and the individuals who supported our research, names have been changed to protect their identity.

To analyze the data using a constant comparative method, each interview was reviewed and an initial analysis attempted as soon as possible after the data was collected. After completing the data collection, we again went through the transcripts, coded the data, and tried to make sense of the phenomenon of our interest. After completing the coding we wrote case studies [3] and conducted analysis for generating some generic results from this study.

In the following section we will present a description of the operations of "Orion," which is maintaining proprietary software from three different locations in the world.

3 Case Study on Orion Limited

Since its inception in 1982, a singular vision—The Network is The Computer—has propelled Orion Ltd. to its position as a leading provider of industrial-strength hardware, software, and services that make the "Net" work. Orion entered India in 1987, through Wipro its sole distributor. Orion India was established in 1995. Soon after, the company established a 100 percent subsidiary, the first such subsidiary of any MNC in the country. Orion's India Engineering Centre (IEC), in Bangalore, commenced operations towards the end of 1998 and was formally launched in May 1999.

IEC has now become a key site for technology development for the company worldwide. Each of Orion's six divisions (Enterprise Services, OrionOne, Network Service Provider, Network Storage, Systems Products, and Software Systems Group) has teams working at IEC. Products and technologies at IEC include a mission-critical Stern Operating Environment and the OrionOne product line: E-commerce infrastructure and application products, security products, and advanced network storage solutions. The India engineering center is slated to grow to a core-engineering site with 3,000-5,000 employees.

The IEC follows a business model of 'virtual teams' where all teams at India IEC are part of worldwide team that operates across geographies. The final decision on work assigned to a particular location is made after giving due consideration to the competence of the team members from different geographically dispersed locations.

The data presented in this case study has been collected from the Stern Software Sustenance team in Bangalore, India, and from some of their counterparts in the US. The sustenance activities are being carried out from different geographical locations to provide year round 24-hour support. At the same time, software development activities are being carried out from different locations to take advantage of local competencies and new business opportunities.

3.1 Stern Sustenance Group

Stern is a high-end proprietary operating system developed by the organization. This software is installed mainly on the servers and high-end workstations. In most of the cases Stern includes the hardware, which is also provided by Orion. This places Orion in a good position to provide support services to its clientele as it provides both the hardware and software. Orion's clientele includes most big companies, in various industries, that use computers extensively in their operations. Its competitors include various other variants of Unix, Windows and Open Source Operating systems.

At present the support for Stern software is being provided from three locations around the world: the US, the UK, and India. Earlier, support was being provided from the US and UK only. The India support center was established in the year 2000. These teams of engineers are providing 24X7 support to customers. Different sub-teams have been constituted to handle different jobs. For example, one team is working in the area of kernel; one team is working only in the networking related areas; one team is working only in the area of interface and naming services; one team is working in the area of commands and libraries, etc. Each sub-team can have three to four engineers in it. There are also sub-teams in the UK and US who are involved in Stern Sustenance. These teams are sandwiched between the core developers who have built and are working on newer versions of the Stern Operating System and the engineering service group that services customer needs.

There are approximately 65-70 engineers in the US, 32-33 engineers in the UK, and 32 engineers in India who are involved in Stern Sustenance. These teams comprise a Senior Staff member, one or two Technical leads, and members of technical staff (MTS). Members of the technical staff are at four levels: MTS1, MTS2, MTS3, and MTS4. Members of the technical staff are the engineers at various levels in the hierarchy.

3.1.1 Setting Up a Sustenance Center in India

This group was started in California to support the Stern operating system. Over time the demand for their services increased and problems arose. In response the group was expanded globally to better provide service to customers located in different geographical regions. It first expanded to the UK, then Europe (France and

Germany), and then a group was started in India to complete the circuit. Together these centers now provide 24X7 support to their customers.

The director of the Stern Sustenance group acted as the sponsor for the team in India. It was her decision to locate the team in India, and she was very clear on how she wanted to go about it, what she wanted to do, and how to spread a nearly uniform culture at all of the locations. The Indian team was able to blend with the existing teams without any major hiccups. As the team head stated:

> Few things she did was get some people from there (US) to come here and work with the team here (India) in the initial stages . . . so that rapport is built and stuff like that . . . and initially we had people traveling either way quite frequently to get to know each other and things like that . . . so those things really helped . . . otherwise if it was only a team sitting here and working over emails and phone calls it wouldn't have come to this level . . . this is what I feel.

The Indian sustenance team is using some of the processes that were put in place by the US and UK teams, and some new processes have been developed to increase productivity. The Indian group started with a disadvantage as most of the people who joined the team had very little work experience and required training. This opportunity was used to put processes in place that were not there in the UK or US groups.

The Indian team was able to develop a well-documented process of doing the 24X7 work, which was later adopted by different teams. According to the team head, "what we have done is we have generated what we call a Process Bible, which basically is a reference material which anyone can go and have a look in case you don't know what to do next." One of the key team member involved in the development of the "Process Bible" said:

> We realized that we need something . . . a big process and bunch of documents to guide the young graduates . . . we used to call it then and we still call it the "process bible" for our group . . . so we have a thick web based book called as bible . . . an ever evolving book . . . which defines all the processes that our engineers need to know to work here . . . so we picked up lot of guys from the team here . . . seven or eight guys . . . once it was done . . . we took it to the global team and said we did that as part of ramping up the team here and obviously all these processes are applicable to the whole global team who are working on this . . . and it was totally accepted in the global team . . . so now that book is sort of sustained by voluntary effort from all over the globe and not just the team here. . . we have cut down the team maintaining that bible to two people here and we have two or three people in Europe and two or three people in US and they all together sustain the book . . . some time we get new processes and some time we remove old processes . . . so we have to keep the Process Bible correct . . . the team does that.

The top management in the organization emphasized processes and the development of team spirit. According to the Bangalore team head,

> Working with team is a significant thing . . . about 25% weightage in performance review is given to the soft skills . . . things like that. When it started from the beginning this was encouraged and since every one was new and everyone was interested in becoming part of the team . . . when we started we were around five-six people and so when we started it was a small team and there was lot of opportunity for people to share and so that bonding developed . . . and once that foundation was there then it was easy to build on top of it.

The development of the Process Bible and team spirit played a major role in successfully setting up the Stern Sustenance Center in Bangalore and after almost three years of operations the team has emerged as the best team in the organization.

3.1.2 Operations

The customer support service model is comprised of four different layers: direct interaction with the customer, field support, back line engineering also known as the enterprise service group, and the fourth layer that solves the problems that cannot be solved through normal routine maintenance activities. Engineers in back line engineering separate problems into different categories depending on whether they are related to the application software, the operating system, or the, hardware, etc.

The sustenance team in Bangalore takes care of service provided at the fourth level for two categories of customers: standard support customers and premium support customers. Standard support entitles customers to a response within four hours for urgent issues during extended business hours, and premium support entitles customers to engineering support twenty-four hours a day, seven days a week.

3.1.3 Technology and Quality Control

The whole service cycle is part of the Process Bible. The organization has guidelines for resolving reported bugs from the logging of the problem to its final resolution. A web-enabled tool called "Scopus" is used to recording the software bugs and all the steps taken to resolve them. Every engineer who works on a bug is expected to periodically file a report on the progress. The periodicity of the reports filed varies depending on the criticality of the bug. Reports are filed on highly critical bugs every three hours. This tool helps keep customers and other stakeholders informed about the progress made in resolving the bug.

The engineers follow a process known as Analytical Troubleshooting (ATS), which is a proprietary problem-solving framework developed by a company called Kepner-Tregoe. The organization has named it as Orion Global Resolution (OGR) process, training of which is imparted to every sustenance engineer in Orion. This framework provides a process for solving problems and doing a root cause analysis, which helps reduce the complexity involved in solving problems. It also facilitates the transfer of activities from one geographical location to another.

Each bug is also recorded in a web-enabled tool known as "Bug-Track." When a bug is reported a Bug-Track work item is created. The item contains the details of the bug as well as a record of who reported the bug, who is responsible for resolving it, and who are the other stakeholders in this process. This tool also helps maintain a historical record of all the bugs that have been reported and who was involved in resolving them. It also facilitates scheduling of various internal reviews and code walkthroughs.

The organization has built various tools, like Scopus and Bug-Track, which incorporate the processes mentioned and collect various metrics. The engineers working at the Bangalore development center have developed some of these tools. One senior engineer told us about one such tool:

> There is something called time stamp in Scopus. Scopus currently gives 'x' amount of states, what we actually wanted to do was we wanted to reduce the amount of time it takes for us to fix a problem . . . so as to do that we needed to do some fine grained measurement of all the phases involved . . . so we came up with this event based mechanism . . . so now every time we update Scopus we kind of put some code in there which corresponds to one of the event which has been predefined with help from management team. Now there are 34 states instead of just 8 states that used to be there in the earlier version of Scopus . . . so now anytime we update Scopus we also mention which event has happened . . . so it now allows us to do a great amount of post mortem analysis . . . in terms of what are the areas that need improvement.

The quality of the service provided to customers is controlled through various such metrics and the quality of the fix is ensured through a comprehensive review process and testing. Fixes generated by this team are reviewed by an internal team code review process, the product group, a change review board, and, if necessary, by the business group before they are released to customers. This ensures that the quality of the fix, generated by this team of dispersed engineers, is not compromised in any way by the manner in which the work is being carried out.

3.1.4 Managing Work Across Space and Time Boundaries

The work managed by the group is transferred from one country to another to facilitate speedy resolution of problems. According to the team head in Bangalore:

> So any time a problem comes . . . if it is hot customer problem . . . and they demand a 24x7 attention . . . then each time zone handles the problem during their time zone and passes it on to the next time zone when their daytime ends. For example if a problem comes up and we pick it up then we start working on it and if it is a hot issue then we shift it to UK at the end of the day . . . UK continues to work on it conducts the analyses . . . and then they pass it on to US. So this goes on till the problem is resolved.

Well-documented processes and the technological infrastructure put in place to facilitate 24X7 has played an important role in bridging the time-space gulf among the geographically dispersed teams.

3.1.5 Best of Stern Sustenance (BOSS)

Various other management initiatives have also played a critical role, together with processes and technological infrastructure, in managing the geographically dispersed work with ease. As the team head said:

> Once we had the foundation of processes and technology that then we said now it is time for us to works toward our specific vision and mission . . . so last year our vision was to be the BOSS . . . it is "Best of Stern Sustaining" . . . so basically among the three teams we wanted to be the best . . . so we identified what are the things that we want to do best . . . so we participated a lot in global technical discussions and do quality work . . . having one single team goal . . . as a team we needed to achieve this . . . so that year we became BOSS team.

The use of internal websites for sharing information about the project statistics, team performance on various parameters, mission, vision, and specific goals has helped disseminate information across the group and also created as shared space for the group. The team regularly conducts mission and vision exercises to facilitate build-up of shared meaning. In these exercises management tries to link the vision of top management with the personal objectives of the engineers. According to the a senior technical lead:

> We have started a website for the team so this is all is published there and then on a quarterly basis then we have our staff meeting . . . we discuss these things and tell them ok these are the objectives . . . then we sit with the individuals and chalk out what they are supposed to do to achieve their objectives . . . that will be tied to the main objectives . . . so we have specific objectives tied to teams objective and . . . and in the end of the year we go back and see what all we have done in each of these areas . . . and map it across and share it with the team.

3.1.6 Managing the People

> Technical brilliance . . . the speed and accuracy with which engineers identify problems and solve them with the help of high quality fixes are the cases where we have outperformed . . . these have been the things that have been touted by outside people about our team . . . like the product group many a time have come back and said . . . Oh this is an excellent fix . . . these are seasoned engineers in the product group . . . they have been able to recognize the quality of the fixes and all that . . . so I think it is their innate ability and skills that they have developed and the demonstration of that . . .

In any software company, managing people is one of the most important concerns of the project leaders. This becomes even more important when you have to retain good people. People management becomes even more important because software professionals are well educated and they know their rights and duties. As one of the senior manager said,

> We have done all these processes and tools etc . . . that is the nitty-gritty part of it . . . at the macro level you have to get the buy in of the engineers to do all these things . . . and the only way to get buy in from the engineers is possible when they say it themselves . . . basically software engineers are not like factory workers where you can force them to do things.

As we have mentioned before, management designed an objective setting exercise that links the goals of the organization to the goals of individual engineers. This exercise also helps in obtaining buy-in from engineers for achieving various objectives of the organization without compromising individual needs and objectives.

Management also facilitates healthy peer-to-peer competition while at the same time promoting teamwork. Engineers are motivated to excel in their domain of work and, at the same time, they constantly compare their skills with other members in the team. This peer-to-peer competition motivates the engineers to learn new technologies and soft skills in their spare time.

> Orion itself has a performance review process where lot of weightage is given to working in team . . . in fact . . . you have heard of performance rating scheme of GE . . . that relative ranking . . . and we have adopted that recently . . . so the initial fears at least in the management was that it will lead to lot of back biting and stuff like that but it didn't turnout that way . . . people are still working the way they used to do earlier in a team.

3.1.7 Improvement in Performance Over Years

When the Indian team began operation its reputation was not worth talking about.

> Two and half years back when we came online . . . you know . . . even if you goof up once it would be a big issue . . . oh you guys cannot do this ... what we did was we focused . . . our focus was two pronged . . . one was focus on process so we virtually eliminated process breakdowns secondly we focused a lot on technical capability and maturity of engineers.

The development of processes and expertise in the team has been a self-sustaining virtuous cycle. Improvements in both arenas have led to increases in productivity for the Indian team.

> Basically both of them have helped each other . . . it is an ongoing process . . . you develop expertise and then you say . . . this process is not needed you knock it off or you would say this is where we are going wrong we need a new process for that or something like that. Whatever work we are doing there are two aspects to it . . . one is the process that we follow and second is the expertise in that domain.

A senior engineer commented on the rise in productivity:

> We had a graph where we charted out "time to report" to "time to resolve" metric . . . so we had a linear line which came down for seven to eight consecutive quarters . . . so that was a huge amount . . . and right now our work load is the highest . . . we are pretty much one-third the strength of the global team but we are handling more than forty percent of global defects . . . so we are delivering more.

Indian management has also come up with a new mission statement—onward and upward—for facilitating the upward trend in the improvement of productivity. According to the team head, the mission statement reflects the status of the Indian team, as other teams in the group now have them as a benchmark and before they only had to benchmark themselves against other teams in the group.

4 Findings

4.1 Increasing Role of "Shared" Space in Process Maturity

Organizations have implemented new processes to facilitate better coordination efforts of the geographically dispersed work teams. Organizations also try to increase the transparency of their geographically dispersed operations by using tools that facilitate the sharing of information and artifacts. These tools help reduce problems related to teleconferencing and emails when coordinating various activities among the geographically dispersed team members. These processes and tools have evolved over a period of time.

The Software Engineering Institute's Capability Maturity Model (CMM) deals with process maturity for a specific location, but in the current environment, when the work has become geographically dispersed, we also need to look at how the organization is managing this transition. Therefore, we have built a process maturity model for geographically dispersed projects. The process maturity stages are:

Stage 1: Initial – Different locations do not follow any process and the software process is characterized as ad hoc and occasionally even chaotic. Few processes are defined, and success depends on individual effort.

This can be seen from the case description and the summary given in Table 1. Orion started its India operation with almost no standardized processes in place so they had to start from scratch to document the processes and then incorporate them in tools (refer to section 3.1.1).

Stage 2: Localized – Different locations have different software processes for managing activities. These are documented, standardized, and integrated into a location-wide software process. Process data is still not being collected for controlling activities within a location.

As described in section 3.1.1 of this paper, the process of development and tools was highly localized in the initial stages. Sustenance processes that were put in place in the UK, France, and Germany were very different from those which were being put in place by the India office.

Stage 3: Sensitized – All the locations are aware of the process data and requirements for coordinating development activities, but the tools that are being put in place are still evolving as different locations fine-tune their processes to get synchronized.

As described in section 3.1.3 of this paper, Orion has put in place various web-enabled tools to coordinate the activities of its various sustenance centers. These web-enabled tools were placed only after the Process Bible was accepted by all the centers. Hence we can say that they were aware of each other's processes at that point in time.

Stage 4: Synchronized – Organizations use tools inscribed with a uniform process, collect similar metrics, and facilitate continuous process improvement from quantitative feedback from the tools and processes in the shared domain. Control and coordination of activities are facilitated with the help of automated tools.

Orion uses, Scopus, to synchronize activities. This tool has evolved over time to capture more stages in the process so that locations are in synchronization with each other when work is being handed over from one location to another (Refer to section 3.1.3). Therefore, we can see that organizations put in place various tools to increase synchronization among different locations.

We have summarized the development of various tools and processes in the form of a table that is given below. These tools (shared repositories, online project management tools, and intranet web sites, etc.) can be considered as 'Abstract Systems' as defined by Giddens [4]. Over a period of time these abstract systems facilitate faceless commitments, which in-turn lead to the re-embedding of face-work commitments among the team members who are separated in time and space [4].

We discuss the impact of these abstract systems in three different domains: local, shared, and global domains. The "local" is one in which people work in their respective individual locales. The "global domain" implies individuals working from different locations towards a common project deliverable. The "shared" electronic spaces enable developers to share messages, data, or software programs with each other [5].

As we can see from the table below, documented processes and tools have been put in place to negotiate the place-space duality. These organizations started geographically dispersed operations with almost no abstract systems in place. Therefore, there were slippages in performance of the team members as they were not able to communicate and coordinate their activities.

Table 1. Time Space Configuration (at the time of starting the organization in India)

	Place: Orion India	Shared Space	Place: Orion US
Local	Independent process to handle problems	Emails, Teleconferencing	Independent process to handle problems
Global	Designated team members	Coordination team	Designated team members

Orion has put in place processes that reduce the need for telecommunication and emails, and increased reliance on processes and tools to support collaboration. Tools like Scopus, Bug Tracker, Test Director, Concurrent-Version System, etc. (refer to section 3.1.3) have reduced the need of teleconferencing to a great extent and have helped to increase trust in the systems used to coordinate activities. From the table, we can also see that there has been an increase in formalization of the operation in all of these organizations since the time they started their operations in India. These processes and tools that facilitate use of these processes help reduce the need for frequent routine communication in projects. Most of these tools and processes were implemented after studying the actual processes in use and were modified to take into consideration any change in the way things are being done (refer to section 3.1.1).

Table 2. Final Time Space Configuration of the organization

	Place: Orion India	Shared Space	Place: Orion US
Local	Similar process for Bug Root Cause Analysis, Solution Design, Coding, Unit Testing,	Documented Process Bible for doing various sustenance activities incorporated in various tools like Scopus, Bug Tracker, Secured websites, CVS, VSS,	Similar process for Bug Root Cause Analysis, Solution Design, Coding, Unit Testing,
Global	Designated team members, and Reviews at various stages.	Coordination team, Formation of Build, Change Control Board.	Designated team members, and Reviews at various stages.

These two tables show that the organization has transitioned from a state where there were no abstract systems in place to another state where these systems are facilitating most of the activities of the organization. In Orion, usage of tools like Scopus and Bug Tracker has increased from the time of its beginning of operations to the present time. These tools are now being used to take care of the processes that have been put in place to decrease the coordination related problems among the team members located in India and the US. This movement from one to state to another state can be described using the process maturity model described below.

We can see that Orion has put in more and more structures as their processes matured. In the later stages (Stage 3 and Stage 4) they started collecting quantitative data that facilitates control and coordination of the development activities. The results are tabulated below:

Table 3. Changes in Process Maturity Stages of Orion

	Commencement of the projects (1999)	At the time of the study (Now)
Orion	Stage 1 (Initial): Orion's India office had to start from scratch in designing its processes.	Achieving Stage 4 maturity (Synchronized): It has been able to put in place various tools and processes in the shared domain to control and coordinate the activities

When it started its operations in India, the processes where of a localized nature but over a period of time they have transitioned to a stage where the processes and tools from different locations are synchronized with each other (shown in table above). We can also see, from the Orion case analyses, that the organization was attempting to create a balance by emphasizing processes (section 3.1.1), people (section 3.1.6), results (section 3.1.5), and customers (section 3.1.7).

4.2 Balancing Different Perspectives

Orion's India operation was able to succeed because of the balance created among the different competing goals of a software sustenance operation. To successfully synchronize different software sustenance activities from dispersed locations, organizations need to balance four dimensions for the long-term viability of their operations:

Learning – Developers working on these projects are also interested in developing their technical and managerial skills. Organizations have to create processes that help fulfill this need for the developers. Tools put in place for coordinating the activities should also incorporate this need.

In section 3.1.6, we can see that managers are focusing on the needs of developers to write better code. Developers themselves set the targets, the number of errors, etc., and these targets are then linked with organizational requirements. This process has helped the sustenance center deliver better code fixes. The potential of developers is recognized by the best in the organization as it is transparent system and everyone is linked through different tools.

Operation – Processes that are to be followed across different geographically spread locations need to be synchronized with the help of information technology intensive tools. These tools should be able to demonstrate any improvements that need to be made for the success of any change in existing process.

In the section 3.1.3, we saw that Orion introduced a new system called Scopus, which was developed by in-house programmers. At later stages of process maturity, more stages were incorporated into this tool to manage global interactions more effectively. This shows that not only did the tool became important for operations but also changes were incorporated into it on an ongoing basis to reflect the growing needs of the teams working from different locations.

Benefits – Managers should be able to use these tools and processes for evaluation and allocation of different team members to different projects depending on their past performance.

In the section 3.1.6, we saw that some of the programmers who designed the original Stern operating system appreciated the code fix which was being developed by some of the new programmers joining Orion. This process of recognition was transparent as each code fix was allocated to a person and the senior programmers were following it very closely. This helped the unit in India to not only improve the capabilities of the programmers but it also resulted in a better allocation of work to different programmers according to their capabilities.

Relationship – These tools and processes should be able to increase transparency of the operations so as to facilitate better customer service. Customers should be able to see the benefits accruing to them and should start trusting this mode of delivery.

As is mentioned in the section 3.1.7, Orion was able to dramatically reduce the time taken to resolve customers' problems. The metrics relating to customer satisfaction were captured by the organization online and were visible to all the different dispersed offices of Orion and its customers. This helped the company develop better relationships with its customers.

We can deduce that these four dimensions are linked to each other. Better learning opportunities for developers lead to improvement in processes, which in turn lead to increases in financial as well as non-financial benefits for the developers. All of this results in better service to the customer and hence strengthens the relationship over a period of time. Better relationships with the customers lead to more projects in the future, and so on. Therefore, this cycle can continue moving forward in a virtuous fashion. The model presented in this paper is not very different from the balanced scorecard proposed by Kaplan and Nortan in 1992 [6]. However, this model is a modification as it emphasizes the role of shared space in balancing these four perspectives.

We saw this virtuous cycle in the case of Orion's sustenance operation. Customer satisfaction from dispersed operations increased over time as the processes and tools, put in place by the organization attained maturity. These tools and processes were co-created by developers and managers working from different locations and were used across all the dispersed locations of the organization. As these processes and the tools inscribed with these processes were put in the shared space, the balancing of these four different perspectives assumed greater importance for sustainability of the operations over a longer period of time.

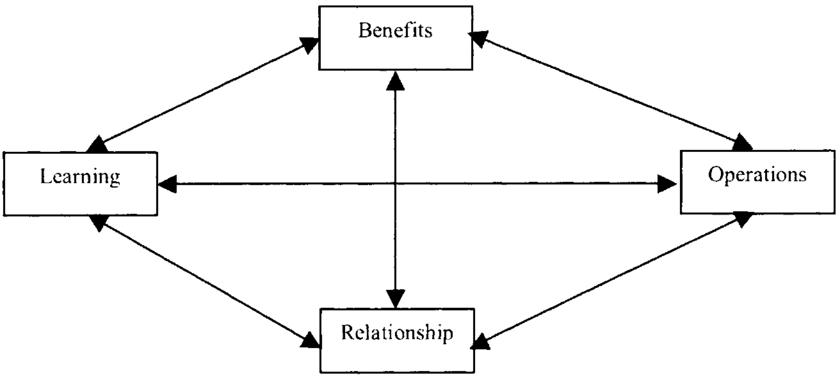

Figure 1: Balancing of different perspectives

5 Implications

Many researchers [7-10] have written about different factors that can have an impact on globally distributed work, but they have not proposed a model that can help practitioners. This study tries to build a case for a balanced model taking into consideration the different factors that other researchers have also discussed.

We have shown that "shared space" is a result of negotiations among different teams involved in globally distributed work. Initially, organizations start their operations with very little shared understanding, but over a period of time their understanding of each other gets synchronized. This was shown with the help of the process maturity model. Once created, this shared space can start a virtuous cycle, leading to a mutually satisfactory situation for all stakeholders.

Creation of this shared space leads to a balancing of the different perspectives of the stakeholders. Customers are interested in developing better relationships, benefits, and operations; developers are interested in learning, operations and benefits; and an organization is interested in all of the four dimensions of this model. Hence, balancing these four dimensions assumes great importance in globally distributed work.

The findings reported in this paper are the result of only one case. The risk of forming conclusions from this small sample may lead to generalizations that may not hold true for all cases. Additional studies are required so that we can understand how globally distributed software work evolves over a period of time. It is expected that the proposed model will facilitate further research in gaining deeper and balanced understanding about learning, operations, benefits and relationships in globally distributed work.

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About the Authors

Dr. Rajeev Sharma is an assistant professor at XLRI School of Management (India). He is also a fellow of Indian Institute of Management. His areas of interest include information system strategy of organizations, implementation of information systems, and financial valuation of benefits accruing from information system implementation.

S. Krishna is a Professor in Information Systems at the Indian Institute of Management Bangalore (IIMB). His teaching and research interests focus on managerial issues in global software & IT industry and information systems in developing countries. His recent books (authored with collaborators) are Global IT Outsourcing: Software Development across borders (Cambridge University Press, Cambridge) and The Digital Challenge: Information Technology in the Development Context (Ashgate, London).

Section 4

Group Processes in Virtual Teams

11

A Structurational Perspective on Leadership in Virtual Teams[1]

Robert Heckman[1], Kevin Crowston[1] and Nora Misiolek[2]
1 Syracuse University, School of Information Studies
348 Hinds Hall, Syracuse, NY 13244 USA
Telephone: +1 (315) 443–1676, Fax: +1 866 265–7407,
Email: crowston@syr.edu
2 Marist College School of Computer Science & Mathematics

Abstract. Building on behavioural leadership theory and structuration theory, we present a two-order theory of leadership. It describes four classes of first-order leadership behaviours (*task coordination, substantive task contribution, group maintenance* and *boundary spanning*) and defines second-order leadership as behaviour that influences changes in the structure that guides group action. We argue that second-order leadership is enabled by first-order leadership and is therefore action embedded and grounded in processes that define the social identity of the group. We propose that effective virtual teams will exhibit a paradoxical combination of shared, distributed first-order leadership complemented by strong, concentrated, and centralized second-order leadership. We conclude by suggesting future research that might be conducted to test and further elaborate our theory.

1 Introduction

We develop a theory of leadership in virtual teams, networked self-organizing technology-supported small groups. Virtual teams are of great interest to organizations because of their ability to bridge discontinuities of time and geography

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to enable access to and transfer of knowledge across geographic and organizational boundaries, thus leveraging human and intellectual capital [1]. Because they can rapidly bring together the specific expertise needed to solve immediate problems regardless of geographical location, virtual teams also permit organizations to respond quickly to unexpected changes in the environment and to non-routine problems. As a result, virtual teams are an increasingly important part of the adaptive capability of an organization to respond to uncertainty and complexity.

Unfortunately, as teams broaden in scope and membership they become increasingly difficult to manage. In particular, members of virtual teams may come from a variety of organizations or sub-organizations; rather than being assigned to the team by a common manager, members often voluntarily choose to participate. As a result, these teams are often *self-organizing*, that is, they are characterized as having a "high degree of decision-making and autonomy and behavioural control at the work group level . . . (such that) a much greater emphasis is placed on control from within rather than outside the group" [2]. A particularly important example of self-organizing teams are those created in the context of inter-organizational alliances where members come from different organizations but there is no dominant partner to impose a structure. Indeed, participants in virtual teams may represent no organization at all, as is often the case in Internet-enabled collaborations such as Wikipedia and Free/Libre Open Source Software (FLOSS) development teams. As organizations become increasingly knowledge-based and dependent on effective coordination of specialized knowledge for competitive advantage, teams in general, and these sorts of virtual teams in particular, grow in importance.

The primary contribution of this paper is to develop a set of theoretical propositions about the nature of emergent leadership in virtual teams based on behavioral leadership theory and structuration theory. We further develop these propositions by considering how structure can be instantiated in shared mental models and the specific behaviors that contribute to building such models. Finally, because there are interesting suggestions that can be gleaned from the nascent literature on leadership in virtual teams, we present propositions about patterns of emergent leadership that seem likely to be more effective. We focus on leadership in virtual teams for two reasons: the high level of discontinuities in virtual teams seems to pose particular challenges for leadership, and, as we discuss in our literature review, existing theories of group leadership do not seem to fully account for the leadership dynamics found in such teams. In the remainder of this subsection we describe these two problems in more detail.

First, Watson-Manheim, Chudoba & Crowston [3] suggest that virtual work is characterized by numerous *discontinuities*, defined as a lack of coherence in some aspects of the work setting. Discontinuities are created and/or exacerbated by the specific features of virtual teams: often fluid organizational membership, minimized organizational context, lack of face-to-face communication, reliance on asynchronous communication, and lack of formal status cues. These discontinuities are problematic for virtual teams because they hinder team members' abilities to make sense of the shared task and of communications from others, or they produce unintended information filtering or misunderstandings [4]. The separation between members may ultimately result in an ineffective team [5, 6]. Researchers have suggested that team leadership is key to helping team members overcome these barriers to performance [7, 8].

Second, the nature of leadership in virtual teams does not seem to be adequately described by current theories of leadership, as we will discuss in more detail in the literature review. In the absence of formally designated leaders, members within the team lead on a "voluntary" basis, either individually or collectively. In these circumstances, leadership is said to be *emergent*. According to Berdahl [9], leaders emerge when "one or more of a group composed initially of equal status peers . . . exhibits notably higher levels of leadership behaviour and thereby attains higher status in the eyes of fellow group members." Some virtual teams will evolve a leadership structure in which a single member emerges and is recognized by other members as the team's leader, while other teams will evolve a less-centralized leadership structure based on interaction and influence patterns. In the second kind of team, a very different form of leadership seems to be at work. No single individual plays an obviously dominant role. When asked who their leaders are, members of these teams will often say, "We have no leaders." If members of a team claim to have no leaders, is it accurate to say that the team has no leadership? Such situations pose several problems for most traditional conceptions of leadership, which is the second motivation for our paper. We argue that leadership is indeed at work in these situations, but in a form that must be looked at differently than as presented by most current theories of leadership.

In the following sections of this paper, we first introduce the two building blocks of our theorizing, leadership theory and structuration theory. We then develop a theory of emergent leadership behaviors in virtual teams. Our focus on emergent leadership leads us to try to characterize the process of emergence rather than to develop a static picture of leadership characteristics. The main contribution of our paper is the integration of various social theories to develop theoretical propositions about emergent leadership in virtual teams and, secondarily, of what patterns of leadership seem to be most effective. Our paper thus provides direction for future research by suggesting what concepts and relationships to study and what kinds of data to collect. We conclude by describing directions for future research to test or further refine and extend our theory.

2 Theory Review

In this section, we review research on emergent leadership in virtual teams, identify the problems these teams pose for existing theories of leadership, and suggest adopting a behavioral perspective on leadership.

2.1 Leadership Theory

As noted above, the presence of discontinuities in virtual teams suggests that team leadership may play a particularly crucial role in enabling team effectiveness.

Leadership has been the topic of extensive research in the general management literature [10, 11]. It is impossible to do justice to this voluminous literature in this paper, so our review is necessarily focused on those theories that are most applicable to our setting. Specifically, we consider only tangentially the preponderance of the literature that focuses on leadership within formal organizational hierarchies, because the nascent literature on leadership in virtual teams [7, 8, 12] suggests that this setting differs fundamentally from leadership in virtual teams. Instead we focus on two streams of research that address in part the phenomenon of "leaderless" teams: (1) leadership in self-managing teams and shared leadership, informed by functional behavioral leadership theory, and (2) the emerging literature on leadership in virtual teams. These views of leadership depart from much of "traditional" leadership theory (for example, trait theory, contingency and situational leadership theories, social exchange and strategic contingencies theory, and leader-member exchange theories) in their basic assumptions about the nature of leaders. Specifically, these views acknowledge that leadership can be shared among team members and that more than one leader can emerge during the course of a team's interactions, rather than restricting attention to formal leadership within organizational hierarchies. In the remainder of this section, we briefly review these theories as background to our own theorizing.

Shared leadership in self-managing teams. We draw first on the concept of *shared leadership*, which is defined as:

> A dynamic, interactive process among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals or both… (that) often involves peer, or lateral, influence and at other times involved upward or downward hierarchical influence [13].

This perspective, similar to the notion of distributed leadership [14], conceptualizes leadership in terms of relational processes and interdependencies among social networks or networks of influence [15]. It differs from conventional leadership theory by conceptualizing leadership as a group-level rather than an individual-level phenomenon. Shared leadership suggests that it is unlikely that a "single multi-role leader" will emerge. Decades of research on small team interactions supports the notion that different individuals perform different leadership roles as circumstances warrant. For example, Houghton and colleagues [16] observe that when the task-oriented and social supportive-oriented leadership roles in small teams have been examined empirically, these leadership roles are often split between two or more individuals. As a result, our research will consider that leadership may be shared rather than the responsibility of a single individual.

Misiolek & Heckman [17] found it useful to distinguish between two types of task roles, *task coordination and substantive task contribution.* Task coordination behaviors are those involved in organizing and directing the team's work (scheduling, dividing labor, creating processes) while substantive task contributions are those that actually accomplish the team's work (idea generation, evaluation, synthesis) Thus, leaders may exercise their influence by means of their substantive expertise as well as through their coordinating and directing activities. Finally, in addition to the task and leadership functions which leadership must satisfy, Ancona and Caldwell [18] argued that there are also leadership functions involved with maintaining relations with individuals and groups outside the team, which they called boundary spanning.

Leadership in virtual teams. The nascent literature on leadership in virtual teams does provide some insights into the behavioral nature of leadership in these teams, and it has considered issues including leadership structure, initiation behavior, and communication quantity and content.

- *Leadership structure.* In the absence of a formal or appointed leader, the literature suggests that different leadership structures evolve within virtual teams [17, 19]. Some teams evolve a leadership structure in which one or two emergent leaders take the initiative to structure and guide the teams' work, while others evolve a more distributed structure in which the leadership of the team is shared by its members [12, 17].
- *Initiating behaviors.* While only two studies examined the relationship between emergent leadership and initiation of communication, both suggest that taking initiative is associated with being identified as an emergent leader [12, 20].
- *Quantity of communication.* Findings from studies of distributed team dynamics suggest that emergent leaders communicate with team members more frequently than non-leaders [12, 17, 19, 21].
- *Communication content.* The literature suggests that although emergent leaders may engage in both more task-oriented and relationship-oriented communication than non-leaders, only task-oriented communication is associated with being identified as an emergent leader. Pescosolido [22] and Hart and McLeod [23] suggest that emergent leaders increase their task-oriented communication in order to reduce ambiguity, provide direction, and move the work of the team forward.

Summary. The shared leadership perspective and the results of empirical investigations of emergent leadership in virtual teams suggest that leadership can be both shared and emergent. Behavioral leadership theory provides additional insights into the classes of leadership behavior that leaders in these types of teams manifest, specifically *task coordination*, *substantive task contribution*, *group maintenance*, and *boundary spanning* [11]. However, while behavioral leadership theory provides a framework for identifying classes of leadership behaviors, it falls short in explaining changes in leadership behaviors over time in response to changes in team composition and the environment; how leadership behaviors enacted by individuals guide team interaction in these contexts; and how structures for task performance and team interaction emerge in conjunction with ongoing interaction and in the absence of a formal hierarchical authority. Understanding these dynamics is the motivation for our theorizing.

2.2 Structuration Theory

To conceptualize the dynamic process by which individuals' actions can provide emergent leadership in virtual teams such as FLOSS development teams, we adopt a structurational perspective [24]. Numerous authors have used a structurational perspective to frame empirical analyses of team activities [25] and in particular, the development of virtual teams [26]. We chose this framework because it provides a recursive view of the relations between team structure and the actions of those that live within, and help to create and sustain, this structure. In particular, it provides a framework for analyzing how the leadership behaviors of one member might shape the actions of others even in the absence of traditional modes of authority.

Structuration theory is best described as a meta-theory: that is, rather than specifically describing the relations between particular factors of leadership, structuration theory describes the form that such a theory should take. Specifically, structuration theory suggests that a theory of leadership in virtual teams should consider structure and action in these teams and how the two are interrelated. By structure, we mean the rules and resources that influence, guide, or justify individual action. Structure is "encoded in actors' stocks of practical knowledge" [27] and "instantiated in recurrent social practice" [28]. In our work, we consider three kinds of rules and resources identified in prior work [27, 29]: (1) interpretive schema that create structures of signification, (2) authoritative and allocative resources that create structures of domination, and (3) norms and rules that create structures of legitimation. Individual actions may be guided by these structures or may seek to change them, as will be discussed further below.

Structure matters because the development of shared structure improves team performance if it enables more effective contributions by team members. That is, it is not a question of the presence or absence of structure, but rather its nature and the degree of agreement among team members. For example, without common interpretive schema (a kind of shared structure), individuals from different teams or backgrounds may interpret tasks differently based on their backgrounds, making collaboration and communication difficult [30]. The tendency for individuals to interpret tasks according to their own perspectives and predefined routines is exacerbated when working in a distributed environment, with its more varied individual settings and less opportunity for informal discussion.

We turn now to the question of how structure is developed. The key notion here is the "duality of structure," meaning that the structural properties of a social system are seen as both the means and the ends of the practices that constitute the social system. As Sarason [31] explains, in structuration theory:

> The central idea is that human actors or agents are both enabled and constrained by structures, yet these structures are the result of previous actions by agents. Structural properties of a social system consist of the rules and resources that human agents use in their everyday interaction. These rules and resources mediate human action, while at the same time they are reaffirmed through being used by human actors or agents. (p. 48).

Simply put, by doing things, we create the way to do things. Or as Askehave & Swales [32] put it more poetically, "the wheels of life go round, and as they go round, they form ruts which channel the wheels of life."

Figure 1, adapted from Barley and Tolbert [27], graphically summarizes the relation between institution (which the authors use synonymously with structure) and action, and how both evolve over time. In this figure, the two bold horizontal lines represent "the temporal extensions of Giddens' two realms of social structure: institutions and action," while the "vertical arrows represent institutional constraints on action" and the diagonal arrows, "maintenance or modification of the institution through action" (p.100). For example, the influence of a team norm on a developer to use a particular testing strategy is represented by a downwards vertical arrow, while reinforcement or changes to the norm, due to actions, is represented by an upwards diagonal arrow. We use this model of action and structure as the basis for our theorizing about the nature of leadership in virtual teams.

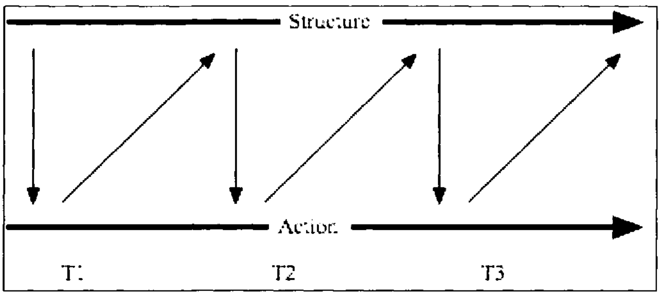

Figure 1: A sequential model of the relation between structure and action.

3 Theory Development: Emergent Leadership in Virtual Teams

In the following section we develop an argument that emergent leadership in virtual teams consists of behaviors that generate or reinforce structure (the upwards diagonal arrows in Figure 1). While it might first appear that a consideration of leadership would be relevant primarily to an understanding of structures of domination, we propose that leadership in virtual teams is expressed through all three systems of structure: signification, domination, and legitimation. Indeed, leaders of virtual teams may lack formal control over authoritative and allocative resources that produce structures of domination. Instead, based on the combination of functional behavioral leadership theory and structuration theory reviewed above, we argue that a key role of emergent leadership in virtual teams is the development of the full range of structures that guide the actions of team members and overcome the challenges created by discontinuities. Thus we define leadership in this context as:

Definition. *Leadership in virtual teams is a process that results in the reinforcement, creation and ongoing evolution of team structures.*

Based on this definition, we present four propositions that describe the specific aspects of the nature of emergent leadership in virtual teams and follow with a set of research questions for future study.

3.1 A Two-order Theory of Emergent Leadership in Virtual Teams

If leadership in virtual teams is a process that results in the reinforcement, creation and ongoing evolution of structures, how does this process operate? The structurational perspective suggests that some actions serve to reinforce existing structures, while others have the effect of modifying structures. It therefore suggests discriminating between two orders of leadership: one that influences team member behavior while maintaining existing structures (first-order) and one that works by modifying team structures (second-order). Thus we propose that leadership in virtual teams operates on two, interrelated levels:

Proposition 1: *Leadership in virtual teams operates on two levels. First-order leadership is predominantly functional. It operates within the constraints of, and reinforces existing structures. Second-order leadership is predominantly transformational, and operates to modify or transform structures as needed.*

The functional theories of leadership reviewed above identified four classes of leadership behaviors that we view as first-order leadership: (1) task coordination, (2) substantive task contribution, (3) group maintenance, and (4) boundary-spanning. These behaviors are especially important in virtual teams. Because such teams lack the formal, hierarchical supervisory structure that assumes much of the coordination burden in traditional teams, they are highly dependent on the emergence of effective and adaptive first-order leadership behaviors. Rather than following a division of labor based on the direction of a manager, team members decide for themselves what they will do (and not do), based in part on observations of what others are doing (and not doing). Most importantly, first-order leadership influences team members by reinforcing existing structures that shape and constrain team member action.

Second-order leadership, on the other hand, is a process that results in modifications to the structures of signification, domination, and legitimation. While first-order leadership influences team member behavior within the given constraints of existing structures (and thereby serves to reinforce them), second-order leadership effects change in the structures. The distinction between first-order and second-order leadership is analogous to the distinction between single-loop and double-loop learning as proposed by Argyris and Schon [33], and the distinction between first-order and second-order change as described by Watzlawick, Weakland and Fisch [34].

Nature of first-order leadership. Positing a distinction between first-order and second-order leadership raises two primary questions that inform our research. First, we propose to identify the patterns of first-order and second-order leadership that emerge in virtual teams, and, second, of those that emerge, which are likely to be most successful. Propositions 2 and 3 address these questions.

First, we consider the pattern of first-order leadership. Research has documented that different teams faced with similar contextual and task demands often evolve very different role and leadership structures and different work practices [17, 35]. For example, in one study [17], virtual teams working on identical tasks within a controlled context developed very different functional leadership structures, some highly centralized with one or two strong leaders performing leadership behaviors, and others highly decentralized with leadership behaviors widely distributed [17]. We expect the teams that say they have no leaders may instead have a form of shared leadership where first-order leadership is widely distributed among the team's members.

However, we propose that decentralized first-order leadership will lead to more effective virtual teams. First, research on face-to-face teams [36] suggests that the same individual is unlikely to perform all four functional leadership roles equally well. Second, teams that attempt to integrate diverse, specialized knowledge workers [37] may require many different kinds of first-order leadership in the form of substantive task contribution. Finally, the voluntary, self-organizing nature of many virtual teams may create other pressures for distributed first-order leadership. In the area of task coordination, for example, self-assignment is often the predominant mode in which division of labor is accomplished [38], a significant difference from the centralized, hierarchical task assignment mechanism found in traditional organizations. In short, the discontinuities that characterize virtual teams create a pressure for distributed first-order leadership. We thus offer the following:

Proposition 2: *First-order leadership can be either centralized or distributed, however, it is more likely to be fluid, distributed, emergent, and widely shared in effective virtual teams.*

Nature of second-order leadership. We next consider the pattern of second-order leadership. As with first-order leadership, we propose that virtual teams will evolve a variety of second-order leadership structures, but in the case of second-order leadership, we propose that a more centralized or concentrated form will be associated with effectiveness in the long run. That is, we propose that the most effective virtual teams will be characterized by a leadership structure that includes widely distributed and shared first-order leadership complemented by strong, centralized second-order leadership. We argue that centralized second-order leadership will be more effective because of the need for clarity and agreement among team members about the important social structures that govern and constrain their behavior. To be effective, teams must have a high degree of shared consensus about structures of signification, domination, and legitimation. This is more likely to occur in teams that have strong leaders who are able to clearly articulate a vision of these structures that is broadly embraced by team members. Studies by Kayworth and Leidner [39] and Piccoli et al. [19] suggest that the most effective virtual teams were those in which one or two team members took the initiative to clarify team members' responsibilities and work process structures. We thus offer the following:

Proposition 3: *Second-order leadership can be either centralized or distributed, however, it is more likely to be centralized in effective virtual teams.*

Relationship between first and second-order leadership. Whether second-order leadership is highly concentrated and centralized or widely distributed and shared, a fundamental question remains: How do those who are able to influence change in underlying team structures gain the power to do so (i.e., why are some actions structure changing and others not)? We propose that the answer to this question lies in the nature of the interrelationship between first-order and second-order leadership. Our preliminary observations suggest that second-order leadership is *action embedded.* By this we mean that second-order leadership derives its authority not from communication alone, but from substantive, action-oriented contribution. Such substantive contribution will take different forms depending on the task and mission of any given team. We thus offer the following:

Proposition 4: *First-order leadership behavior, especially substantive task contribution, is a prerequisite for second-order leadership behavior. Members acquire "permission" to be second-order leaders by performing first-order leadership behaviors.*

This proposition, about how individuals accumulate the authority to lead in virtual teams, appears to conflict with commonly accepted theories of power that equate power with the capacity to influence team members. In this view, the ability to be a second-order leader (to influence change in social structures) is a function of the power an individual has accumulated. In the standard theories of power, this capacity is thought to derive from the control of resources that are valued or desired by others. Team members are believed to be dependent on resources controlled by the influencer for need satisfaction or goal achievement, and are thus they are willing to grant power [40]. In short, control of resources and resource dependence produces power and power is the source of influence. However, this approach has recently been challenged by a social identity model of leadership and power [40], which reverses the causal sequence. The social identity model argues that it is psychological group formation that produces influence, and that power and control of resources derives from influence [40]. In self-organizing virtual teams, control of resources and dependence are problematic concepts, because team members are often volunteers who are free to work as little or as much as they like and to leave the team at any time. Thus the social identity model theoretically supports the action-embedded nature of second-order leadership we have observed.

3.2 Shared Mental Models as Structure

The theory we have developed above describes effective leadership in virtual teams as a process that results in the reinforcement, creation and ongoing evolution of effective structure. To further develop our theory of effective leadership in virtual teams, we must identify the particular second-order leadership behaviors that create and evolve structure. To do so, we need to examine in more detail the constitution of structure in virtual teams. Schein [41] argues that structure reflects still deeper levels of shared basic assumptions and beliefs (which he considers the deepest levels of culture). We suggest that these shared assumptions and beliefs can be viewed as forming *shared mental models.* Shared mental models, as defined by Cannon-

Bowers & Salas [42], "are knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and in turn, to coordinate their actions and adapt their behavior to demands of the task and other team members." (p. 228)

The issue is not so much whether team members have mental models, but rather the degree of similarity among the models of team members. Prior research suggests that the existence of accurate shared mental models that guide member actions are important for team effectiveness [42]. Leadership in virtual teams therefore can be seen as an influence process that results in the creation, maintenance, and ongoing evolution of accurate shared mental models, and effective leadership translates into creating such shared mental models. Thus, we share with Schein [41] the notion that a primary operation of leadership is the transmitting and embedding of shared cognitions through the development and modification of shared mental models.

3.3 Summary

In summary, we argue that second-order leadership consists of behaviors that build accurate shared mental models in the form of commonly accepted interpretive schema, role structures and rules and norms for behavior. The propositions above suggest that second-order leaders will be those individuals that contribute to socialization, conversation and recapitulation to build effective shared interpretive schema; to task division and decision process development to build effective shared role structures; and to collaborative, interactive problem solving, political negotiation, and experiential learning to build effective shared rules and norms.

Is such change incremental or discontinuous? Advocates of double-loop learning [33] believe that change in underlying structures is only possible when groups have consciously reflected on conditions eliciting a need for change, have surfaced the group's deep assumptions and beliefs, and engaged group consensus for change. In effect, double loop learning theory requires that group members be consciously aware of team structures before they are able to change them. Before changes in theory-in-use (the tacit structures that govern behavior) are possible, members "require external references. There must be public representations of organizational theory-in-use to which individuals can refer . . . . These are the shared descriptions of the organization which individuals jointly construct and used to guide their own inquiry" [33].

In contrast to this highly rational, discontinuous change model, we propose that the structural change influenced by second-order leadership may sometimes also result from a more incremental, subconscious process. For example, a team's role structure may gradually evolve as the overall task of developing the system is divided into pieces suitable for different kinds of participants. The job of coordinating task assignment is an example of first-order leadership, and much of this work will be distributed self-assignment—individuals voluntarily taking on tasks for which they have particular skills or interest. But as the role structure evolves, second-order leadership will call attention to and clarify the newly emergent structure, and influence the group to embrace it. The process of consciously surfacing and describing underlying structures may not be necessary in our context because in virtual teams using information and communication technology to collaborate the transparent dialogues themselves, archived for subsequent viewing as they are, become the external reference called for by Argyris and Schon [33], the public representation of organizational theory in use to which individual members can refer.

4 Discussion

In this paper we have presented a two-order theory of leadership in virtual teams, using an approach built on a foundation of structuration theory and functional, behavioral leadership theory. Because functional leadership theory does not fully explain the relationship between leadership and group change, we have expanded upon it to include the notion of second-order leadership, a form of leadership that influences changes in the structure that guides group behavior. We have proposed — that effective virtual teams will exhibit a paradoxical combination of widely shared, distributed first-order leadership complemented by strong, concentrated, and centralized second-order leadership. Finally, we have proposed that second-order leadership is enabled by first-order leadership, is therefore action embedded, and is grounded in processes that define the social identity of the team.

We conclude this paper by discussing several methodological issues and possible research questions to guide future systematic inquiry. We have described the process of leadership in virtual teams as an influence process leading to the development, maintenance, and evolution of accurate shared mental models. A variety of research approaches could be applied to study this process. Use of interview data would enable exploration of the group members' perceptions of the leadership process and allow direct comparison between different members' mental models, thus explicitly examining how shared models are developed. On the other hand, content analysis of the interactions between members of virtual teams would enable detailed analysis of the influence process as it unfolds. Such analysis infers the deep structures and processes from informed examinations of the artifacts that these surface level dialogues provide. This approach has the advantage of avoiding reliance on the recollections of team members, which may degrade over time or be unreliable in other ways. However, two guidelines for such research should be kept in mind. First, observations should be longitudinal and dynamic, carefully observing changes that occur over time. The phenomenon of leadership is inherently rooted in the passage of time and cannot be observed in a snapshot. As a structurational process, it can only be seen through a longitudinal lens. Second, the unit of coding and analysis in such research should be the episode. Leadership is fundamentally an interaction process between leaders and followers, and such interactions are best observed episodically.

The two-order leadership theory and propositions we have presented suggest several specific research questions to be addressed in our future work, and these questions apply to the study of effective leadership of virtual teams more generally:

RQ 1. What are the dimensions of first-order leadership? Building on functional leadership theory, we have proposed that first-order, functional leadership consists of four classes of behavior: (1) coordination, (2) substantive task contribution, (3) group maintenance, and (4) boundary-spanning. Future research should assess whether these four dimensions provide a relatively comprehensive description of first-order leadership.

RQ 2. What patterns of first-order leadership emerge in virtual teams? In previous research on leadership in virtual teams [17], we observed that very different patterns of first-order leadership can exist in different teams. While we have discussed centralized versus decentralized leadership patterns, such a distinction may prove to be too simple to fully describe the leadership patterns that emerge in various types of virtual teams. Future research should classify the first-order leadership patterns that emerge in order to develop valid and reliable operational definitions of centralized and decentralized patterns.

RQ 3. How do patterns of first-order leadership evolve over time? Leadership is not a static phenomenon. As teams grow and attract new members, lose existing members, or face new environmental constraints, leadership patterns may change. For example, in our current study of FLOSS teams [43], we observed growing levels of participation in decision-making in one project and declining levels of participation in another. A longitudinal research design will be necessary to systematically observe and understand such dynamic changes in leadership patterns.

RQ 4. What aspects of structure are most important to observe in order to understand second-order leadership, and what is the nature of this structure? We have described structures of signification, domination, and legitimation that exist in virtual teams, and we have suggested that shared mental models underlie all three types of structures. Again, the observation of various types of virtual teams will allow us to inductively infer and classify these structures, better understand their nature, and their instantiation in actions.

RQ 5. How does second-order leadership influence change in team structures? Some scholars [33] suggest that deep structures are best modified by a rational, discontinuous change process that includes discovery of hidden beliefs and assumptions (structures), followed by a consensus-based examination of and experimentation with potential new structures. Others suggest that the change process might be less rational and more emotional, less discontinuous and more incremental, and action-embedded rather than communication-driven. Schein [41] noted that some of the most powerful mechanisms for embedding and reinforcing culture are based on leaders' actions—what they pay attention to, reward, sanction, and their reaction to critical incidents and crises.

RQ 6. How do second-order leaders gain influence? We have proposed that second-order leaders gain influence by virtue of their action-embedded first-order leadership contributions. We also suggested that this process is more consistent with the social identity model of power than with the traditional resource dependence models of power. These assertions require systematic testing that will best be accomplished through detailed longitudinal observations of numerous virtual teams.

RQ 7. How do different patterns of leadership (both first-order and second-order) relate to team effectiveness? Once we have inductively classified the first-order and second-order leadership patterns that emerge and have developed valid and reliable operational definitions of these patterns, we will be in position to test the proposition that the most effective virtual teams will exhibit decentralized first-order leadership and centralized second-order leadership.

RQ 8. What are the boundaries to first- and second-order leadership? We have argued that first-order and second-order leadership involve reliance on and changes to shared mental models. However, such models are never shared perfectly and so may present a boundary to the influence of this form of leadership. On the other hand, Kellogg et al. [44] note that coordination does not require equivalence or similarity of interpretations; rather, different teams can agree on "general procedures of exchange even while they may have different local interpretations of the objects being exchanged" (p. 39). The onion-like structure in FLOSS teams [45] provides an interesting setting to explore this question. We expect core members to have a high level of commonality in their mental models, but that this commonality will decrease in less active members.

The theory and propositions we have developed represent an attempt to integrate and consolidate several previously developed theoretical perspectives on leadership and group dynamics in virtual teams. We hope that this will provide a starting point for future research and thereby make a contribution to the study of virtual teams within the organization literature. We note that while we are particularly interested in virtual teams in which leadership is emergent, we believe that these propositions may also apply to cases in which leadership is assigned.

5 Conclusion

The primary contribution of this paper has been to develop a set of theoretical propositions about the nature of effective leadership in virtual teams. However, even in its nascent state our theory has some implications for the practice of leading small groups. The theory suggests specific actions that members of technology-supported distributed small groups can take to improve performance. These include ensuring that all first-order leadership functions are performed well and preferably by many team members in a decentralized mode. It also suggests that there is value in centralizing second-order leadership functions. Virtual teams might more explicitly recruit or select members who are particularly skilled at these functions and pay more attention to the on-going process of developing shared interpretive schema, role structures and rules and norms. More generally, educational programs for all kinds of workers might incorporate these ideas. For example, distance education classes that use technology support for instruction should provide instruction for students on the nature of leadership in virtual teams and thus set expectations for how the work can best be accomplished, as well as requiring team projects to provide an opportunity to practice these skills.

Whether these propositions are confirmed or disconfirmed by future research, understanding how teams of independent knowledge workers can more effectively work in virtual environments will improve both the traditional and non-traditional organizations within which they exist. The results of the research we hope to stimulate will then serve as a road map to improve organizational performance and foster innovation.

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About the Authors

Dr. Robert Heckman is Associate Professor and Director of the Graduate Program in Information Management at the School of Information Studies, Syracuse University. His current research is focused on effective use of asynchronous learning networks, leadership in virtual teams, and discretionary technology-mediated collaboration. He received his Ph.D. in Information Systems from the University of Pittsburgh in 1993.

Kevin Crowston is a Professor in the School of Information Studies at Syracuse University. His research focuses on new ways of organizing made possible by the use of information and communications technology, including in particular virtual teams and organizations. He approaches this issue in several ways: empirical studies of coordination-intensive processes in human organizations; theoretical characterizations of coordination problems and alternative methods for managing them; and design and empirical evaluation of new kinds of computer systems to support people working together.

Nora I. Misiolek is Assistant Professor of Information Systems in the School of Computer Science and Mathematics at Marist College. She earned her doctorate in Information Science and Technology from the School of Information Studies at Syracuse University, and holds an M.B.A. in Innovation Management and Marketing from the Whitman School of Management, also at Syracuse. Her research interests include virtual teams and collaboration, influence of information technologies on innovation, and technological entrepreneurship.

12

Ambassadorial Leadership

A Pilot Study of a Model for Leading Virtual Teams

Michael R. Ryan and Richard R. Reilly
Stevens Institute of Technology
Wesley J. Howe School of Technology Management
Castle Point on Hudson, Babbio Center, Hoboken, NJ 07030
mryan@stevens.edu
Richard.reilly@stevens.edu

Abstract. Existing models of leadership have been built on the assumption of face-to-face interaction, cultural homogeneity, and hierarchical organizational structures. We introduce a new model, Ambassadorial Leadership, which recognizes that different behaviors are needed for leading globally distributed virtual teams. The behaviors include those that are characteristic of an Ambassador who must be culturally sensitive, able to span boundaries created by geography and functional background, and able to help build a collective identity for the virtual team. We conducted a pilot study to examine the model and to compare our model to the transformational leadership factors. The results showed good discriminant and convergent validity as well as some indication that the new model adds some complementary dimensions to the transformational leadership model.

1 Introduction

Virtual teams have three basic characteristics: members are geographically, organizationally, or personally dispersed; collaboration and communication occur through the use of information technologies; and interactions are more likely to be temporally displaced or asynchronous [1, 2].

Although early scholarship tended to treat virtuality as a dichotomous concept [3] more recent research [4] has recognized that virtuality is a continuum. In fact, Arnison and Miller [5] believe there is no distinction between a virtual and traditional team, in that both utilize the same technology and communications. Finally, Fiol and Edward [6] presents the traditional vs. virtual argument as a continuum with two endpoints, the traditional and virtual teams. These end points are

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linked by hybrid teams that may exist at any point along the continuum. Along this continuum, the traditional teams would meet most frequently face-to-face (FTF); while virtual teams would rarely if ever meet FTF, and would depend predominantly on technically mediated interaction [2, 7].

Whether the team is collocated, global, or completely virtual, a predominance of technically mediated communications and collaboration presents new challenges to the team leader. Challenges such as building trust, motivating team members, bridging cultural diversity, and clarifying team goals are far greater and yet remain foremost the leader's responsibility [8]. Collaboration, whether it is FTF or computer mediated, occurs within a much broader context or climate, which includes interpersonal, social, organizational and technical factors, all of which have important implications for the attitudes and behavior of team members and their ability to succeed and innovate [9].

2 Virtual Teams and Virtual Distance

In addition to those items that are most frequently identified as the defining elements of virtual teams: geographic distribution, temporal dispersion, and technology driven communication [1, 2, 10], there are a number of other characteristics that may occur to varying degrees within a virtual team. These additional attributes contribute to the overall environment of the virtual team and must be considered by the virtual team in developing an overall strategy that will ensure the team's effectiveness and success. Some of the more frequently occurring attributes include: relational histories, cultural factors, infrastructure, isolation, identification, task interdependence; team size, FTF interaction, multi-tasking, and level of technical skills. As stated previously, these attributes may be present in varying degrees. Even if these elements are only minimally present, their combined effect can have a significant impact on team performance [4].

2.1 Identification and Faultlines

Virtual teams typically have a diverse membership determined by demographic characteristics, cultural background, skills, interests, etc. Lau and Murnighan [11] coined the term "faultlines" to describe characteristics that determine these sub-divisions. Faultlines can be determined by a single or multiple characteristics. Multiple characteristics that are aligned will produce stronger faultlines with a greater level of homogeneity within the sub-group.

Individual members of the virtual team frequently experience uncertainty and role ambiguity at the team's inception [6]. While these experiences are not unique to virtual teams, the traditional relief of a local supportive infrastructure may or may not exist. As a reaction to these stressors, the individual member will seek to join with other members who have similar attributes, interests, skills, demographic characteristics, etc. These sub-groups will form along the faultlines determined by those characteristics. With the formation of these groups, the members attain an immediate sense of identification and initial relief from some of the uncertainty and role ambiguity that existed [6]. This identification with sub-groups is attributable to social identity theory [12, p. 3].

The challenge in a virtual team is to develop a new allegiance to the comprehensive team and subsequently instill in the member an identity with this collective unit. This new identity may co-exist, complement, or challenge that of the sub-unit. When identity within the virtual team challenges the identity of the sub-unit, it can be detrimental to the effectiveness of the virtual team. This situation may arise from a number of factors; one possibility may be a strong and effective actor in the leadership position of a sub-unit. The emergence of a new leader for the collective virtual team may be viewed as a challenge to the sub-unit leader. This challenge could threaten the member's self-identity and create a conflict between membership in both the sub-unit and collective team. This situation may be further complicated if other sub-units also have a strong and effective leader that becomes evident with the forming of the virtual team.

How does the assigned team leader overcome this real challenge not only to authority, but also to the very real mission of the team? How does the leader maintain neutrality between the sub-units while demonstrating a strong commitment to the objectives of the team?

3 Leadership and Virtual Teams

The primary objective of our research is to examine a new approach to leading virtual teams. Research on leadership has a long history but the existing models are based on the assumption that interaction is mostly face-to-face and that organization structures are traditionally hierarchical. As we move toward virtual teams with globally distributed, culturally diverse subgroups, the relevance and efficacy of existing leadership models needs to be examined. Our objective in this pilot study was to test a set of items designed to measure factors that we hypothesized would influence the performance of virtual teams. We call our model Ambassadorial Leadership because we believe that networked, culturally diverse teams demand skills that are akin to those of an Ambassador. An individual who is culturally sensitive, can bridge organizational and cultural divides and act as a facilitator and mediator when conflict or misunderstanding arises because of differences in functional, geographic or cultural backgrounds.

3.1 Full Range Leadership Theory

The single most influential leadership theory in current academic research is transformational leadership [13]. In fact this theory combined with that of transactional leadership and laissez-faire has been called the Full-Range Leadership Theory (FRLT) in recognition of its broad acceptance and support based on empirical findings [14, 15]. Its popularity has far exceeded any of the other theories that have been spawned since Weber introduced the concept of the charismatic leader in the early part of the twentieth century [16]. Although transformational leadership is not the first of the neo-charismatic theories [17], its contributions to leadership research dictate a prominent role in any discussion.

Transformational leadership includes four types of behavior: idealized influence, individualized consideration, inspirational motivation, and intellectual stimulation [10]. Each of these four behaviors can affect the team members and subsequently the performance of the team itself.

Transactional leadership is composed of three behaviors: contingent reward, active management by exception, and passive management by exception [10]. Laissez-faire completes this theory by allowing for the absence of leadership.

Although transformational leadership has been widely accepted as a valid and useful theory, Yukl [18] offered some criticisms of the FLRT. First, he notes that, "Some important transformational behaviors are missing in the Bass [19] version of the theory and in the MLQ, which was designed to test the theory" [20]. Among the missing behaviors that Yukl identifies are those related to empowering such as consulting, delegating, and sharing sensitive information, all of which relate to the notion of shared leadership. He also notes group level behaviors including facilitating mutual trust and cooperation, building group identification, and collective efficacy. Finally, he notes that the model does not include behaviors that involve leader interaction with superiors, peers, and outsiders whose information, cooperation and political support are essential for a group's performance of its mission (for example, networking, acting as spokesperson for the group, negotiating agreements, persuading people to provide political support and necessary resources, resolving problems and conflicts with outsiders). Yukl also makes the argument that there has been insufficient specification of situational variables and their moderating effects on the effectiveness of FRLT. In particular he notes that organic structures and situations where boundary-spanning units supersede the technical core have not been studied sufficiently. Many virtual teams, and especially globally distributed virtual teams would appear to have precisely these characteristics: networked structures and boundary-spanning with respect to functionality and location.

3.2 Ambassadorial Leadership

Virtual teams, especially those that are geographically distributed and culturally diverse, require a rethinking of traditional leadership models. We hypothesized that four factors would complement the full range leadership model. These include, Internal Boundary Spanning, External Boundary Spanning, Shared Leadership, and Advocacy. Each of these factors should act to decrease the emotional and psychological distance between team members and subgroups and have positive effects on trust and team performance.

3.2.1 Internal Boundary Spanning

For a virtual team, internal boundary spanning is defined by the activities that bridge the geographically, culturally, functionally diverse team members. The needs that drive the interdependence between team members dictate the level of boundary spanning that must occur. A team that is highly differentiated often has a greater need to exchange information than a less differentiated team [21, 22]. This internal spanning may be of greater importance than external relationships depending on the tasks that are assigned to the team [21, 22]. As the team engages in collaborative effort, the members perceive it to be more effective and there is a positive effect on team cohesion [23, 24]. Vinokur-Kaplan [25] found a correlation ($p < 0.01$) between both team cohesion and interdisciplinary collaboration with team effectiveness. Seers, Petty, and Cashman [26] investigated team-member exchange and found that teams with a higher level of communication and collaboration were more efficient. They defined team-member exchange as the reciprocity between a member and his or her team.

Internal boundary spanning does not only exist in the one to many construct of the team-member exchange. It may also exist between sub-units within the team. These sub-units may result from faultlines that develop from different cultural, socio-economic, geographic, functional, or other differences between the team members [6, 11, 27-29].

3.2.2 External Boundary Spanning

Teams, whether traditional face-to-face or virtual do not exist in a vacuum. Their existence is associated with external sources, Sundstrom, Demeuse, and Futrell [21] state that it is necessary not only to consider the internal processes, but that effectiveness may hinge on the inherent relationship between the team and those external sources.

External boundary spanning addresses issues that exist between the team and these outside sources. Ancona and Caldwell [30] have identified four activities that may be included: (1) protection and persuasion; (2) task coordination; (3) scouting; (4) guarding. Protection and persuasion involves securing support and resources from the outside sources. Task coordination pursues specific elements from the outside sources that are required to complete the team's task. Scouting is concerned with gathering information and monitoring the competitive environment. Guarding is a function of managing the boundary to ensure that critical information that would inhibit the team's effectiveness does not pass through.

Boundary management contributes to the overall success of the team [22]. Similar to Ancona and Caldwell's [30] guarding are the Gatekeeper and Representative roles [31]. The leader or team designate that serves as a gatekeeper filters the information that is coming into the team and acts as a buffer to external sources. Likewise, the team's representative monitors and controls the information that the team reveals to external sources [31, 32].

Social network theory and diffusion theory reinforce the need for external boundary spanning in their own way. The ties that exist between the team and external groups provide an avenue for diffusion of information between the two entities [33, 34]. There is a need for leadership that acts as a broker between the team and the external units and helps to develop relationships between these entities [18].

3.2.3 Shared Leadership

The literature on shared leadership is extensive. From Mary Parker Follet's concept of the law of the situation in the early part of the twentieth century [35, 36] through the emergence of the self managed work groups of today, shared leadership has been described in a myriad of ways—vertical leaders, emergent leaders, self-managed teams, empowered teams, distributed leadership, etc [10, 37, 38]. Yukl [10, 18] suggests that shared leadership must be researched further and current leadership theories should place a greater emphasis as a contributor to the theory.

Lipnack and Stamps [39] are unequivocal about shared leadership and virtual teams; they state simply that it is the norm. House [40] describes three forms of distributed leadership: delegated, co-leadership, and peer leadership. Delegation involves a division of the leadership roles based upon the situation and skill sets needed. Co-leadership recognizes to distinct leadership roles—task leadership and social leadership. The suggestion is that one individual cannot adequately perform both roles. Peer leadership evolves when the tasks involved can be simultaneously executed by multiple individuals who thus share the leadership.

Within the framework of this research, shared leadership is aligned primarily with House's [40] delegated model. The co-leadership form will likely exist in an informal arrangement as it is expected to be evident within the sub-groups that emerge as a result of faultlines. In the virtual team, shared leadership confers additional status and responsibility on selected team members in different geographic, functional or cultural units. Leaders may empower team members or they may emerge in response to situational demands. Although these shared leaders may engage in multiple leadership roles, the final responsibility remains with the team leader.

3.2.4 Advocacy

Advocacy is an extension of the behaviors that exist within boundary spanning. It includes activities such as spokesman, negotiator, buffer, arbitrator, and others [18, 41]. Advocacy, as with boundary spanning, can exist wholly within the team or across external boundaries. Within the team, advocacy refers to the leader or other team member actively promoting, pleading, or arguing in support of a sub-group or member's efforts. Externally, advocacy is designed to secure external support for the team and individual members. Recognition, as cited above, may be one of the methods employed by the team leader or members to advocate for another individual, group, or even themselves. Advocacy may serve to build an esprit de corps, and in so doing it will reduce virtual distance, which should increase trust between members. This factor also includes behaviors that the team leader can use to encourage contributions from the team and individual team members. It may be employed when dealing with any external group in a general way by reinforcing the team's contribution to the organization as a whole.

4 Method

4.1 Instrument Development

In addition to reviews of the literature a series of interviews and discussion with experts and individuals experienced in virtual team led to the development of a pilot instrument that included the following factors: (1) internal boundary spanning (5 items), (2) external boundary spanning (4 items), (3) shared leadership (2 items), and (4) advocacy (8 items). All items used a Likert-type 0-4 point scale. The pilot study also included the 45 items from the MLQ-5X instrument. These items were included in the pilot so that we could examine convergent and discriminant validity for the Ambassadorial Leadership Model and the FLRT. The data for the pilot test was secured using a web based survey instrument that retained the responses within a database that was maintained on the hosting server. The database was accessible at any time by the administrator and it downloaded automatically into an Excel spreadsheet.

The sample included responses from the authors' industrial and commercial contacts, as well as current and former students in a Management of Technology Master's program. There were 178 responses to the web survey. Of these responses 45 were from undergraduate students. As it is unlikely they had experience with work teams outside of academia, these data were eliminated leaving a total of 133. Two additional responses were discarded, as they were obviously unresponsive. This produced a usable sample of 131 data points.

4.2 Results

A first step was to assess the factor structure of the a priori Ambassadorial factors. We first performed a confirmatory factor analysis (CFA) with the four hypothesized factors. The fit was marginal with a RMSEA of .0945, AGFI = .735; CFI = .917. Based on a review of the modification indices we decided to perform an exploratory factor analysis (EFA) on the data. The results yielded five factors with eigenvalues greater than 1.0 that we rotated according to the varimax criterion. Our interpretation of the five factors was as shown in Table 1. As a result of the factor analysis we determined that a fifth factor, Recognition was necessary. Recognition is a behavior that reinforces the efforts put forth by the team members. Recognition has been shown to be an antecedent of Perceived Organizational Support (POS) [41]. Additionally, employees with higher POS expect that extended effort on their part will result in greater reward and recognition. This creates an alignment between the organization's goals and that of the employee [42]. Recognition may emerge from a number of sources: direct recognition by the team leader [18], recognition from other team members [26], or recognition from external sources [42]. Recognition from external sources may occur in part by promotional efforts (advocacy) of the leader or other members of the team.

Table 1. Ambassadorial Leadership Factors

Factor	# items	Sample item
Internal Boundary Spanning (IBS)	5 (.67)	*helps build trust among team members across locations.*
External Boundary Spanning (EBS)	4 (.67)	*obtains political support for the team's mission*
Shared Leadership (SL)	3 (.62)	*shares sensitive information with team members in different locations*
Recognition (RC)	5 (.91)	*publicly recognizes the efforts and accomplishments of individual members to the rest of the team*
Advocacy (AD)	2 (.49)	*promotes the importance of the team's goals to the organization's senior management*

Note: Alphas for the Ambassadorial scores are shown in parentheses.

Scores for each of the Ambassadorial items were computed by taking the mean score on the items assigned to each of the five factors. We then examined the discriminant and convergent validity of the Ambassadorial factors. Table 2 shows the correlations between the Ambassadorial scores and the Transformational Leadership scores.

Table 2. Correlations between Transformational and Ambassadorial Leadership Factors

	IBS	EBS	SL	AD	RC
IS	.47	.31	.39	.30	.47
IC	.43	.37	.38	.38	.41
IM	.44	.38	.42	.36	.49
IB	.31	.28	.24	.20	.33

The average correlation between the Ambassadorial and Transformational factors was .37, in contrast to the within transformational average correlation of .65 and the within Ambassadorial correlation of .44.

We examined the regression of the outcome variables on the ambassadorial factors. The MLQ includes nine items measuring the influence of the leader on effectiveness, satisfaction and effort. A factor analysis revealed one large factor for these nine items accounting for 75% of the variance so we calculated an outcome score based on the average of the nine items. We then conducted a multiple regression analysis of the outcome variable on the five ambassadorial factors (see Table 3).

Table 3. Results of Regression of Outcomes on Ambassadorial Leadership Factors

Variable	Beta	t-value
IBS	.256	2.84**
EBS	-.023	-0.272
SL	.234	2.35**
RC	-.022	-0.245
AD	.314	3.58**

Notes: R2 = .38; ** = p<.01.

We then conducted a hierarchical regression analysis to determine whether the Ambassadorial items explained any additional variance in outcome over and above that explained by the Transformational Leadership variables. The results showed a significant increment in the squared multiple R when the five Ambassadorial items were added ($\Delta R2 = .043$; $F = 3.45$; $df = 5/121$; $p<.01$).

4 Discussion

Our results showed that our original four-factor model did not explain our data well and that a five-factor model was more appropriate. Our data indicate that the Ambassadorial model may complement the Transactional leadership model. The discriminant validity of the Ambassadorial factors was supported with relatively low correlations with the Transactional factors. In addition, the Ambassadorial factors predicted outcome variables and explained additional variance after the transactional factors were entered in a hierarchical regression analysis.

Although these results are promising, it should be noted that the pilot data collected in this study was not an ideal dataset with which to fully examine the Ambassadorial model. Our intent was to examine the convergent and discriminant validity of the Ambassadorial factors, but we did not collect data indicating whether the project teams were highly virtual or not. Our expectation is that as teams become more virtual with greater geographic and cultural differences the importance of the Ambassadorial factors in influencing team performance will increase. As a result of this pilot we have revised our questionnaire around the five factors suggested by our pilot data. We have added some new items and rewritten some others based on feedback from participants and experts. Preliminary indications are that the five-factor model of Ambassadorial leadership has sufficient construct validity to proceed with a larger scale data collection.

We are planning to collect data from several organizations with a mix of globally distributed teams with functional and cultural diversity. Our objective in this research will be to further examine the role of the Ambassadorial model and its influence on performance outcomes as measured by survey responses and organizational metrics. We will examine the following model, with the new, expanded dataset and we will be able to report on these results in July.

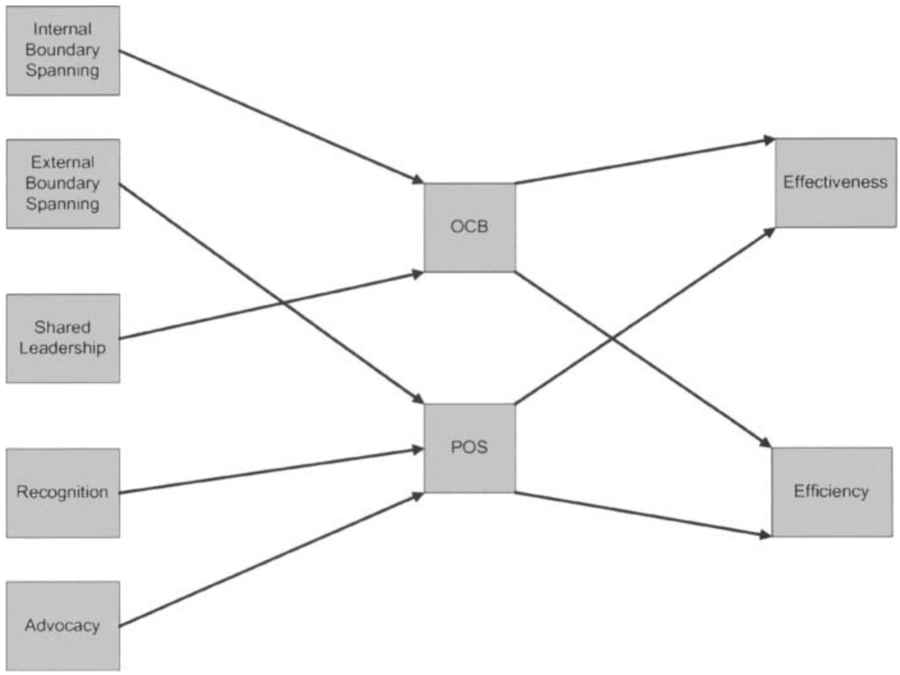

Figure 1. Proposed Ambassadorial Leadership Model

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About the Authors

Michael R. Ryan holds the Executive Masters of Technology degree from Stevens Institute of Technology. His research interests include leadership development, team development, product innovation, and project management. His current research focuses on ambassadorial leadership™ and its affect on team performance. He renewed his academic interest after 25 years in industry where he held leadership roles in the airfreight and logistics fields during his early career. He founded and subsequently sold his own logistics company and in 1989 he started an IT venture that addressed the computing needs of the SMB market. He spent the last 10 years in industry as a consultant for AT&T and Lucent Technology. Michael is currently a Ph.D. candidate at Stevens Institute of Technology, Hoboken, New Jersey. He plans to complete his degree in the spring of 2007. Consequently, Michael intends to start a career in academia where he can pursue both a teaching position and continue his research.

Richard R. Reilly received his Ph.D. from the University of Tennessee in Organizational Psychology. He has been a research scientist for Bell Telephone Laboratories, Educational Testing Service and AT&T. He is currently Professor, in the Howe School of Technology Management at Stevens Institute of Technology in Hoboken, New Jersey where he also heads the Ph.D. program. Dr. Reilly's research interests span the areas of measurement and assessment, management development and innovation. He has published over 60 journal articles and has co-authored several books including *Blockbusters* (2002), a book on innovation. He has been a consultant to government and Fortune 500 corporations in the areas of assessment, organizational development, leadership development, and employee selection. Dr. Reilly is a fellow of the American Psychological Association, the Association for

Psychological Science and the Society of Industrial and Organizational Psychology. He also holds a certificate in Industrial Psychology from the American Board of Professional Psychology. His current research interests include virtual team performance, leadership development, and innovation.

13

The Presentation of Self in a Virtual but Work-related Environment

From Protagonists to Fools

Emmanuelle Vaast
Long Island University, School of Business, 1 University Plaza—H700, Brooklyn, NY 11201, USA.
emmanuelle.vaast@liu.edu

Abstract. More and more people take part in virtual environments in which they present a "virtual self"—an online profile that indicates key information about them to other participants and viewers. This research investigates how people present themselves in the virtual yet work-related environments of occupational online forums. To do so, the research analyzes the profiles of more than 300 registered users of an online forum dedicated to issues of interest to bankers. These profiles are interpreted in relation to Goffman's (1959) seminal ideas of mystification (allowed by the separation between backstage and public action) and presentation of self and of Turkle's (1995) ideas of multiple, interrelated, online and offline selves. This research builds a grounded categorization of profiles. The four categories of profiles that emerged from the data correspond to clearly distinct ways participants in the online forums present themselves. Over time, two categories have become dominant while another has dwindled. This research holds implications for the understanding of the presentation of self in virtual but work-related environments. It shows how participants in online forums build their virtual self by playing with the mystification inherent of the virtual environment. It also shows an interplay between the virtual and the offline when some participants "de-mystify" their profile. Finally, the increasing prevalence of two categories of profiles suggests that, over time, social norms of presentation of self emerge and condition socially accepted virtual selves in occupational online forums.

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1 Introduction

The increasing ubiquity of electronic communications has changed the way people present themselves by providing greater freedom from the constraints of direct interactions, physical appearance, and disabilities [1-4]. The history of the Internet is full of stories of people who created an online persona that fooled others [5-6]. "Lonelygirl15" on *Youtube* is one such recent example of how people can manipulate the self they present in a virtual environment[1].

More generally, the virtuality of electronic communications makes it possible for people to control how they present themselves in ways that they deem favorable, as has been shown in the context of online dating and personal web pages [7-8]. This greater ability to control one's presence in a virtual environment than in regular "offline" contexts has become even more widespread as more and more people have become part of various virtual environments, either to play video games, discuss hobbies or news-related topic, find support for difficult offline situations, or ask, find, and exchange information related to one's job [9].

With regard to online forums in which people can exchange occupational information, the literature has already noted their learning potential [10], and it has discussed the motivation to actively participate versus merely lurking in these forums [11-15]. People usually become active users in these forums by filling out a profile that allows them to post questions and to get answers on issues related to their occupation. Despite the popularity of these forums and the fact that they attract many participants from various occupational fields, so far, the literature has not yet investigated the ways in which people present themselves in these forums. Yet, to convey an impression on the audience of the forums, one can expect that participants craft their online presence in a certain way, taking advantage of the greater freedom allowed by the electronic media. For instance, Butler et al. [15] suggested that certain (but not all) members of online forums take on authority roles without becoming official administrators of the forums. Also, McLure, Wasko, and Faraj [11] showed that active participants want to improve their reputation. It is possible that such members of online forums present themselves in ways that are designed to convey authority and to improve reputation.

This research investigates the ways in which people build their presence in the virtual environment of occupational online forums and, more precisely, explores how participants in occupational online forums present themselves when adopting an online profile.

The paper is organized as follows. It first presents Goffman's [16] conceptualization of presentation of self and explores how this conceptualization can be updated to fit virtual environments. Then, the investigated forum and interpretive research methods are presented to introduce the grounded analysis of more than 300 online profiles of users of the "Bankers On Line" (BOL) forum, an online forum dedicated to banking issues. The discussion section interprets how the different

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[1] http://www.youtube.com/profile?user=lonelygirl15

profiles in the samples express various ways of building a virtual self. It analyzes how these profiles may be related to offline situations and shows how the evolution over time of these profiles indicates the emergence of social norms of presentation of self. The conclusion section summarizes the research, presents its limitations as well as its main conceptual and practical implications.

2 Presenting Oneself in a Virtual Environment

2.1 Goffman and the Encounters of Everyday Life

Goffman was fascinated by the micro-sociological encounters that constitute social life. In particular, he developed a dramaturgical perspective in which people involved in interactions produce performances that aim at producing a certain impression on the audience [16]. In this perspective, performances and impressions are partly shaped by the social environment and by the audience's interpretation. An important dimension of the performance is its "front," that is, "that part of the individual's performance which regularly functions in a general and fixed fashion to define the situation for those who observe the performance." [16, p. 22]. Through his analysis, Goffman explored the relations between individual performances and social identity and contended that some fronts become prevalent and socially accepted by the audience and the performers.

2.2 The Presentation of Self in Virtual Environments

Goffman's seminal analysis solely concerned situations in which people are "in one another's immediate physical presence" [16, p.15], which does not fare well with a virtual environment. Interestingly, however, Goffman noted in [17, p. 2]:

> Social interaction can be identified narrowly as that which uniquely transpires in social situations, that is, environments in which two or more individuals are physically in one another's presence. (Presumably, the telephone and the mails provide reduced versions of the primordial real thing).

Virtual environments, in which interactions take place electronically, may also be viewed as other "reduced versions" of the "primordial real thing" with specific characteristics that affect the front that people can adopt. In this regard, electronic media arguably provide more limited opportunities than face-to-face interactions to present a sophisticated front, since people cannot rely on the rich palette of cues conveyed by co-presence [5; 18]. The difficulty to rely solely on words to convey complex messages and the occasional e-"flaming" that results in miscommunications and confusions are illustrations of the less sophisticated front that people present in virtual environments [19].

2.3 Mystification and Virtual Interactions

Yet, electronic communications allow for a greater "mystification," in Goffman's terms, that is, for a greater distance between performers and the audience, keeping the audience at awe. The audience's lack of access to the offline backstage of the performance creates such potential for greater mystification. Participants in virtual environments can therefore easily hide aspects of their offline persona they do not want known to others, while emphasizing other aspects they deem presentable. Such presentation of self online may also disinhibit from offline constraints [6; 20-21]. Turkle [6], in particular, showed how MUD users are able to present multiple fronts simultaneously in various virtual environments, and that, very often, these virtual fronts help MUD players cope with their offline situations.

There lays a question, though. So far, the literature on the presentation of self in virtual environments has been mostly dedicated to the investigation of individuals' or companies' web pages and blogs [22-24]. It has showed how people present a certain image of themselves online and has investigated the main characteristics of these images [8]. It has proposed that, online, people follow a strategy of ingratiation, through which they seek to be liked by others, or of competence, wishing to be perceived as skilled and competent [25-26]. Hence, these studies have corroborated the idea that people try to present themselves in an idealized way [27]. However, they have not yet investigated the social nature of mystification and idealization. Essential to Goffman's conceptualization is that, through mystification, people aim at producing an impression that is *socially* sanctioned, and that the personal front represents norms and values that are consistent with the social groups or communities with which people identify [16, pp. 67-70; 28]. Idealization and mystification are thus not mere strategies of the individual. Rather, they are social in nature; they position people in their social environment.

The literature on the presentation of self in virtual environments has not yet much investigated this social dimension. The data collected for this research thus aimed at exploring the presentation of self in an occupational online forum and, possibly, at identifying emergent social norms of presentation of self in a virtual and work-related environment.

3 Methods

3.1 Research Setting: Bankers On Line Forum

An online forum dedicated to issues of interest to bankers constitutes the setting of this research. This forum is publicly available from Bankers On Line (BOL)[2], a website dedicated to all banking issues that includes news, legal information, training opportunities, blogs, and a forum. Most contents of the BOL website are publicly available. The BOL website was selected for two reasons. First, bankers are not

[2] www.bankersonline.com

known for being especially computer savvy or extremely willing to adopt innovative behaviors with regard to IT (as contrasted with, say, computer programmers or analysts). Focusing the investigations on the presentation of self of members of an occupation that cannot be considered among the "early adopters" of IT could provide an idea of how "mainstream" impression management in occupational yet virtual environments had become. Second, the BOL website is well-known in the banking industry and various members of the occupation acknowledged (independently from this research) their repeated use of the website and mentioned the popularity of the website among their colleagues.

This research analyzes profiles filled by registered users of the BOL forum. Overall there are more than 12,000 registered users (Fall 2006). Registration is free and open to anyone from the banking and the non-banking industries. Registered users can browse the threads but cannot participate in the discussions. It is noteworthy that, until after data were collected, anyone (registered or non-registered users) could freely browse the profiles of registered users. Registered users (henceforward called users) can browse, ask, and answer any question on any BOL forum (about 20 threads in Fall 2006, dedicated to issues ranging from compliance to state specific issues and from chat to security or human resources, see url: http://www.bankersonline.com/ubbthreads/ubbthreads.php/Cat/0).

Participants' profiles consist of various items that users may or may not fill: user id (only mandatory field), e-mail, member number (automatically attributed depending on when the user registered), homepage, occupation, hobbies, location, birthday, bio, and date of registration. The BOL website also automatically gives users' a "title" (according to the number of posts), and publishes their total posts. Figure 1 provides an example of such a profile.

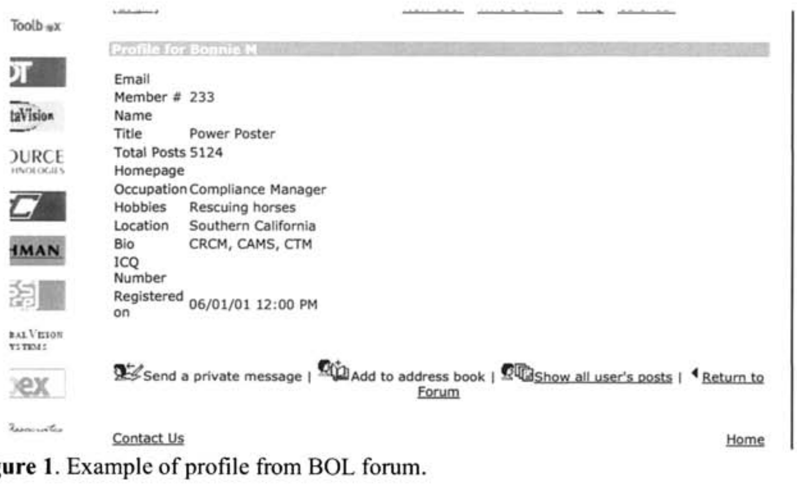

Figure 1. Example of profile from BOL forum.

3.2 Data Collection and Analysis

Data collection took place in two stages, in January-February 2006 and in August-September 2006. During the first stage, a sample of profiles from three major discussion threads was collected: the "Ask a banker" thread, in which non-bankers ask questions about any issue they may have with banking ("What is a good credit score?"); the "Compliance" thread which deals with compliance, a central issue for bankers ("How to document a lending application when the applicant is doing a joint application with another institution?"); and the "Chat" thread, in which performers freely discuss non-banking related issues (dating troubles). 50 users from these threads were randomly selected. Due to cross-listings—users can participate in any discussion from the BOL forum—the first sample contained 129 users.

These 129 profiles were analyzed through descriptive quantitative and qualitative analysis. The descriptive quantitative analysis (number of items in the profile filled by participants) gave a sense of how different participants in the forums filled out their profile, and helped initiate comparisons among profiles. In particular, the distribution of number and types of categories in the profiles filled, as well as the date of registration were analyzed. The qualitative analysis helped interpret individual profiles and identify patterns in presentation of self. It relied on well-established qualitative approaches for data reduction and analysis [29-30] including the Straussian version of grounded theorizing [31-32] that allows for a continuous dialog between previously established conceptualizations and inductive observations. In particular, I developed a thematic coding of different items of the profile (user id, hobbies) that followed the guidelines of grounded theorizing (open, axial, selective coding of profiles).

The results of the exploratory quantitative and qualitative data analysis were put together to establish a categorization of profiles. The four emerging categories were labeled as four types of characters in a play, in a way that followed Goffman's [16] analogy: protagonists, deuteragonists, tritagonists, and fools [33-34]. The categorization aimed at making sense of the variety of profiles while possibly identifying similar ways of presenting oneself in the BOL forum. Forum users were assigned to different categories by following a principle of internal homogeneity and external heterogeneity [35]. The attributes concerned the main categories of the profile (i.e. user id, picture, e-mail, occupation, hobbies, bio) and emerged from the thematic coding.

In order to test the reliability of the analysis and the categorization beyond the three aforementioned threads, a second sample of 180 profiles of users was randomly selected from all threads of the forums (10 users per thread). These 180 profiles were analyzed and categorized. Results were highly comparable, especially in terms of proportion of users in each of the four categories. To test the reliability of the typology, a second, independent, coder was asked to double code all profiles of the two samples (total: 309 users). The inter-coder agreement rate for the two combined samples was of 88.6% and deemed acceptable.

Consistent with Goffman's symbolic interactionist perspective [36], the epistemological stance of this research is interpretive and assumes that "our knowledge of reality is gained only through social constructions such as a language, consciousness, shared meanings, documents, tools, and other artifacts" [37, p. 69]. Because data were entirely secondary, Klein and Myers' [37] guidelines for the conduct of field studies did not apply readily. However, I strove to respect the *principles* of hermeneutic interpretive research presented by Klein and Myers. In particular, Lee's [38] joint investigation of individual e-mails and overall context was an inspiration to take in consideration the principles of hermeneutic circle and contextualization. In the present research, individual profiles were constantly related to one another to make sense of the differences and similarities among them, and to interpret the overall meanings of the profiles. Also, as this research relied on secondary data, there was no direct interaction with users. In order to respect the principles of suspicion and multiple interpretations, I relied on double coding of the profiles. Finally, the principle of abstraction and generalization was respected by constantly confronting my interpretations with existing conceptualizations, in particular with Goffman's [16] presentation of self, Turkle's [6] multiple online identities and Donath's [18] mystification in online contexts.

4 Interpreting BOL User Profiles

4.1 User Id and Number of Filled Fields

The user id was the only required field of the registration form. More than 70% of users from the samples (222/309) chose a user id that seemed significantly different from their "real" offline name. The samples showed diversity in these ids, but a few patterns appeared. Among the main sources of inspiration were the banking world: (sometimes with a twist of humor: "Blue Banker," "Compliance 101"), hobbies ("Redsoxfan" or "Georgia Golfer"), pop culture ("Princess Leia"), and even values or ideas ("Bliss"). Some user ids seemed to reflect the disinhibiting effect of virtuality noted by the literature ("Wacokid" or "Wild turkey"). Others seemed to reveal a desire to remain anonymous ("Random name" or "barely there"). In contrast, a third of users (87/309) chose user ids that seemed credibly related to their offline id (user id: "Len S"; name: Len Suzio, or "Don Narup").

In addition to this required field, users could fill out any other fields: image, e-mail, name, birthday, homepage, occupation, hobbies, location, and bio. Users in the samples filled out some of the 0 non-required fields (min = 0, max = 9, average = 3.10, standard deviation = 2.05). Table 1 presents the distribution of number of filled fields in the combined samples.

Table 1: Number of non-required categories filled in online profiles

# of filled fields	# of profiles
0 to 2	121
3 to 5	118
6 to 8	70
Total	*309*

Among the profiles with few filled fields (0 to 2), the fields that were most often filled were the birthday, location, or the occupation. Among profiles with an average number of filled fields (3 to 5), the fields usually filled were: the birthday, picture, occupation, hobbies, location, and / or bio. The fields that were not usually filled were the e-mail, name, and homepage. Among the profiles with many filled fields (6 to 8), the categories that were least filled were the birthday and the picture. The categories that were the most filled were the ones related to the banking world (occupation, bio).

Regarding how the categories were filled, again, several patterns appeared. Among the users who filled out very few categories in their profiles, the categories that were filled were so with few words and with a high degree of generality (occupation: "banker" or "marketing dude"). Among the profiles with an average number of filled fields, there seemed to be two main groups of profiles in the samples. Most of these users filled fields out with information that credibly seemed to come from their offline situation (occupation: "V.P. compliance" or bio: "17 years of risk management experience in compliance and internal audit. CRCM and CFSA"). Occasionally, fields were filled with distance and humor (bio: "Being a good worker is 3% talent, 97% not being distracted by the Internet"). In profiles where a large number of fields were filled, certain fields (in particular, the occupation and the bio) were filled in a very specific and detailed way (occupation: "CRA Officer & Community Relations Coordinator" or bio: "OCC Regulated $370 million in assets, Jack Henry Silverlake bank, ABA Compliance School Graduate, OBA Banking School Graduate").

4.2 Specific Fields in the Profiles

With regard to the fields of occupation and bio, 191 profiles of the sample provided the user's occupation, 69 of them presented a bio, and 58 presented both their occupation and a bio.

Among the profiles that provided an occupation and/or a bio, despite the varying degrees of detail, there was a relative homogeny in the information presented. Occupation and bio often mentioned the job title currently and previously occupied, but never the name of the company, even though no explicit rule forbade it in the BOL forum. In the same vein, profiles usually included technical and professional certifications but, save exceptions, did not mention degrees or institutions. The occupation field seemed to hint at how users wanted to be perceived (a banker who works in compliance, v.p., loan assistant) as well as what they did not want to be associated with ("NotALawyer"). Overall, the profile also hinted at how users perceived the banking community. In this matter, some users expressed distance vis-à-vis the banking world, very often through humor (occupation: "Slave, oh, I mean, loan assistant" hobby: "anything non-banking", or bio: "I did not want to grow up to be in compliance, I wanted to be a rock star").

Ninety-four profiles mentioned hobbies. The hobbies presented fell into only a few categories: indoor activities (reading, scrap booking, cooking), outdoor activities (fishing, sailing, hiking), and sports (golf, volleyball). The proper character of these hobbies was noteworthy. There was no mention of "TV," "gambling," "smoking," "bar hoping," or any non-socially sanctioned hobby. Just as they would probably not have claimed publicly in their workplace that they love to gamble, BOL users avoided mentioning any hobby that was not socially sanctioned offline. What is more, in some profiles, the presentation of hobbies seemed to reinforce the impression of professionalism or of social status. Golfing appeared very often in the hobbies, which reminded of the way in which, in (offline) work environments, mentioning that one is a golfer contributes to establish one's status. In the same way, the family and, especially, the children or grand-children, were often mentioned in the hobbies category ("reading/playing with my son" or "Playing with my step daughter. Isn't being a parent the coolest thing?"). In the BOL profiles, the frequent mention of kids among the hobbies reminded of the picture of the kids that one finds on people's desk.

Regarding pictures, few were the profiles that presented pictures that credibly looked like pictures of the "real" users (less than 20 in the samples). Most pictures were related to the user id, to a landscape (horses running), or pop culture (Tinkerbell, The Matrix, Superman logo). Many pictures were animated jpegs that presented little clips of action that usually bore no direct relationships with the banking occupation.

Table 2: Examples of profiles from each category

	Protagonist	Deuteragonist	Tritagonist	Fool
Example user profile:	**LenS**	**kvb**	**Marykaylady1**	**Murphysgirl**
Image		*Not provided*	*Not provided*	
Name / E-mail	Len Sunzio - homepage provided	*Not provided*	*Not provided*	*Not provided*
Occupation	Bank consulting	Loan Auditor	*Not provided*	Everything
Birthday	*Not provided*	Oct. 21st	*Not provided*	*Not provided*
Location	*Not provided*	Kentucky	*Not provided*	*Not provided*
Hobbies	Golf and sailing	*Not provided*	*Not provided*	Professional clown
Bio	CRA and HMDA consultant providing banks CRA exam preparation services and CRA Performance Evaluation support as well as market data. Expertise in CRA, HMDA and computerized mapping	*Not provided*	*Not provided*	I did not want to grow up to be in compliance, I wanted to be a rock star.

4.3 Four Categories of Profiles, Like Characters in a Play

Putting together the similarities and differences in users' profiles, four categories of profiles emerged. As noted supra, consistent with Goffman's dramaturgical analogy, these four categories were named after typical characters in a play [33]: Protagonist (the leading character); Deuteragonist (a secondary character); Tritagonist (a minor character whose specific background the audience is not made aware of), and; Fool (a humorous character). Table 2 illustrates each of these profiles with examples from the samples, and Table 3 presents the number and percentage of profiles from the two samples in each category.

Table 3: Number and percentage of profiles in each category of the samples

Category of profiles	Number in the samples	%
Protagonists	54	17.48
Deuteragonists	140	45.31
Tritagonists	103	33.33
Fools	12	3.88
Total	309	100

The "Protagonist" category represents the profiles where most fields were filled and where users seemed willing to provide information that could identify them in their "offline" world. In these profiles, users often adopted a user id that included their first and last name, and/or they provided their e-mail address or a link toward their website. Also, this category contrasted with the other ones in the sample by providing a relatively high degree of detail for fields related to the banking occupation (occupation, bio).

In contrast, within the "Deuteragonist" category, not so many fields were filled and profiles did not include information that could identify the user in his / her offline situation. Also, banking-related fields were not filled with much detail, but some information about the occupation and/or the bio, location, and hobbies was usually provided.

The "Tritagonist" category grouped together profiles in which very few fields were filled beyond the mandatory choice of userid. Profiles from this category provided very little information about the offline or even the online persona of users.

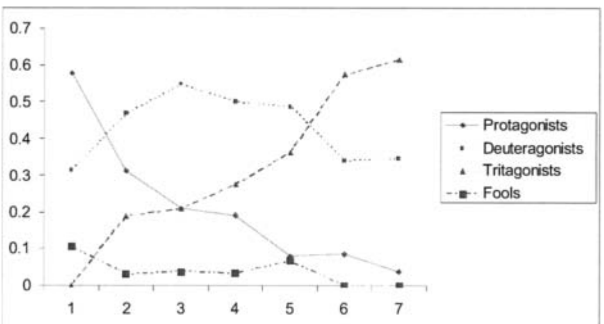

Figure 2. Proportion of new profiles in the BOL forum per category and per year

Finally, the few profiles from the "Fool" category had more filled fields than the "Tritagonist" one. The playfulness and multiplicity of jokes or humor spikes inside the fields characterized this category of profiles.

Substantial differences appeared with regard to the year of registration of users of different categories of profiles. Figure 2 presents the proportion of new profiles from each category.

The "Fool" category was unusual but relatively stable over time. After 2001, the "Deuteragonist" category became the most frequent category. In contrast, the "Protagonist" category was much more frequent among the users who registered during the first years of the BOL forum. It became steadily less adopted as users registered in later years. The "Tritagonist" category followed a reverse evolution. It was adopted on average by between a sixth and about a quarter of the users who registered until 2003. After 2003, though, the proportion of new users who adopted a tritagonist profile increased dramatically and, since 2005, it has been the dominant category of adopted profiles among new users.

5 Discussion

5.1 Playing with a Virtual Front

Profiles can be interpreted as "fronts" (in Goffman's terminology) that users present in the virtual environment of the BOL forum. Users picked and chose different aspects of their personality and life offline to be presented in their profile. They also took advantage of the disinhibiting effects of electronic media. For instance, the pictures of the profiles were rarely directly related to the main official purpose of the BOL forum (discussing banking-related issues) and allowed BOL users to exert their freedom of choosing any front, freed from the constraints of wearing a suit and a tie in the day-to-day job.

These observations, which are consistent with the existing literature [18, 5], could lead to suggest that profiles were highly diverse. Yet, there was a *limited diversity* among them. This limited diversity was observed in the few markers of offline social identities that transpired in the BOL profiles, as well as in the expression of membership to the banking world.

First, a few markers, of offline social identities crossed over most of the profiles. In particular, gender and motherhood surfaced very often in the profiles (userid: "LadyJoey's mom" or hobby: "Mom to a 5-year-old"). Such observation was consistent with the existing literature on online behaviors that has suggested that gender differences are reproduced in virtual environments [39]. Beyond corroborating these existing insights, though, the BOL profiles also revealed the absence of other social markers of identity that are prevalent in offline environments (age, ethnicity). Also, while training and past experiences were often mentioned in the profiles, there was usually no detail about the certifying institution and the previous companies for which the user had worked. These observations support the idea that BOL users were playing with the aspects of their offline self they presented in the virtual environment of the BOL forum: they fine-tuned the degree of "mystification" of their online profile. These observations also suggest that social norms of what was to be presented in the profiles (and what *was not* to be presented) had emerged.

Second, most BOL forum users were brought together by the sharing of a common occupation. The profiles they adopted often explicitly expressed this work-related bond. Many userids were related to banking ("Compliance man," "BankerBoy," or "Fraudpup"). The irony and distance that often accompanied these ids as well as other fields (job: "Slave, oh, I mean, loan assistant") was striking. It suggests an ambivalence of BOL users with regard to their identity and practices as bankers, ambivalence that is not uncommon with regard to occupational identities [40-41]. With their profiles, users distanced their virtual front from the image they had of their banking occupation while also re-affirming their membership to the occupation. Other aspects of their profiles seemed to reproduce in the virtual environment some prevalent social norms in the work context. In particular, many hobbies presented in the profiles are socially accepted and even considered as conveying social status in the workplace (golfing, sailing). The frequent occurrence of these hobbies in the profiles suggests that the online profiles reproduced in a virtual environment some of the (often tacit) social norms prevalent in the workplace on how to present one's self.

5.2 Mystification and De-mystification in a Virtual Environment

It has been suggested that mystification is more strongly established in virtual environments than in offline ones since the distance between the audience and the performance can easily be maintained [see supra and 18]. Yet, two categories of profiles of BOL users revealed unexpected insights with regard to mystification.

First, profiles in the "Protagonist" category provided a lot of information on the user's offline situation (full first name and last name, e-mail, website). In this virtual environment in which mystification was very easy to achieve, these users "de-mystified" their profile; that is, they limited the distance between the front they presented online and their offline situation, allowing the audience to reach them offline. Such "de-mystification" may have been used to build the credibility of one's online persona and to make others in the virtual environment trust the user. De-mystifying an online profile may thus have been part of an impressions management tactic. In a virtual environment where anyone can be anything and anyone else, providing credible information about one's offline situation may be used to build a feeling of truthfulness with regard to the overall virtual persona, which may be especially valuable in work-related environments.

Second, the few profiles of the "Fool" category revealed an opposite tendency with regard to mystification. Most of the fields of the "Fool" profiles were filled with jokes and humor that made the profile seeming very far from what could be the offline professional persona of the BOL user. The "Fool" profiles thus seemed to push further the logic of mystification. The jokes and apparent significant distance between the online profile and the offline situation could be easily identified and contrasted with the majority of profiles in the BOL forum, which seems to indicate that some expectations with regard to what was to be presented in user profiles in the BOL forum had emerged.

5.3 Front Selection and Emerging Social Norms of Presentation of Self

In Goffman's [16] perspective, the samples' limited diversity of profiles is an indication of the social nature of the presentation of self. The emerging prevalence of two of these categories of profiles (the Deuteragonist and the Tritagonist ones, see figure 2) can thus be interpreted as a sign that the virtual environment of the BOL forum had become a virtual social entity whose participants respected emerging shared norms of presentation of self.

The evolution over time of new profiles in each category was thus consistent with Goffman's assertion that "fronts are selected, not created" [16, p. 28]. The prevalent categories of profiles changed over time, suggesting that the adoption of a new profile participated in the negotiation (reproduction and transformation) of the emerging social norms of presentation of self in the BOL forum. For instance, it is hardly surprising that the "Protagonist" category was the dominant one at first. In the absence of established references in the BOL forums on how to present one's profile, new users provided a wealth of information about their job and occupation. In contrast, the "Tritagonist" profile gradually became a socially accepted front in the BOL forum, as seen in the steady increase in the proportion of profiles from this category. The emergence of this prominent front seemed related to the main front of another type of virtual environment, that of online chatting. The mostly blank profiles of "Tritagonists" reminded of participants in chat rooms who are usually only identified by their user id. An interpretation of this observation could be that, in order to present themselves in a new virtual environment, some people may get inspiration from established fronts in other virtual environments. New participants in the BOL forum who were familiar with online chats may have used familiarity with the fronts presented in online chats in order to present their profile in the BOL forum. Finally, over time, the "Deuteragonist" and the "Tritagonist" categories became the most prevailing ones. New users could get inspiration from existing profiles[3], which led to a self-perpetuating process. It is possible that the "Deuteragonist" and "Tritagonist" categories of profiles became prevalent through mimicry: new users could get inspiration for their profile from existing ones. Since most profiles were from the "Deuteragonist" or the "Tritagonist" category, new users could mimic these types of profiles. This mimetic behavior in turn could enact the emerging norms of what a profile in the BOL forum should be.

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[3] Up until after data were collected (see supra, methods section), new users could freely browse the profiles of already registered users before registering.

6 Conclusion

This research investigated how people present themselves in a virtual yet work-related environment by providing a grounded analysis of 309 profiles of users of an occupational online forum.

This research is not without limitations. In particular, collected data were solely constituted by users' profiles, and no investigation was made of users' motivations. Moreover, profiles were collected, but not the interactions that actual took place in the BOL forum. Yet, electronically mediated interactions also affect impressions building in virtual environments. Future research should investigate the relationships between the presentation of self in virtual environments and the actual interactions that take place in them.

Despite these limitations, this research holds several noteworthy conceptual and managerial implications. In terms of theory, this research advances toward an understanding of behavior in virtual but work-related environments. The analysis revealed several distinct categories of participants that presented themselves in a strikingly different way in the online forum and thus seemed to pursue diverse impressions management strategies. As this research only investigated a banking online forum, no statistical generalization can be sought regarding the four categories that emerged from the samples. However, a conceptual generalization of these findings [42] could be that participants in a virtual environment tend to adopt one of several main types of profiles. Some of these fronts are likely to become dominant over time. This research also helped understand better how people build the relationship between their virtual and their "real" (or offline) self. It showed how people play with various degrees of mystification and how they may use offline social markers to establish their virtual self and impress their audience in different ways. Finally, this research discovered that, over time, how participants present themselves is related to the emergence of shared norms in a virtual environment.

With regard to practice, the temporal dimension of findings suggests that the design and management of online forums could change according to the stage of development of the online forums. New profiles could be monitored to encourage stronger involvement in the forums at different stages of their evolution.

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About the Author

Emmanuelle Vaast is Assistant Professor of Management of Information Systems at the School of Business, Long Island University, in Brooklyn, NY. Her research interests deal with

the practices and social representations related to the management and use of Information Systems within and across organizations and to the relationships between online and offline behaviors. Her research has appeared in MIS Quarterly, Organization Science, Journal of Management Information Systems, and Information and Organization, among others. Emmanuelle earned her PhD in Management of Information Systems from the Ecole Polytechnique, Paris, France.

14

Understanding Virtuality

Contributions from Goffman's Frame Analysis

JoAnn M. Brooks
MITRE,
202 Burlington Rd. Bedford, MA 01730
jbrooks@mitre.org

Abstract. Although virtual interactions are often assumed to be separate and distinct from the "real world," they are ultimately situated in material reality. In this paper I propose that a situated approach to understanding virtuality can be drawn from Goffman's *Frame Analysis* (1974/1986). I explain how Goffman's terminology and concepts afford a powerful way of integrating the study of virtual action and interaction with the study of social action and interaction more generally. His frame analysis provides language and concepts for distinguishing virtual worlds from each other and from real worlds in a way that is consonant with significant aspects of human-computer interaction. It helps to account for the phenomenon of immersion in virtual worlds, while at the same time, it is better suited for understanding both co-present and mediated social interaction. I conclude by discussing some limitations of this approach and suggestions for further research.

1 Introduction

RW, an acronym for the 'Real World' and commonly used inside virtual spaces to refer to the non-virtual world, implies that the material world is separate and distinct from virtual worlds. Yet, people engaged in virtual action, whether virtual work, online games, or simply electronic communication, are *situated* in the real world and using material technology. Woolgar has stressed the importance of the

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local and the "real," relative to virtuality, in a chapter on "rules of virtuality" [1].[1] Such a local, material perspective is consistent with the tradition of situated approaches to research on how information and communication technology (ICT) is used—stretching back at least as far as Suchman's *Plans and Situated Action* [2].

In fact, most virtual activity is grounded in real-world actions such as tapping fingers on a keyboard, directing gaze at a monitor, and moving a computer mouse (or other physical instrument). And, as the rarified forms of virtual experience such as 'virtual reality caves' become outnumbered by situated instances of virtual teams, virtual organizations, and virtual workplaces for business, virtual spaces and interactions are becoming even more tightly integrated with the "real world."

And yet, although virtual action is situated at least partially in the local, material world, something else is also going on. Users interact with technology acting as *if* distant or abstract resources are local. The question then is, "How is it that participants situated in a local material environment are able to think and act as if they're working in a team or organization or other simulation with others who are not physically co-located?" More succinctly the question might be, "How do people, and researchers, understand what is going on in their virtual environments?"

Phenomenological approaches applied to virtuality, such as Heidegger's [3] "ready-to-hand" and "present-at-hand" and Polanyi's [4] proximal and distal aspects of the tacit dimension can explain individual experience but remain essentially individualistic and offer little explanation of the interface between virtual activity and situated social interaction.

In this paper, I propose that important aspects of virtuality can be understood and explained using Erving Goffman's *Frame Analysis: An Essay on the Organization of Experience* [5] in a way that supports a broader understanding of the relation between virtuality and social interaction. Goffman's research examines situated interaction: how people interact with each other in co-present situations. Since virtual experience entails situated action – including human-computer interaction and mediated social interaction – Goffman's work on situated social interaction seems a likely place to start for shedding light on situated aspects of virtual/mediated social interaction.

Frame Analysis is one of Goffman's most relevant works for understanding virtuality because it readily addresses 'frames of reference' more generally. Such perspectives are well developed in social science (where they are often referred to as "interpretive frames") and are reflected in the information systems literature at least as far back as Orlikowski & Gash's [6] work on "technological frames." Orlikowski & Gash provide an extensive review of the socio-cognitive literature on frames and define technological frame as "a core set of assumptions, expectations, and knowledge of technology collectively held by a group or community" [6, p. 199].

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[1]Four of Woolgar's [1] five rules reference "real" or "local" (emphasis added): (1) The uptake and use of the new technologies depend crucially on local social context (3) Virtual technologies supplement rather than substitute for real activities (4) The more virtual the more real (5) The more global the more local.

They also note how 'congruence', or alignment of frames on key elements across stakeholders, is correlated with shared expectations across these same groups.

Therefore, Goffman's *Frame Analysis* is relevant to understanding virtuality because he uses a situated perspective, he is concerned with interaction—especially social interaction—and frame is a convenient way of understanding virtual perspectives. In this paper, I therefore start with an overview of Goffman's [5] work on *frames* and then demonstrate how several important aspects of virtuality can be well-accounted-for by this approach: the non-virtual "Real World," the meaning of simulated images and processes, immersion in simulated images and processes, and virtual social interaction. I then discuss how this approach fits in with a larger perspective on virtuality. I conclude with suggestions for further research.

2 Goffman's *Frame Analysis*

In *Frame Analysis*, Goffman sets out a bold and ambitious agenda, "My aim is to try to isolate some of the basic frameworks of understanding available in our society for making sense out of events and to analyze the special vulnerabilities to which these frames of reference are subject." (10)[2] The phrase 'framework of understanding' refers to psychological schemata of interpretation that an individual brings to a situation, based on prior experience/learning that normally enable the individual to come to terms with that situation. It also refers to the way that people understand and describe *what it is that is going on* in social interaction (8).

Goffman posits that in any human, and especially social, activity, a correspondence exists between the organization of the activity and how that activity is perceived (the current frame of understanding).[3] For this, he draws from the work of Gregory Bateson [7] highlighting the role of psychological frames in perception and linking them to Gestalt psychology. Bateson notes:

> Psychological frames are exclusive . . . . [and] inclusive. From the point of view of set theory these two functions are synonymous, but from the point of view of psychology it is necessary to list them separately. The frame around a picture, if we consider this frame as a message intended to order or organize the perception of the viewer, says, 'Attend to what is within and do not attend to what is outside.' Figure and ground, as these terms are used by Gestalt psychologists, are not symmetrically related as are the set and nonset of set theory. Perception of the ground must be positively inhibited and perception of the figure (in this case the picture) must be positively enhanced. [7, p.187]

In other words, perception highlights some aspects of an activity while it de-emphasizes or even ignores others. Bateson also notes that psychological frames are

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[2] Page numbers without references are to Goffman's Frame Analysis [5].

[3] Whether the correspondence is "accurate" or not is another matter; suffice it for now to consider that some correspondence exists. The possibility of totally random perception and activity is unlikely enough in most work environments.

related to "premises" that tell the viewer what kind of thinking to use; where *premise* "denote[s] a dependency of one idea or message upon another" [7, p. 186].[4]

Building on Bateson's concept of frame and his identification of premises as dependencies, Goffman posits that, despite "the fact that there are likely to be many valid principles of organization that could but don't inform perception" (26), at any single moment one set of correspondences informs perception and other possible mappings do not. He refers to the specific correspondences or dependencies in effect as *organizational premises*. These organizational premises, or "principles of organization which govern events—at least social ones—and our subjective involvement in them" constitute Goffman's definition of the "frame" of an activity (10-11).[5] He notes that these organizational premises are "sustained both in the mind and in activity" and something that human cognition "arrives at, not something cognition creates or generates" (247).[6]

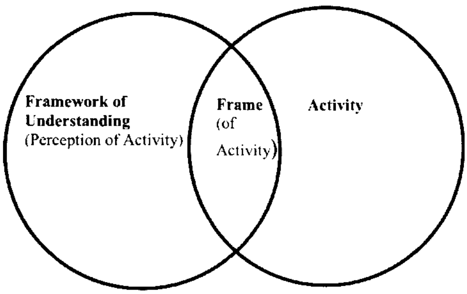

Figure 1: Relationship between Framework of Understanding, Frame, and Activity

[4] Noting, however, "that the 'premise' relation in psychology is likely to be intransitive" [7: 186]: dependencies between A and B, and between B and C, do not necessarily imply dependency between A and C.

[5] Although in at least one case he hedges slightly stating, "frame is the word I use to refer to such of these basic elements *as I am able to identify*. That is my definition of frame" (11; emphasis added).

[6] "It has been argued that a strip of activity will be perceived by its participants in terms of the rules or premises of a primary framework. These frameworks are not merely a matter of mind but correspond in some sense to the way in which an aspect of the activity itself is organized–especially activity directly involving social agents. Organizational premises [dependencies] are involved, and these are something cognition arrives at, not something cognition creates or generates. Given their understanding of what it is that is going on, individuals fit their actions to this understanding and ordinarily find that the ongoing world supports this fitting. These organizational premises–sustained both in the mind and in activity–I call the frame of the activity." (247)

Following Goffman therefore, the 'frame' of an activity is the set of correspondences between the organization of the activity and the organization of the framework of understanding, as in Figure 1.

To review:

- A *framework of understanding* (interpretive frame) shapes the meaning of an activity or event, enabling description of it, and informing/regulating the person's activity.
- A *frame* is comprised of the *organizational premises* (dependencies) between the organization of activity or an event, and the organization of subjective experience.

Having initially clarified these differences, Goffman proceeds to employ 'frame' as synonymous with 'framework of understanding' elsewhere in his book; nevertheless, the distinction is useful and I retain it.

Take a simple case of virtuality–'flying' a flight simulator–Goffman's concept 'frame' highlights the visual perception of what is displayed on the screen and de-emphasizes perception of other bodily movements (including and perhaps especially manipulating controls). In this example, the organizational premises are the correlations (resemblances) between aspects of the visual display and aspects of real world geographic terrain and airspace.

3 The Non-Virtual "Real World"

As Giddens [8] notes, in discussing social integration and system integration, technologically-mediated relationships presuppose co-present relationships. Relative to the topic at hand, "virtuality" has meaning only in contrast to that which is non-virtual; we therefore need to be able to describe the material world and co-present interaction in a grounded situated way that still supports distinctions between virtual worlds and the real world. Consequently I next focus on how Goffman's *Frame Analysis* approach can be used to distinguish "real world" (non-virtual) frames of reference, grounding the ensuing discussion of virtuality.

While innumerable frameworks or interpretive frames can exist for understanding any set of events, Goffman distinguishes "primary frameworks" as the interpretive schemata that people rely on for understanding what is "really" going on: "Actions framed entirely in terms of a primary framework are said to be real or actual, to be really or actually or literally occurring" (47). This is in contrast to other interpretations of a situation that are more layered and thereby removed from 'reality,' such as the enactment of a story in the staging of a play, or in the deception practiced by a con artist. Thus, relative to understanding the situated use of computer technology for engaging in a virtual environment, Goffman's construct of primary framework is useful for denoting that which is non-virtual.

He further notes that recognizing a situation implies the application of a primary framework, normally enabling its user to "come to terms with all events in that activity" (347). Thus, descriptions such as 'tapping one's fingers on a keyboard', 'directing one's gaze at a video monitor screen', and 'moving a computer mouse with one's wrist' are generally accepted as descriptions of what is "actually" happening in RW while one is otherwise immersed in a virtual world. Goffman also theorizes that as the primary framework imparts a sense of what is going on, it also guides that person's actions, "informing and regulating many of them" (347). Thus an individual participating a virtual world would gear their actions to the appropriate specific operating system (for example, Mac vs. MS Windows) that they were using, even while their attention was focused on what was going on inside a virtual space. A primary framework is nevertheless relative. To a human factors engineer concerned with force of keystrokes, an ophthalmologist conducting an eye exam, or a mechanical engineer testing mouse performance the frameworks mentioned above are likely superseded by other primary frameworks. Thus Goffman's *Frame Analysis* offers a way of distinguishing RW from 'virtual worlds' at the same time as supporting explanation of activity in each.

4 Simulated Images and Processes

Simulated images and processes enabled by technology comprise the "environments" of virtual worlds as in the case of the flight simulator. Yet to participants in virtual worlds, they are more often viewed as virtual objects and activities resembling real world objects and activities. Goffman's *Frame Analysis* approach also offers a way to understand and explain these. To keep things simple, I start with an elementary case of a computer user working with virtual "folders" and "documents" on a virtual "desktop." Such simulated images and processes are so common today that it is easy to forget that historically, mapping between "real" desktop, folders and documents on the one hand, and virtual desktop, folders and documents of graphical user interfaces on the other, was a major innovation,[7] and that understanding how to employ the analogic mapping was something of an exercise initially.

4. 1 Meaning in/of Simulated Images and Processes

Goffman's concepts of 'key' and 'keying' are quite useful for understanding the relation of simulated images and processes of on-screen 'desktop,' 'folders' and 'documents,' to situated action. He describes these concepts as:

> a central concept in frame analysis: the *key*. I refer here to the set of conventions by which a given activity, one already meaningful in terms of some primary frameworks, is transformed into something patterned on this activity but seen by the participants to be

[7] First invented by Doug Engelbart at SRI, the innovation was developed at Xerox PARC and then moved into production by Apple Computer, Inc.

> something quite else. The process of transcription can be called *keying*. (43-44, emphasis added). [8]

The distinction between primary framework and keying is significant in terms of meaning and how the activity is described. Compared to a primary framework in which an activity is considered "real or actual, to be really or actually or literally occurring", a keying of that activity is considered "not literal or real or actually occurring" (47). The examples that Goffman offers include, threat, deceit, ritual, staging, fantasizing, analyzing, etc.

Thus in the example of a virtual desktop with iconic folders and electronic documents, the set of conventions for representing "actual" desktop, folders and documents via iconic images can be understood as a *key*. The frame (organizational premises) may even be explicitly represented in Human-Computer Interaction (HCI) design principles linking a bitmap image of a folder and its associated functionality with a subjective experience or belief associated with 'opening' a folder to find 'documents' 'inside.'[9] Rather than typing on a keyboard as in the previous section, the typist could now be understood/explained as relying on a specific key to perceive herself as "typing a quarterly report"; the screen gazer (employing a different key) as watching a live video cam stream; and the mouse user could describe his behavior as "formatting a marketing presentation."

Goffman notes that concomitant change in activity between a primary framework and a keying may be quite minor, but its effect on the descriptions that participants would offer relative to "what's going on" can still be vast:

> the systematic transformation that a particular keying introduces may alter only slightly the activity thus transformed, but it utterly changes what it is a participant would say was going on . . . . A keying, then, when there is one, performs a crucial role in determining what it is we think is really going on. (45)

The keying concept provides a useful way of underscoring the distinctions in perception and intent accompanying similar sets of actions in different virtual worlds, as for example between a claims processing clerk and a tech support engineer both pressing the same keys while gazing at the same simulated images and processes on the same machine. Applying different keys, one is enacting the "paying claims" key, while the other would be invoking the key of "debugging a software glitch." Goffman's approach also highlights how selection of a key is closely related to social conventions. Thus the virtuality literature includes numerous cases where

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[8] Goffman derives the term "keying" from an analogy to music—i.e. transcribing music from one key to another, although he acknowledges that musical "mode" rather than "key" might actually be more accurate (44).

[9] This is sometimes explained in HCI via reference to a 'mental model'; I avoid that term because it implies the model resides within the subject, whereas Goffman's frame and organizational premises connote a more coherent bridging between organization of subjective experience and organization of (external) activity.

members of a virtual team interpret simulated images and processes in ways consistent with their locally situated community or occupational group rather than consistent with other members of their virtual team [9-11].

4.2 Immersion in Simulated Images and Processes

The experience of feeling "immersed" in a virtual world is another common aspect of virtuality. For this, Goffman's term '*involvement*', which is a second aspect of frame, serves well. It denotes the extent to which an individual's attention and emotions are focused on and engrossed in an activity.

> Frame, however, organizes more than meaning; it also organizes involvement. During any spate of activity, participants will ordinarily not only obtain a sense of what is going on but will also (in some degree) become spontaneously engrossed, caught up, enthralled. (345)

Involvement in simulated images and processes, paired with keyings closely correlated with material reality, enables situated activity to seem convincingly real in a virtual sense. The more 'involved' the user becomes in the simulated images and processes, the more believable the transformational keying is.

Goffman notes also that frames normally include normative upper and lower bounds on involvement: "All frames involve expectations of a normative kind as to how deeply and fully the individual is to be carried into the activity organized by the frames" (345). Such norms associated with appropriate intensity of attention in virtual worlds are revealed in frustration over "slow response time" when degraded technological capabilities do not support normal involvement. Similarly, people who frequently transgress the upper bounds on normative involvement may be labeled as "addicted to computers," while those who operate below the lower bound are more likely to be considered "Luddites" or "computer illiterate." Taking this approach one step further, another common attribute of virtuality is that simulated images and processes are often designed specifically to intensify involvement, as in the case of computer games.[10]

5 Virtual Interaction

Having described Goffman's terminology of frames, keying, and involvement as providing powerful tools for understanding virtuality in terms of the relationship between situated action and simulated images and processes on the one hand, and perceptions of "virtual activity" in "virtual worlds" as distinct from the "real world" on the other, I now discuss how Goffman's *Frame Analysis* is useful for understanding virtual social interaction, as in computer-mediated interaction of a virtual team.

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[10] Goffman terms artifacts designed with this quality "engrossables" (345).

First though, a necessary digression into the basics of interaction is required. Interaction, co-present or mediated, involves alternating turns of action with attention directed toward a common focus of activity. In the co-present case, interaction also involves mutual monitoring and awareness by participants of each other and their alternating actions. Each participant responds (or reacts) to the actions of the other in turn, and involvement in the interaction is thus mutually sustained. This is essentially the same set of dynamics with which HCI is concerned albeit with person and computer rather than person and person, face-to-face.

However, the flip side of interaction, as Goffman points out, is that if one participant's attention wanders to something outside the mutual focus, the other will detect this deviation and not be able to sustain the interaction one-sidedly. That is, if one participant fails to express proper involvement in the shared interaction, the other consequently/ necessarily also becomes less involved in the formerly mutually-constructed and sustained activity.[11] Highlighting this effect, Goffman posits that mutual involvement in co-present (co-located social) interaction is thus an "*interlocking obligation*" (346, emphasis added).

How and why such an 'obligation' is manifested and experienced in face-to-face interaction is a significant issue. According to Goffman scholar Anne Rawls:

> Goffman's contribution to social theory consists in the idea of an interaction order sui generis which derives its order from constraints imposed by the needs of a presentational self rather than by social structure. . . . He argued carefully over the course of his career that there were interactional prerequisites and needs of self which places constraints on interaction. . . . Persons conformed with these because if they did not their social selves would cease to exist. [12]

Goffman presents numerous cases in which participants' encounters with such constraints are marked by "embarrassment" or loss of 'face'. Scheff [13,14] further extends this perspective, positing a continuum of moral emotions ranging between pride and shame as the regulatory mechanism. In face-to-face interaction, bodily expressions of such feelings are usually evident in body language and facial expressions visible to other interactants.

In virtual interaction, team members usually cannot directly monitor bodily expressions of each other's involvement. Nevertheless, consistent with Goffman's emphasis on *observable* action/expression of involvement, participants are often cognizant of external evidence of the other's involvement as it is expressed through recognizable action, for example, whether the person at the other end has responded to email or contributed expected deliverables. Even though the interaction is mediated, an attenuated version of interlocking obligation, contingent on electronic signs of involvement, still applies. Examples of interactional constraints, based on needs of presentational self in a virtual team, include the guilt experienced when delaying a response to an urgent email or the concern felt when seeing one's work forwarded by others to a broader audience. Repeated occurrences of interlocking

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[11] No surprise to HCI professionals.

obligation build trust for continuing interactions in the future and are especially significant for supporting virtual interaction over longer time periods.

Goffman's terminology and concepts also support viewing ICT as reducing the dimensions of expressed involvement to digital images and processes in the virtual case, making it more difficult to ascertain whether the 'other' participant is indeed genuinely involved. Interlocking obligation is attenuated through technological mediation because of the inability to observe bodily expressions of involvement. This can help explain characteristic phenomena in virtual worlds such as spam, junk mail, "gaming," phishing, and online predators. The mediating technology acts as an "involvement shield" obscuring one participant's false 'evidence' of involvement, with the interaction eventually breaking down as failures in interlocking obligation become evident.

6 Discussion

As described above, aspects of Goffman's *Frame Analysis* provide coherent explanations for important aspects of virtuality. These include contrast with the "real world," meaning of simulated images and processes, immersion in them, and virtual interaction. Here I briefly consider a higher-level view of how this approach might contribute to understanding the broader interaction of interdependent social and technological phenomena using virtual teams as an illustrative example.

For virtual teams it seems reasonable to assume that congruence [6] across team members' frames is important. This entails isomorphic organizational premises—or linkages between their frameworks of understanding and their external activities—that ultimately require some version of parallelism in the material aspects of their ICT. This suggests the possibility of viewing two separate layers of interaction, one social and one technological, each with its own (separate) logic of interaction, and also interacting with each other at numerous points. The two layers can be understood as two sides of a coin. One side is technological interoperability; the other side involves social practices effecting 'translation' of keyings. Both layers or sides are distributed geographically, and joined together at various points (locations) in various ways.

On the technological side, interoperability (of ICT) is important because it affords a material basis for congruence across organizational premises of team members' frames. On the human/social side, frame congruence across dispersed team members can be understood as achieved via translations shaped by a transitive set of interlocking obligations across locations. This view highlights the importance of complementarity between social practices that shape meaning (frames of understanding) and individuals' involvement in these practices.

How congruence between frames of understanding and frames is actually achieved when team members are dispersed, and how this congruence is maintained or repeatedly reconstructed in parallel across space and time, are issues that Goffman's *Frame Analysis* does not address. One of the prime limitations of his approach is that it relies heavily on conceptual typifications [15] and provides little explanation (apart from references to ritual and social convention) of how people ascertain which frame is appropriate to use in any specific situation. That virtual teams actually work as well as they do testifies to the diligence and creativity of individual virtual team members who are willing to initiate the phone calls and the face-to-face meetings required to bring their frames into congruence and create/restore interlocking obligation, compensating for its attenuation via mediated technology.

One promising approach for explaining how *Frame Analysis* is integrated with practices is the ethnomethodological approach. Originating in work by Harold Garfinkel, who helped to inspire Goffman's development of *frame analysis*,[12] the ethnomethodological approach has been identified as a good complement to it [15]. Furthermore, the ethnomethodological approach has already shown promise in the study of computer-supported cooperative work [16,17]. The combination, therefore, may well afford a fruitful way ahead.

7 Conclusion

In this paper I have argued that Goffman's *Frame Analysis* offers a powerful approach (or in Goffman's terminology a "key") for understanding important aspects of virtuality from a situated perspective. Goffman's terminology and concepts afford considerable potential for integrating the study of virtual action and interaction with much of what is already known about social action and interaction more generally.[13] His frame analysis provides language and concepts for distinguishing virtual worlds from each other and from real worlds, in a way that is consonant with important aspects of human-computer interaction. It also helps to account for the phenomenon of immersion in virtual worlds while at the same time it is better suited for understanding both co-present and mediated social interaction.

Specifically, the contrast between the "real world" and virtual worlds can be understood through Goffman's concept of *primary framework*. How people interact with simulated images and processes can be explained via Goffman's notions of key and keying. The phenomenal experience of immersion while using ICT (especially ICT "engrossables") is well characterized by Goffman's description of *involvement*—including both cognitive and affective components. And virtual interaction (as in a virtual team) can be accounted for with Goffman's notions of *interlocking obligation* and parallel or complementary *organizational premises*.

Possibilities for further research utilizing these and other aspects of Goffman's frame approach are significant. First, more thorough analyses of the relation(s) between co-present (social) interaction, human-computer interaction, and computer-mediated (social) interaction should be carried out. Such research may lead to clearer categorization of similarities and differences between these alternate forms of

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[12] Anne Rawls, personal communication, March 6, 2007.

[13] Goffman's work underlies and informs much of contemporary sociological and social theory [18].

interaction. If this much proves valuable, the approach could then be further extended to clarify how these different kinds of interaction can be portrayed in work on organizing practices involving ICT such as Yates and Orlikowski's [19-21] genre approach and Orlikowski's [22] work on scaffolding, as well as in Actor Network Theory [23,24]. While the road ahead is challenging, selected aspects of Goffman's *Frame Analysis* offer an approach worth pursuing.

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About the Author

JoAnn Brooks is a Research Sociologist at the MITRE Corporation in Bedford, MA, and an Adjunct Assistant Professor of Sociology at Bentley College in Waltham, MA. Her research interests focus on developing social theory relevant for understanding ICT usage. She received her PhD from University of Michigan where her work concentrated on organizational studies. She holds an MS in Computer and Information Science from UMass/Amherst, and worked as a software developer on user interfaces for large and complex information spaces prior to her doctoral work.

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Conditions Enabling Effective Multiple Team Membership

Mark Mortensen[1], Anita Williams Woolley[2], Michael O'Leary[3]
1 MIT-Sloan School of Management
2 Harvard University
3 Boston College

Abstract. There is a long tradition of research on work in teams and their increasingly important use as an approach to organizational design. While the implicit assumption has been that individuals work on one team at a time, many individuals are now being asked to juggle several projects and their associated multiple team memberships (MTM) simultaneously. This creates a set of interesting opportunities and challenges for organizations that choose to structure work in this way. In this paper, we review the limited existing research on MTM work. We then present the results of a survey documenting the prevalence of MTM work and the findings from a pilot interview study suggesting a number of challenges, benefits, and enabling conditions associated with MTM work. We discuss the implications for managers working in MTM environments as well as for scholars of teams and, in doing so we describe what we see as key items on the agenda for future research on this topic.

1 Introduction

There is a long tradition of research on work in teams and the use of teams as an important approach to organizational design [1, 2]. In general, this research assumes that people are members of one team at a time and are able to focus all of their energies on that team's task without competing commitments. In practice, people are often members of more than one team at a time and they, their team leaders, and organizations must manage the challenges posed by relying on multiple team memberships (MTMs) as a way to structure work. Those challenges are becoming more common as organizations become flatter, more project-based, and more

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geographically dispersed [3-5]. Multiple team memberships have implications for how individuals, teams, and organizations do, manage, and communicate about their work. They also have implications for the information systems designed to support the management of projects and the assignment of people to them.

Previous research directly addressing MTM is limited. Reviews of the teams' literature include only studies that (implicitly or explicitly) focus on single team membership [9, 10-12]. Only a handful of studies allude to MTM as an approach to organizing work and still fewer address it directly. Among those alluding to its existence, Utterback [6] found that spending less than 50 percent of time on a single project reduced idea generation effectiveness. Watson-Manheim and Belanger [7, p. 78] noted in passing that "membership in multiple teams adds complexity to individuals' communication strategies" and the focal team in Majchrzak, Rice, Malhotra, King, and Ba [8] included members who contributed no more than 15% of their time to it.

The few studies directly addressing MTM focus on the individual level. For example, Leroy and Sproull [13] report survey results on the stress caused by working on multiple teams and the impact of leadership and role ambiguity on that stress. A study in operations research highlights the link between "project overload" (the "perceived fragmentation, disruption and inefficiency, caused by switching between assignments for separate but simultaneous projects") and psychological stress, competence development, and deviations from budgets and schedules [14]. Surveying 392 project managers and members in 9 European mechanical, pharmaceutical, and construction firms, these researchers [14] found that the average respondent was a member of three projects simultaneously, with only 23% working on one project at a time.

Research that focuses on team-level issues in multiple-team work settings deals primarily with leadership and coordination issues [15-18] and integration mechanisms, including but not limited to leaders [19, 20]. In addition, some work in the project management and operations research literatures has also addressed the same coordination/integration challenges as well as more specific project management, cross-project staffing, and optimization issues [21-24]. While these studies address how organizations can coordinate the efforts of multiple teams, they do not address the challenges or benefits associated with dividing time among multiple teams. As defined by Mathieu et al. [18, p. 289], multi-teams systems (MTSs) include "two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals." As such, the definition of MTSs technically allows for people splitting their time across teams, but empirical studies of multi-team systems have all included people who devote 100% of their time to one team. In contrast, MTM work environments by definition involve people splitting their time across *multiple* teams.

Aside from the few studies mentioned, we are aware of nothing that has been written about MTM's potential benefits, including organizational innovation, team performance, and individual learning and career development. Nor have we found anything that addresses the implications of MTM beyond the individual level stress that it causes [13]. Given the lack of research on MTM, the work presented in this paper is necessarily descriptive and exploratory [25]. We present data from a survey of 401 professionals, documenting the prevalence of MTM across a range of industries and occupations. In addition, we present the results of interviews with 13 professionals regarding two questions:

1. Consequences of MTM – For individuals, teams, and organizations, what are the important positive and negative consequences of multiple team membership?
2. Conditions for Effectiveness in a Multi-Team Environment – What conditions, when in place, enhance the likelihood that MTM will improve individual, teams, and organizational effectiveness?

Building on the survey and interview data, our research lays a foundation and sets an agenda for future studies on the individual, team, and organizational implications of MTM. We believe our research will help address a common but understudied practice in 21st century organizations.

2 Methods

Given the nascent nature of research on this topic, we adopted a two-pronged, grounded, exploratory approach. After reviewing the literature on MTM and related topics, we surveyed 401 professionals about the prevalence and nature of MTM in their work. We also interviewed a sample of 13 professionals in an organization (XYZ Corp.) that makes heavy use of MTM.

2.1 Survey

We added questions regarding MTM to a general background survey administered to 401 current and former full- and part-time MBA students at two universities. We achieved a response rate of 90%, of whom 88% worked on project teams. Most were junior to middle-level staff members in their organizations, with an average organizational tenure of 3.2 years.

Our survey questions were primarily demographic and descriptive. Questions addressed firm-level characteristics (size and primary industry) as well as those of individual respondents (functional affiliation and occupation, number of people managed, location in organizational hierarchy). We also asked about MTM-related processes and procedures (whether they work in project teams; on how many teams they work; who assigns them to teams; and what their own role was in team assignment to teams). For those who worked on multiple teams, we asked questions about the two or three teams to which they dedicate the most time (whether they were formally assigned to the teams, whether they charged time to them, how many people were on the teams, the percent of time they dedicated to each in the last month, and what boundaries the teams crossed, for example: departmental, organizational, city, state, national).

2.2 Interviews

The interview component of our work used Glaser and Strauss's grounded theory approach [26-28]. Such an approach is appropriate for new or understudied phenomena when researchers want to develop a deep understanding from the data [25].

We conducted 13 interviews at XYZ Corporation (see Figure 1) – a federally funded research and development center with 4,700 employees in which MTM is common. Interviews followed a semi-structured interview protocol, which we modified slightly after pilot interviews with people outside XYZ Corporation. All of our interviewees had served as both project leaders and members. The interview sample included six men and seven women, with an average organizational tenure of ten years. All but two had responsibility for managing others outside their project work.

3 Findings

3.1 Prevalence of MTM

Our survey data indicated that MTM is indeed quite common. Of the 401 respondents, 65% worked on more than one team at a time (M = 2.7 teams simultaneously, SD = 2.2). Many of these teams were cross-functional (67%) and inter-organizational (53%) and a considerable minority (34%) was also international. The teams averaged 7.5 members each.

When asked to describe up to three teams on which they worked, respondents reported that they devoted 46%, 25%, and 20% of their time to those teams, respectively; indicating that most had a core team to which they devoted nearly half of their time. Although many large service firms have people devoted to allocating staff to projects, fewer than 5% of our respondents were assigned to teams by HR or a central staffing office, with functional, departmental, or project managers doing so for the other 95% of respondents.

3.2 Challenges and Benefits of MTM

Our analysis of the interviews suggests a number of challenges and benefits of MTM at the individual, team, and organizational levels. In many ways, many of the challenges of MTM are also its benefits [29].

3.2.1 Individual

For individuals, MTM demands high personal discipline and interpersonal competence in addition to the expertise required to complete the task itself. Functioning in an MTM environment further creates the need for individuals to negotiate competing demands on their time and to multi-task, as explained by the following interviewee:

> I am slapped about the head and shoulders regularly by the project leader to spend more time on the task . . . Well, so then you feel bad, so then you try to put in a few more hours . . . You find out what the real sticking-point is, why they want more time, is it that they have a meeting scheduled, is it that there is a deadline coming up? And you figure out what the real problem is, and act against that.

Although MTM work is demanding, it provides employees with opportunities to shape their careers by joining projects related to expertise they have or want to develop.

> A lot of what happens in your work program is that you are an autonomous person, an entrepreneur within the confines of an organization that puts people to good use. At any given time, I think about "Well, what am I working on?" but there's also the "Well, what am I going to be working on?" or "What do I want to be working on?" So some of the projects that I'm starting now are sort of seeds for additional things. So there is a strategy of how will this lead to that and lead to the other, and which path am I choosing to go down to get me there.

3.2.2 Team

For teams, MTM leads to challenges in scheduling and getting members' time and attention. One person, who was both a functional resource manager and a project leader, experienced this problem repeatedly and explained that, "One of the reasons I became a group leader is so that I would have control over people's time . . . . You know I have the final say on what they work on. So the ideal situation is the one I have, where I am the project leader but I am also the resource manager."

While managing conflicting demands remains an issue, MTM can also benefit teams through cross-project learning, as one interviewee noted, "I think the projects benefit from members' being able to bring best practices and lessons learned from other projects to bear on their problems."

In addition, projects operating in an MTM environment benefit from being able to "afford" special expertise that would be too costly if acquired outside the organization or through a dedicated full-time employee, "In order to be really good stewards of client dollars, we don't want to pay for five weeks of the time of someone with special skills when what we really need is an intense effort from them in week 5 of the activity."

3.2.3 Organizational

For organizations, MTM work is quite complicated to coordinate. Not only must the total required effort be estimated and matched to individual workers, but timing of that effort must be coordinated among projects. Slippage in one project can create a domino effect, as the work on other projects needs to shift to accommodate unanticipated difficulties or delays. Keeping managerial roles reasonable in such an environment is a challenge. With knowledge and expertise highly valued, managers are rarely able to "just" manage but are expected and want to contribute as well. As a result, managerial roles become unwieldy and individuals overextended:

> The detriment to doing [MTM] plus managing is quality of work life and home life, you are stressed and you don't have enough time, the way I manage it is that I do my project work during the day and my corporate management work at home at night after the kids go to bed. So I get online and answer all of my emails, and get back to my staff and respond to their questions after the normal work day. And you know, I'll typically have my laptop on my lap and be doing stuff while I watch TV and that type of thing.

MTM is particularly challenging in environments where management wants to restrict information distribution due to intellectual property or security concerns. However, where that is not a concern, a significant benefit of MTM is that it enriches the social network of the organization, "The benefits [of MTM] are that I have a global awareness of what is going on in other programs, and I get more exposure to company staff, and I am getting to know a lot of the talent in the company which is helpful [for future projects]."

MTM also provides a valuable motivational tool where learning is valued, but opportunities for official promotion are scarce due to flat hierarchies. As one interviewee commented, "I've gotten to a point where I am not going to go any higher in the company . . . and I am at a point in my life where I don't want to spend time on something unless I enjoy the work and I enjoy the people . . . so I find projects I enjoy."

3.2.4 Information Systems

MTM work is often distributed, asynchronous, and inter-organizational, which has its own challenges [30, 31], but some of those challenges are manifested in distinct ways when employees are working on multiple teams. For example, while email is critical for communication and coordination in distributed, asynchronous MTM contexts, it is often hindered or blocked by client firewalls:

> I began on this one project, and needed to connect with this particular team member who was working on-site on another client project and there was no way to get in touch with him through the usual means (email) so we fell back on the old fashioned "Let's get together for lunch." So I drove down to where he was to get the information I needed, and I mean then you are talking about a whole day, because there was no other way to get going on the project without his input, and the client sites we were working at just didn't have compatible systems.

While communication challenges are also significant in single-team contexts, MTM contexts have the additional challenges of managing multiple systems, connections, and security protocols since individual team members may be working from multiple different locations.

Organizational communication and information systems are critical for working seamlessly across multiple team boundaries as well as for providing the managerial backbone of a well-functioning MTM system. Good project planning, time tracking, and communications systems are all needed to support MTM work. As our interviewees noted, when these systems falter or fail, it can be a serious impediment to MTM work, "The other day, I went in to put my hours in for the week, and I couldn't enter my hours because the system had me as at my limit on my project . . . but I wasn't. So I had to spend some time on the phone with the HR and IT people fixing that."

At the same time, the strong information systems set up to support an MTM environment can also enrich the social network of the organization. At XYZ Corp., the project work time-tracking system is tied to the intranet telephone directory, so that employees can easily find out who is affiliated with different projects. In addition to project communications, both email and the XYZ's intranet are used to support listservs and special interest groups, which both help employees build their expertise and connect with others who could use their skills on a project.

3.3 Conditions for Increased Effectiveness of MTM-based Work

Our interviews and observations suggested that the following six conditions can increase the chances MTM will yield positive outcomes for individuals, teams, and organizations:

1. The ability to recruit individuals with the proper social and task management skills
2. A task and team structure amenable to MTM work
3. High familiarity and trust among team members and between the teams and their clients
4. Appropriate and adequate organizational information and communications systems
5. An organizational climate that permits access to the information needed to match projects with individual skills
6. The availability of a system to help "load balance" project assignments.

Staffing: Choosing the right people to work in an MTM work environment is critical. Individuals need not only the expertise to complete the projects, but interpersonal and time management skills as well. Prior research has shown that there are stable individual differences in the ability to multi-task [32] and to communicate effectively [33]. These abilities are related to, but are not completely correlated with, overall competence.

> Employees are here because they have a critical skill set, and they know their business, and we try to find a match . . . but if you don't do well in this kind of environment, you probably won't stick around . . . [When hiring new staff] I am trying to figure out the right things to look for up front . . . Right now it is just kind of trial by fire. I focus a lot on

> behavioral things, past behaviors, have they worked in this type of environment before? I put a lot of emphasis on that

Once the right people are hired, MTM project work can keep performance standards high by making people accountable for producing good work because they are "hired" for each project: "I think this system is good because it keeps people accountable for doing a good job on the projects they work on; if they don't, then nobody wants to hire them for their project in the future."

Task and Teams Structured for MTM Work: Our interviews pointed to three features that help make work amenable to the MTM approach: (1) a more "mature" and well-defined (not early-stage) project; (2) a "modular" project in which individuals can work separately on assigned pieces to be recombined later; and, (3) predictable deadlines and a work pace punctuated by regular meetings or checkpoints to keep everyone aligned.

Effective project leaders at XYZ Corp. recognized that the MTM approach was not well suited to projects in the early phase. As one manager explained:

> One project I've had for a year, so it takes no spin-up, I can walk in there, I can be productive very quickly, I know what I need to do. The new project I have, it is new to me, a new customer, we've met with them several times, heard about his needs, how he likes to do business, trying to get an understanding of how we can bring the most value, how they can use my expertise. So there is a lot of think time, a lot of talking . . . I think when you have to do that type of thing, you can't do it in two hour chunks, so I try to spend the whole day when I am working on that task . . . When we have projects like that, we usually put one or two people on it full-time until it gets going.

Standard wisdom on good team management includes the notion that selecting and structuring tasks appropriately for teams is critical [34]. However, for MTM tasks, although moderate interdependence is necessary to promote the work of the team [35], tasks also require the modularity that allows work to happen asynchronously. This coupled with a work rhythm paced by regular meetings and established deadlines, helps members intersperse project work with their other commitments. For example, one interviewee commented:

> If someone has a particularly hot project, one that is important to the company . . . those projects can rise to the top of the cue and people will rearrange their schedules to participate. Realistically, though, you are never going to have everyone at the same table at the same time, especially if you are dealing with a project of high complexity, high volatility, high significance, you'll always be short somebody . . . so then we coordinate asynchronously.

In talking about a project that was particularly well managed, another interviewee noted:

> We all came in and knew what to do . . . The expectations were clear, the product was clear. If I showed up to work on something, as someone else was finishing up, there was a

> system for leaving comments so I knew where to start. It was all well thought out and coordinated.

In addition to structuring tasks to be amenable to asynchronous work, team structure needs to accommodate members with varied levels of time commitment to the project. Roles need to be flexible as members with specific expertise are brought in to work on discrete portions of the project, while others are involved from start to finish. In this sense, some members are core to the team while others are more short-term or peripheral [36]. One interviewee explained how this worked:

> On my main project, I work 50% of my time . . . On this other project, I am just a consultant, like 4 hours a week, because they need me for a particular part. So they tell me about all of their meetings, and I try to make as many as I can, especially at the beginning, but if I can't they are like, 'Oh, it's OK, you're a consultant.'

Familiarity and Trust: The relationships that team members have with each other and the relationship between the team and the client are important in setting the stage for effective MTM work. There is an inherent tension in MTM work environments with respect to team member relationships. While a central benefit of MTM work is the opportunity to work with different people on many different projects and expand one's social and knowledge base, individuals also acknowledge that MTM work is much easier when members have established relationships and high trust for one another. Team members must be able to trust each other to honor commitments and deliver the work the team is expecting to receive, "While I like working on multiple projects with different people, I think it is really tough when you can't keep a good team together. Sometimes I try to go out and find work in order to keep a good team together . . . A good team is important."

Trust is important in all teams, but is particularly important in MTM contexts where members have more difficulty monitoring work progress and lack the time to take on tasks not done well by fellow teammates. Thus, over time, MTM workers tend to gravitate toward projects that involve people they know in order to mitigate these risks:

> Knowing the people ahead of time is a critical success factor. We could not have done that project successfully if we were trying to cobble together a team of people who had never worked together. The degree of complexity of the client's problem set was so great that we had to have people who were known high performers and who were known to be good at keeping each other aligned and posted.

Building a strong relationship between the team and client is also critical to supporting effective MTM work. As noted above, significant time must be spent early in a project getting to know the client and defining the problem and client needs. Thus, the early phase of a relationship and project may not be well suited to members whose time is divided among multiple teams. However, as the project evolves, team members and the team itself might be able to manage more commitments. This was especially true for teams with direct client contact:

> Some customers want to see you sitting there, they want to see you working on something . . . At one client, I have a desk there, and at the beginning I spent a lot of time there, got to know all of the people there and I did a lot of interviews and that sort of thing. Once I feel like people know me, and know what I do, I don't feel like I need to spend as much time in the environment, I can spend more here at the office and work back here or wherever is the best environment to work in.

This manager went on to explain that the ideal is to have one or two people on-site full-time during the early phase of projects to get to know the client, their context, and their needs. After the basic relationship is established and some initial satisfactory output has been produced, she explained that it is possible for most or all of the team to move to a part-time status, enabling them to work on multiple teams.

Information and Communications Systems to Coordinate Work: As mentioned earlier, information and communications systems provide important tools for facilitating MTM work. One such tool used by XYZ Corp. was centralized planning software to coordinate the workloads of individuals involved in different projects.

> There is a process of assessing people's time, as part of the project budgeting process . . . Every year they set budgets, and every quarter they actually look at who is assigned to work on things. There are certain ongoing projects, something we know is going to happen, and people are budgeted according to how much time is required, and so they take a look at that and if people are allocated more than 100%, then they have to juggle that. So they try and do that at the beginning of the year, and then readjust it on a quarterly basis for financial purposes, and it also helps in judging peoples' work loads and trying to adjust.

In addition to managers' project planning systems, XYZ Corp. had email, intranet, and file server systems accessible from off-site and provided employees with laptops to facilitate distributed work. Being able to work in their choice of location greatly facilitated individuals' ability to work on multiple projects simultaneously, as it greatly reduced the "switching costs" associated with physically moving to separate locations for different projects. It also helped people coordinate with one another when working at different client sites for different projects.

> Most of the time, people juggle two or three projects . . . so that creates some interesting challenges in terms of how do you get people together in a room to have a conversation? How can you most effectively use the technology, because a lot of the collaboration technologies are not available if you are working on a client site on another project? So you can't just have a web chat, you can't just make a quick conference call, at that point we have to be really resourceful and creative to make sure we keep everyone tuned in so that they can do their individual work and do their work collaboratively.

Open organizational climate: As discussed above, MTM work usually evolves in a setting where individual expertise is highly valued, as MTM work arrangements allow teams to access more focused, specialized expertise than they would otherwise. To facilitate that access, organizations must create a climate in which project leaders can learn about the skills and capabilities of others in the organization, and individuals can learn about the projects that need staffing. Open discussions about projects, networking groups, topic-oriented listservs, and intranet portals on which employees post their resumes or project information are all tools for matching employees with projects. Interviewees stated, "Our company has these networking lunches, and I started going to those soon after I started work here . . . I've made a lot of contacts with people to find projects and find people to work on my projects" and "Sometimes I find work because I have expertise and interest in a particular topic area, and I hear about a project that involves that, so I make sure the project leader knows I am here and that I'm interested."

In some organizational contexts, concerns over security or intellectual property create barriers to communication across projects. While such concerns may be real, some organizations fall into the habit of making everything "secret" and may be unnecessarily undermining their ability to create connections among employees that can enhance the quality of their work overall.

Load Balancing System: While careful planning in MTM settings can assure that each employee is assigned the right amount of project work, changes inevitably occur requiring mechanisms for making mid-course corrections. New, high-priority projects are requested by important clients, individual workers suddenly leave the job for personal or professional reasons, or deadlines change as a result of unexpected difficulties. All such events create changes that reverberate across a system of linked projects, necessitating changes in work assignments. At XYZ Corp., it is important to manage these kinds of conflicts effectively: "For me, it's extremely important that I help [in times of conflicting deadlines], I'll go to the project lead or the project lead's management and explain that it is my decision to give this other project priority, and keep the burden as much as possible off of the staff."

In other settings, managers might have weekly meetings with their staff and/or other managers to review project workloads and anticipate difficulties. Such mechanisms help to avoid the stress that workers often experience in MTM settings [13], as well as ensure that projects get the effort and attention necessary to insure their quality.

4 Conclusions

This research represents a first attempt to model the benefits and challenges of work involving MTM. As such, it represents the beginning of a multi-level theory [37, 38] regarding the conditions under which MTM can enhance individual, team, and organizational innovation and effectiveness. We believe the preliminary findings reported here hold numerous implications for both scholars and practitioners managing in MTM environments. For scholars, these include implications for new and existing theory and methods, as research on MTM might may call into question existing findings that are predicated on a "one person, one team" assumption. For practitioners, these findings reflect key conditions necessitated by MTM contexts. As discussed, these include implications for the types of individuals organizations recruit, the design of work, the informational and communications systems necessary to coordinate work, and the openness of communication within and across teams. Though increasingly prevalent in organizations, MTM contexts remain largely unstudied. Since organizations' reliance on MTM is likely to grow, we encourage further MTM research to explore this common but understudied approach to organizing work.

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About the Authors

Mark Mortensen is an Assistant Professor of Organizational Behavior at MIT. He studies group dynamics in geographically distributed teams and the effects of technology on interpersonal interaction. His recent research includes studies of distributed team structure as well as a series of studies examining the different nature of conflict within geographically co-located and distributed work teams. In this research he has investigated the intervening effects of shared identity and mental models as well as spontaneous communication on the relationship between geographic distribution and conflict. He is currently involved in research exploring the phenomenon of team boundary disagreement within geographically co-located and distributed teams. Through this research he is examining the antecedents of team boundary disagreement and its effects on numerous team level outcomes including performance, innovation, and knowledge management.

Anita Williams Woolley is a Lecturer and Postdoctoral Research Associate in the Department of Psychology at Harvard University. She has been working in the field of organizational psychology as a researcher and consultant for over 14 years. Among her activities at Harvard, she manages an NSF-funded interdisciplinary collaboration among organizational psychologists and cognitive neuroscientists focusing on the interaction of individual differences and team performance strategies in affecting team performance. This work involves collaboration with the intelligence community, and helping them to learn about the structures that need to be put in place to quickly deploy and support interagency crisis action teams. Her work on MTM has been a natural extension of this research, as interagency teams often involve the sharing of personnel with multiple taskings across multiple agencies simultaneously.

Michael Boyer O'Leary is an assistant professor at Boston College's Carroll School of Management and received his Ph.D. from the Massachusetts Institute of Technology's Sloan School of Management. He is interested in dispersed, mobile, and other forms of work done in nontraditional office settings; team performance; and the social and behavioral aspects of information technology use.

Section 5

Knowledge and Virtuality

16

Learning Triggers in Virtual Groups

The Case of the Apache Web Server

Hala Annabi
The Information School, University of Washington
Box 352840, Seattle, WA 98195-2840
hpannabi@u.washington.edu

Abstract. Learning is a critical capability for virtual group effectiveness. The objective of this study is to understand when learning occurs. Once we understand when learning occurs we are better able to stimulate learning to enhance the effectiveness of virtual groups. Additionally, understanding the nature of learning triggers and the results they produce informs how we may achieve desired learning outcomes. This study develops a framework to explain, and empirically studies, when learning occurs in virtual groups. The study employed a single, embedded, qualitative case study designed to study learning triggers in an Open Source Software project. Findings suggest that learning occurs ensuing learning triggers. Learning triggers vary in type and source. The type and source of learning triggers effects whether learning occurs in the group and the type of learning outcomes the trigger produces.

1 Introduction

The complex business environment convoy with rapid technological changes has forced organizations to compete globally [1]. Organizations increasingly depend on groups to perform complex organizational tasks and functions [2]. These groups are often made up of knowledge workers distributed around the globe [3, 4]. This results in a new organizational form where work is done by virtual groups of knowledge workers [3, 4].

Virtual groups face challenges manifested in the lack of, or misunderstandings in communication, problems in product and process management, coordination difficulties and failures, and knowledge management problems [5-9]. These challenges make it difficult for members to make sense of the task and communications from others [10], which makes it hard for group members to develop a shared understanding of the developing project [11].

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To minimize the negative effects mentioned above, virtual groups must learn effective communication and coordination practices suitable to their new environment. Facilitating learning on the group level in a virtual group of independent knowledge workers is critical to survival in the current business environment [12-15]. In their study of distributed cross-functional groups, Robey et al. [16] suggest that to be successful, distributed groups must learn. However, research and practitioner communities know little about facilitating learning suitable for distributed groups [16, 17].

To facilitate learning in virtual groups it is fundamental that we understand the phenomenon of group learning in that context. Wiegand [18] and Prange [19] determined six critical questions to address in order to understand organizational or group level learning including: what does Organizational Learning mean; who is learning; what is being learned; when does learning take place; what results does learning yield; and how does learning take place. In this paper I will focus on ***when learning occurs***. The paper presents a framework to study learning triggers developed through an in-depth case study of an Open Source Software (OSS) project as an interesting example of virtual groups of knowledge workers.

1.1 Context of the Study

OSS is a broad term used to describe software that is developed and released under a form of "open source" license. There are many licenses with a range of different features, all of which allow inspection of the software's source code. There are thousands of OSS projects that span a range of applications; the Linux operating system and the Apache Web Server are probably the most well known. OSS projects provide important examples of virtual groups of independent knowledge workers who fully integrate ICT's into their work. Many OSS groups have been outstandingly successful in meeting the challenges of developing large and complex software systems (while others have not). Many OSS groups include complete records of their interactions and work products, which are publicly accessible and provide a rich environment for the study of learning. Finally, OSS development projects are often formed outside of a specific organizational context and project members face a particular challenge in learning to work together, which makes a study of their group learning particularly interesting.

The remainder of the paper is organized in four sections. In the first section I review the literature and develop an initial framework of learning triggers. The second section presents the empirical findings of the study and the revised framework of learning triggers. The paper concludes with the theoretical and practical implications of the case study.

2 Conceptual Background

Learning in OSS groups is a complex and latent phenomenon. Learning occurs within a social process focused on completing project objectives [20]. In this section

I review related literature and develop an initial framework of learning triggers in OSS projects. The framework integrates several areas of research including: Organizational Learning, Group Research, and Shared Mental Models.

2.1 Learning on the Group Level

The literature pertaining to learning in work and work-like settings provides many definitions of learning on a collective level as opposed to an individual level. In general, learning refers to developing new understandings or interpretations of information and or events [21]. I draw on the definition of group learning developed in an earlier study [20] to conceptualize project level learning. In the earlier study I [20] define group learning as "the process by which group members share knowledge and information and integrate it into the group's implicit and explicit rules, leading to changes in the behavioral potential of the group." I use the concept of behavioral potential in accordance with Huber [22] to emphasize the cognitive nature of learning, explaining that learning outcomes are not always observable. In the earlier study, I [20] define explicit rules as verbalized rules, policies, procedures and requirements, and implicit rules as the group's shared mental models.

I also draw on the earlier study's [20] use of learning opportunity episodes (LOE) to bound the phenomenon of learning. LOE is "a group event that occurs over time as a result of a learning trigger. It may or may not lead to changes in the behavioral potential of the group" [20]. The definition is illustrated in Figure 1.

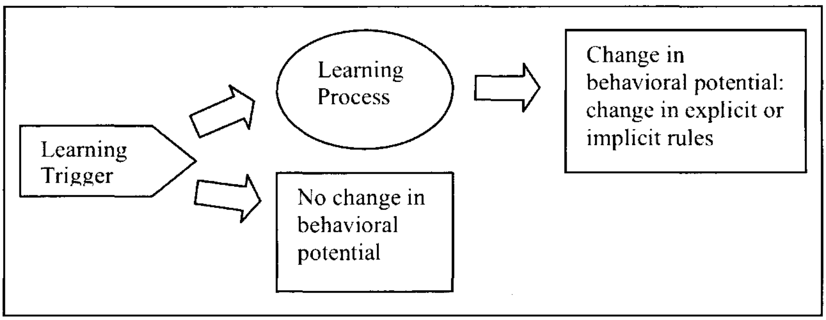

Figure 1. Learning Opportunity Episode

2.1.1 Learning Triggers: When Does Learning Occur?

In an earlier study I [20] propose that groups have an opportunity to learn if any of the group functions are not met, or can be met more effectively or efficiently. Drawing on Walton and Hackman [23], I [20] identify five important group functions: social, interpretive, task, agency, and regulative. Implicit and explicit rules are created and/or emerge to guide group behavior in achieving its goals and functions. The regulative and interpretive functions of groups, presented in Walton and Hackman [23], suggest that one aspect of group functions is to create rules (implicit and explicit) and to interpret them and the reality in which the group resides. Walton and Hackman's [23] social, task management, and agency functions are satisfied through members' input and interaction with one another and the task within a specific environmental context. Groups are effective in meeting their function, according to Hackman [24], if task output is acceptable to the group and evaluating parties (for example, users, customers and/or management), the group is maintained and strengthened, and members are satisfied. If any of the measures of effectiveness is missing, the group has an opportunity to change certain aspects of its behavior or understanding; in other words, the group has an opportunity to learn. She refers to this opportunity as a learning trigger (the focus of this paper). Consistent with an earlier study [20] I define learning triggers *as a group event where any or all of the group functions are not met or are not met effectively or efficiently.* This event presents an opportunity for the group to change its implicit or explicit rules, in other words its behavioral potential, to meet its functions and/or improve effectiveness and efficiency. Investigating the literature from this view I observe a number of internal and external learning triggers.

Internal triggers are events that occur within the group, where any or all of the functions of the group (identified in Walton and Hackman [23]) are not met or are not met effectively. The reason for this could be a lack in resources (capital or human) to perform tasks [25, 26], an error or mismatch of expectations [27, 28], problems in cohesiveness or the rise of conflict [29], a misinterpretation or multiple inconsistent interpretations [23, 30], or a misfit between regulative components (such as leadership, norms, rules, and procedures) and the functions of the group and task that manifest as errors due to process [27].

External triggers are events that happen in the environment or context of the group that require the group to change certain aspects of its behavior to meet its goals and functions. External triggers could come in the form of user needs [23], new technologies [23], or external expectations (for example, new regulations, or societal expectations that might change the way social needs are met, what products and services should be produced, or how products and services should be produced) [31, 32]. The fifth function Walton and Hackman [23] present is agency function. This function of the group speaks to the representation of group interests to the environment and the negotiation of membership into the group. This function may be triggered by internal—a lack or resources when there is a need for new members with particular expertise—or external—an offer for contribution when a co-developer desires to join the core in OSS context) pressures. The possibility of new members joining or contributing is an opportunity for learning as Grant [30] suggests. This presents a learning trigger in two ways: gaining new knowledge and expertise which might lead to changes in explicit roles as to how things are done and, in addition, there is a gap in the shared mental models of group members as the new member needs to be socialized into the group's ways of doing things and understanding of the code.

To further develop this framework of learning triggers, I conducted an in-depth qualitative embedded case study of one Open Source Software Project as an example of a virtual project.

Table 1. Initial Learning Triggers Framework

Learning Trigger	Indicator	Group Function [23]	Definition
External	User Need [23]	Agency Task management	A request by users for new product features, new distribution channels, or new help pages
	New Technology [24]	Task management	Introduction of new technology that allows or requires doing things differently (e.g. tools)
	External Expectation (stress or tension) [31, 32]	Agency	Indication of pressure from other developers or the outside community to change a process or a product
	Offers to Contribute [30]	Agency	A request or inquiry from co-developers or active users to contribute to a particular part of the project
Internal	Misrepresentations [23, 30]	Interpretive	Indication of misunderstandings of how things should be done and what the expectations are
	Cohesion Problems [29]	Social	Indication of hostility, lack of supportiveness, or negative feelings within the group
	Conflict [29]	Social	Indications of interference by member or group when another member or group is attempting to achieve a goal
	Lack of resources [25, 26]	Task management, Agency	Not enough material or non-material resources such as people, machine power, money, or appropriate procedures to perform tasks
	New Member [30]	Agency	Introduction of new member to the group
	Error [27]	Task management	Mistakes made due to process

3 Methodology

This study employed a qualitative case study design to better understand the phenomenon of learning in a work setting as suggested by Miner and Mezias [33]. More specifically, I employed a single embedded case study design, based on a theoretical sample strategy. The case for this study is the Apache httpd Project. The embedded unit of analysis is the LOE, which is defined earlier.

Theoretical selection criteria in this study were group size and group effectiveness. I selected a group having more than seven core developers, a lower-limit sample as suggested by Hare [34]. The literature suggested that learning leads to effectiveness [12, 13]. The research selected an effective group previously identified as successful in the OSS literature, Apache Web Server, which increases our chances for observing learning triggers.

In 1994 eight software developers started collaborating via private e-mail. In early 1995 they established a Web presence and mailing list to continue their development effort of the Apache HTTPD Server Project as an effort to develop and maintain an open-source HTTP server for modern operating systems [35]. The Apache Web server has been the most widely used Web server on the Internet since 1996, holding 64% of market share in 2003 according to Netcraft Web Server Survey (http://news.netcraft.com). I observed the Apache httpd Project between its inception (February 1995) and the first stable release, Apache 1.0 (December 1995), and tracked the group movement from alpha to beta to stable.

I chose to bound the learning process using LOE as suggested by Miles and Huberman [36] and operationalized in an earlier study [20]. Behavioral potential is manifested in changes in explicit rules (from which I focused on changes in rules and procedures) and implicit rules (from which I focused on shared mental models). I considered a LOE to have no change if one month passed without a direct response to that trigger (the average between LOE times four). Explicit learning outcome was measured by identifying a change in rules or procedures in the group. Implicit learning outcome was measured by identifying group shared mental models evident in change in the code, agreement, or course of behavior. An LOE can be selected by identifying learning triggers, indicators of learning process, or identifying explicit changes to rules. Once any of these elements was identified as being part of the LOE the related interaction messages and documentation were collected. The interaction data was content analyzed using Atlas-ti, and the documentation was reviewed. I used the initial framework in Table 1 to analyze learning triggers in the Apache httpd Project.

4 Findings

The study identified 178 LOEs. More than one trigger can appear within a learning-opportunity episode. In this study, the trigger that initiated action around the issue is considered the main trigger for the episode. In this section I report the revised framework and present an overview of the impact of learning triggers on the learning process.

4.1 Revised Learning Triggers Framework

Table 2 presents the refined framework of learning triggers. The triggers that emerged during the inductive data analysis are indicated by an asterisk (*).

Table 2. Revised Learning Triggers Framework

Learning Trigger	Indicator	Definition
External	User need*	A request by users for new product features, new distribution channels, help, or new help pages
	New technology*	Introduction of new technology that allows/or requires doing things differently
	External influences*	Suggestions or knowledge shared from external members, or involvement or indication of pressure from other developers or the outside community to change a process or a product beyond the code-development level inter-organizational and industry level
	Offer to contribute or new member	A request or inquiry from co-developers or active users to contribute to a particular part of the project, or the knowledge of a person that the group wants to invite to join the group
	User identified error	Error (undesirable outcomes) in code identified by users
Internal	Misrepresentations or gaps in understanding*	Indication of misunderstandings or lack of understanding of how things should be done and what the expectations are or how the code functions. This could be in the form of a question or request, or an indication of confusion or misunderstanding.
	Conflict	Indications of interference by member or group when another member or the group is attempting to achieve a goal
	Lack of resources	Not enough material or non-material resources such as people, machine power, money, or appropriate procedures to perform tasks
	Summarize/update/share information of code and product status*	Presenting a summary of an update of the state of the code or process.
	Efficacy of the process	Highlighting problems with the effectiveness and efficiency of how tasks are handled and completed brought forth by members or co-developers
	Innovation in the product*	Contributions of members to innovate in the product. They propose to change aspects of the direction of the code (e.g. coding style, features, license) and suggest plans or ideas about making the improvements
	Innovation in the process*	Contributions of members to innovate in the process that the group follows. They propose to change aspects of the process or procedures and suggest plans or ideas about making the improvements.
	Member identified error [27]	Error (undesirable outcomes) in the code or procedures identified by the members of the group

Changes and Refinements to Definitions of External Learning Triggers

The changes to the external learning triggers were as follow:

- External expectation: This learning trigger in Table 1 was relabeled "external influence" to capture the external effects in the form of knowledge and advice given to the group and sought from the group (made up 4 of the 11 triggers in this category), as well as expectations (made up 2 of the 11 in this category); requests to use the code or name or practice (made up 5 of the 11 triggers in this category). This is important to capture the collaborative and open nature of the group.

- Offer to contribute: this learning trigger was expanded to include the notion of the inclusion of new members. Initially, it was considered an internal learning trigger. During the research process, offers of contribution and new members were combined to highlight the fact that new members are initially an external trigger, as they require a process of socialization and internalization by the group (opportunities for learning). New members, like external offers to contribute, bring resources not previously available to the group.
- User identified error: This is a new code that emerged from the data. It was added to illustrate the fact that some learning episodes related to the code are a result of user engagement with the development and use of the code, and therefore provide opportunities for the group to learn more about the code and potentially improve it. In fact, 6% of learning triggers were errors identified by users and co-developers, and 14% of the learning triggers were errors identified by core developers.

Changes and Refinements to Definitions of Internal Learning Triggers

The changes to the internal learning triggers are as follow:

- New member: This learning trigger was combined with the external learning trigger "offer to contribute," as explained above.
- Cohesion problems: This trigger was combined with conflict trigger as cohesion problems manifest in conflict.
- Member identified error: This trigger was redefined to reflect the type of error in OSS groups that are identified by the group members as they are testing the code or using processes. Fourteen percent of learning triggers included errors identified by core developers.
- Assess the efficacy of the process: This is a new trigger to capture the proactive nature of members evaluating the effectiveness and efficiency of the process used by the group. Ten percent of learning triggers were assessing the efficacy of the process triggers.
- Shared information on code and product status: This trigger was added as suggested by the data. It captures the episodes in which new information or knowledge about the code are presented, leading to challenging members' understandings or presenting the gaps in the group understanding that those members can fill. This became a mechanism used regularly by the group to generate learning. The "shared information on code and product status" learning trigger accounted for the largest single percentage of learning triggers making up 20% of learning triggers.
- Innovation in process: This trigger speaks to the innovative and creative nature of the members and is related to members' expertise and skills. New

ideas from members to improve process present opportunities for learning. This learning trigger accounted for 9% of learning triggers.

- Innovation in product: Like innovation in process, this trigger also captures the creative nature of the group to improve the product that they produce. This learning trigger accounted for 7% of learning triggers.

4.2 Overview of Learning Triggers in Apache

This section reports on the results of the analysis of the learning triggers using the revised learning triggers framework presented in Table 2. The most striking finding (illustrated in Table 3) is that 75% of learning triggers come from internal forces (core developers) and 25% of learning triggers are external to the group, representing the needs, pressures, and opportunities presented to the group from users and co-developers. OSS advocates and developers (including Apache developers) claim that the strength of OSS development lies in the fact that it is open to outside contributors and thereby provides an endless supply of innovative ideas [37]. In comparison to proprietary development teams, an external trigger of 25% could be significant. Comparative studies with proprietary teams would further enhance the discussion of this finding.

Table 3. Frequency of Learning Triggers

Learning Trigger	Indicator	Number	Percent
External		44	25%
	User need or request*	13	7%
	New technology*	3	2%
	External expectation/ requests *	11	6%
	Offer to contribute or new member [30]	6	3%
	Error*	11	6%
Internal		134	75%
	Misrepresentations or gaps in understanding*	29	16%
	Conflict [29]	0	0%
	Lack of resources [24]	0	0%
	Error [27]	25	14%
	Shared information on code and product status*	35	20%
	Efficacy of the process [38]	17	10%
	Innovation in the process*	16	9%
	Innovation in the product*	12	7%

Internal learning triggers that focus solely on process make up 19% of the learning triggers observed. Innovation triggers make up 16% of triggers observed. Additionally, triggers that could potentially lead to innovation (external expectations, new technology, and offers to contribute) make up 11% of triggers observed. Lastly, Table 3 indicates that there was no conflict or lack of resources learning triggers in this group at this stage. It is possible that conflict and lack of resources influence the learning process but do not necessarily initiate learning.

An example of an external trigger is user need or request. The quote below is an example of a user request for help and information regarding functions in the code and how they can be modified. The trigger generated a discussion around the user question and led to developing shared mental model of GET, PUT and LIMIT functions of the code.

Example (What is this? 3/13/1995):

> I was looking through the code to httpd and noticed the functions Put and Delete - apparently using the same access controls as get, etc. Does this mean the default is that anyone can delete and put replacement files in http servers? I removed the code (to no negative effect) from my httpd but didn't test to exercise the potential problem. I would be interested to hear of anyone who tests and finds that outsiders can modify their servers this way.

An example of an internal trigger is misrepresentation or a gap in understanding. An example of this trigger was evident on 10/13/1995 when one of the core members needed clarification on who was building Apache 1.0.

Example (Anyone Building 10/13/1995):

> Anyone building 1.0?
> Anyone planning to?

This episode contained two messages, one containing the trigger, the other containing a response from the person who was building 1.0 (indicated in the quote below), which led to the clarification of the initiator's understanding, and let the rest of the group know who was working on 1.0. From this I infer that the group developed a shared mental model of who was working on version 1.0.

Perhaps the most interesting aspect concerning learning triggers that emerged in the inductive data analysis is the trigger to share information on the code and product status. This trigger is a mechanism that the group developed to ensure group members were on the same page. To ensure that the group members had shared mental models, a member, often a release coordinator, would provide the group with a summary of the code and the patches with the intention of generating a discussion to clarify understanding. Other members contributed information to correct errors or omissions provided in the summary. This was an important mechanism for learning as it addressed shared mental models of the code and who was doing what, as well as providing grounds for developing to-do lists and timelines. This mechanism became an information sharing mechanism to which the whole group could contribute. An example of this trigger is provided below from an episode on 3/18/1995 that discussed patches on hyperreal and an update on voting.

Example (hyperreal 3/18/1995):

I've put apache-0.2.tar.Z into
http://www.hyperreal.com/httpd/dist/
It's based on the votes I read before sending this mail, which
included Roy's which killed off some but revived others.
Included are,
B01_CERT_security.txt
B02_linger.txt
[list omitted for space considerations]
All remaining patches should now be replaced with new patches which are relative to apache-0.2. Drop them in
http://www.hyperreal.com/httpd/patches/for_Apache_0.2/
. . . then we can start discussing them. All votes collected so far have now expired.

Response 3:

I just upped a revised B18 which handles redirects. This was left out of 0.2 because Roy spotted that the patch I uploaded last time was faulty (the patch file - not the idea)

Response 5:

If possible, I think it would be better to split this patch into two; one to fix the addtype bug, and another to clean up the script code.

The excerpts from this learning-opportunity episode suggest that the code and patch status generated discussion in the group concerning changes to the list as well as problems with some of the patches. The discussion of individual patches often led to developing a shared understanding of the patches and how each patch might affect various modules in the code. Furthermore, these discussions provided new ideas about how to write a particular patch. One can infer from this episode that a shared mental model of the patches and alternatives for future actions were developed. This is evident in the actions group members take (for example, patch fixes that are then submitted). Future research would benefit from doing a contemporary observation of a group and using cognitive maps to elicit data for further evidence of shared mental models in a group.

Table 4 presents the product or process focus of learning opportunity episodes in relation to the various learning triggers. The table indicates that 50% (22/44) of external triggers lead to product episodes; 14% (6/44) lead to process and product episodes; 36% (16/44) lead to process episodes. In internal triggers, 43% (57/134) lead to product episodes; 32% (43/134) lead to process and product episodes; 25% (34/134) lead to process. These percentages indicate that both the external and internal forces are more focused on product issues than process issues as only 28% (16+34/178) of the learning triggers are solely focused on process. Surprisingly, the focus on the process is slightly higher in external triggers (36% versus 25%). This could be explained by looking at the external indicators. Detailed results of Table 4 indicate 75% of external triggers leading to process are in the form of offers for contribution and external expectations. Both of these lead to process learning, such as integrating a new person into the group's processes or changing processes to accommodate external expectations. This indicates the fact that the external environment presents the group with opportunities to formalize process in order to maintain some consistency.

Table 4. Learning Triggers Leading to Process and Product Episodes

Learning Trigger		Process		Product		Both Product and Process	
External	Total External Triggers	16	36.36%	22	50%	6	13.64%
	User need or request*	3	18.75%	9	40.91%	1	16.67%
	New technology*	0	0.00%	2	9.09%	1	16.67%
	External expectation/ requests *	7	43.75%	2	9.09%	2	33.33%
	Offer to contribute or new member [30]	5	31.25%	1	4.55%	0	0.00%
	Error*	1	6.25%	8	36.36%	2	33.33%
Internal	Total of Internal Triggers	34	25.37%	57	42.54%	43	32.09%
	Misrepresentations or gaps in understanding*	5	14.71%	13	22.81%	11	25.58%
	Conflict [29]	0	0.00%	0	0.00%	0	0.00%
	Lack of resources [24]	0	0.00%	0	0.00%	0	0.00%
	Error [27]	1	2.94%	19	33.33%	5	11.63%
	Shared information on code and product status	4	11.76%	14	24.56%	17	39.53%
	Efficacy of the process	10	29.41%	1	1.75%	6	13.95%
	Innovation in the process	14	41.18%	1	1.75%	1	2.33%
	Innovation in the product	0	0.00%	9	15.79%	3	6.98%
Total of Internal and External		50		79		49	

Perhaps what is most interesting about Table 4 is that 88% of triggers leading to both product and process focus were internal. Episodes that have both product and process focus are more complex episodes as they tackle more than one issue and they often contain opportunities for developing both rules and shared mental models. These episodes are often more involved in terms of the number of messages involved. More core developers, co-developers, and active users are typically involved in these episodes. This finding suggests that external triggers lead to simpler episodes for fixing an error, creating a different distribution channel, or clarifying code function. Internal triggers lead to more complex episodes that in turn lead to more critical analysis.

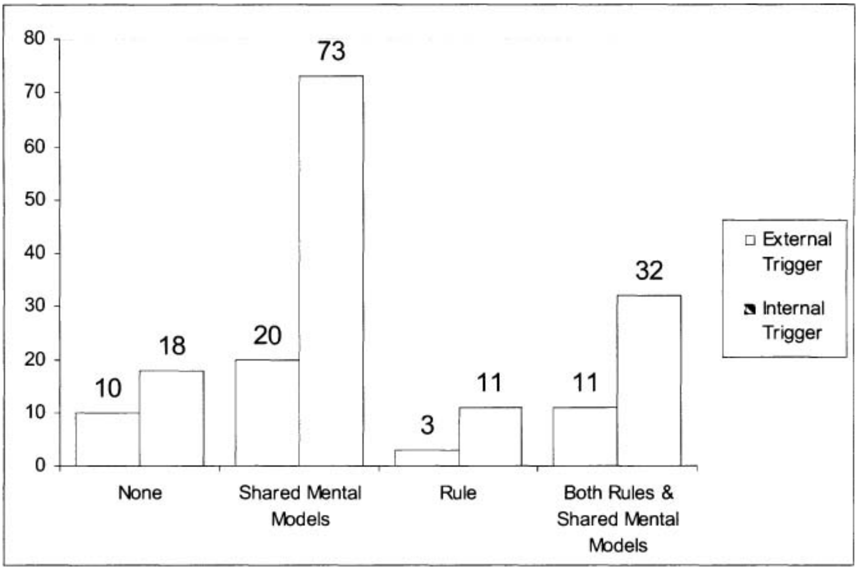

Figure 2. Learning Outcomes of External and Internal Learning Triggers

Figure 2, above, indicates that 36% (10/28) of total episodes leading to no learning were a result of external triggers, and 64% (18/28) were a result of internal triggers. Twenty-two percent (20/93) of learning episodes leading to shared mental models were a result of external triggers, and 78% (73/93) were a result of internal triggers. Twenty-one percent (3/14) of learning episodes leading to rules were a result of external triggers, and 79% (11/14) were a result of internal triggers. And lastly, 26% (11/43) of learning episodes leading to both shared mental models and rules (what we refer to as complex episodes) were a result of external triggers, and 74% (32/43) were a result of internal triggers. Once again, these results suggest that a larger number of more complex episodes are triggered internally. It is interesting to note that in the distribution of external and internal triggers and their learning outcomes, the distribution remained very close to 25% external triggers and 75% internal triggers. The exception was episodes that led to no learning, in which case 10 out of 28 (36%) were external. This suggests that the group was slightly more likely to respond to internal triggers than they would external triggers. This could be explained by the fact that most individuals participating in the development process (writing code and documentation or creating procedures) were volunteers working on what was of interest to them when the time was available. For example, the volunteers often championed issues they were interested in, and in some instances this led to learning. In instances where the learning trigger was presented from external forces that had no internal champion or did not present significant pressure, the group did not respond. So in addition, this suggests that external learning triggers are more likely to be ignored or be deemed irrelevant.

5 Discussion

The objective of this paper is to understand learning triggers in virtual groups such as OSS groups. I developed a framework for studying learning triggers in virtual group. This section reports on the final revisions to the framework derived from the empirical findings presented in the findings section. The revised framework presents implications to the critical question identified in organizational learning literature [18, 19]: When does learning occur?

The literature suggests that learning occurs when there is a deficit in resources [25, 26], stress or tension [31, 32], or error or mismatch of expectations [27, 28]. The OL literature includes internal as well as external triggers to learning; however, the literature focused on learning as a reactive process and neglects the proactive and innovative nature of learning. This is a shortcoming, especially considering that the main assertion of OL research is that learning is important for innovation and consequently survival and competition of any group or organization.

This study contributes to the literature by including proactive and innovative learning triggers. In the study the inductive data analysis identified three new learning triggers that highlight the possible innovative and proactive instances of learning: innovation in process, innovation in product, and sharing information on code and product status. In fact, 36% of the learning triggers in the study fell under the three above-mentioned learning triggers. It is interesting to note that the learning trigger labeled "shared information on code and product status" emerged in the group and became a mechanism for the group to learn. A release coordinator during a particular week would provide the group with a status report according to his understanding. The other group members then would discuss the report pointing out errors, misrepresentations, or other observations. This became a proactive mechanism to build shared mental models of the code and decide on plans to proceed with the work. Soon after the mailing list for the founders of Apache was established, one of the members generated a summary e-mail to generate consensus among the group members about the group's goals, status, and proposed procedures and new patches. The earliest example of this learning trigger is provided below (transcript has been edited to contain only relevant material):

> Here's my impression of the group consensus on areas where I think there is a consensus, along with a few important issues where I don't think a consensus has been reached.
>
> From the top:

NCSA httpd 1.3 was originally released the better part of a year ago. Since this release (which came more or less with the departure of Rob McCool to what is now Netscape)... [*text deleted for space consideration*]

This group consists of people who've all had to patch 1.3 at one time or another, [test deleted for space consideration]

Our goal is to produce a revised version of NCSA 1.3 which [*text deleted for space consideration*]

Our current plan is to set up an RCS source tree someplace (probably hyperreal.com), with the distributed NCSA server (which one?) as a base. We're going to [*text deleted for space consideration*]

Finally, I might as well start listing the various patches which I've seen discussed here over the past few days, [*text deleted for space consideration*]:

Bug fixes: (most available in multiple versions)
*) The stack-scribbling security hole...

[*remaining patch list deleted for space consid*eration]

Functional enhancements: (Note that many of these are still in the process of being packaged up for submittal):

*) DBM-based user databases for HTTP authentication. [BB]
[remaining list deleted for space consideration]

If anyone has something *right* *now* that they'd like to see in an early Apache release, which I haven't listed, this would be a good time to step forward.

After a discussion with the group, some of the information above was updated to reflect the current understanding and led to the development of the shared mental model of the code and group status and goals.

Additionally, the study suggests that learning triggers come from external as well as internal sources. OL literature focuses mostly on learning triggers that are internal to the group or organization (for example, error, lack in resources, stress or tension). The case study suggests that while 75% of learning triggers are internal to the group, 25% of the triggers are external to the group. It is important to identify and study external learning triggers as they provide the mechanism to respond to the changing environment that is critical to the competitiveness and survival of any group or organization. This is especially important for virtual organizations and new forms of virtuality that blur the boundaries or groups and organizations and opens the learning process to the external environment.

In summary, learning triggers present the group with opportunities to learn either related to the product or process. The trigger focus and source determine the types of behaviors required for learning to occur.

6 Conclusion

Findings from this study have pragmatic implications for OSS groups and virtual work groups. OSS developers and managers can carry out these suggestions to facilitate learning in their groups. These implications can be easily used in educational groups and other organizational settings.

The learning triggers identified serve as guidelines for initiating learning in OSS groups and other virtual groups to improve performance and foster innovation. Members of these groups may initiate learning triggers to generate desired learning outcomes. Members can be selective about which learning trigger to introduce to increase their chances of generating changes in product or process. For example, members in these groups can introduce learning triggers (for example, assess the efficacy of the product; share information, or updates of code status, etc.) to initiate a learning process that focuses on the chosen process or product concerns. As well, the triggers can determine the learning outcome in terms of implicit or explicit rules. Members of these groups should also be aware and pay attention to the source of learning triggers. Groups and managers can become more sensitized to external learning triggers and benefit from the learning opportunities they provide. Lastly, members of OSS groups and other virtual groups may use the learning triggers in the framework to monitor group learning and outcomes.

This study is an initial step to understanding when learning occurs in virtual groups. Future studies can expand the framework of the learning triggers developed. Studies may expand the framework by applying the learning triggers in various types of OSS groups to compare the nature of learning triggers in effective and less effective groups. As well, the study should explore the learning triggers across various stages of project development to investigate the differences in type of learning triggers and their outcomes in the various stages. Last, the framework can be further developed by applying it to diverse virtual group settings other than OSS groups. These studies may further develop our understanding of learning triggers that significantly increase our capabilities for facilitating learning in virtual groups, a necessary capability for their success.

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About the Author

Hala Annabi is an Assistant Professor at The Information School at the University of Washington. Her research and teaching interests center around the effects of information technology on learning in both the work and educational settings. More specifically she studies how the new forms of computer mediated work and education affect the learning processes of individuals and groups in these settings. In the work setting Annabi focuses on organizational learning in distributed groups by studying how groups of distributed knowledge workers (such as Open Source Software groups (OSS)) develop rules and shared mental models, and how leadership plays a role in that learning. In addition, Annabi investigates organizational learning in distributed environment by studying how distributed communities of practice lead to organizational learning. In the educational setting Annabi focuses on how Asynchronous Learning Networks (ALN) affect the learning process and change the role of students and teachers, and how those changes affect student learning outcomes and satisfaction. Additionally, she investigates how ALNs can be used to augment face-to-face classrooms to facilitate reflective collaborative learning and build learning communities.

17

Sharing Knowledge in Global Virtual Teams

How Do Chinese Team Members Perceive the Impact of National Cultural Differences on Knowledge Sharing?

Kangning Wei
School of Information Studies, Syracuse University,
Syracuse NY, 13210, U.S.A.
kwei@syr.edu

Abstract. Virtual teams have been seen as a promising way of organizing work for organizations to cope with the current rapidly changing business environment. Issues concerning virtual teams have received considerable attention in both the academic and practical world. In this paper, a case study approach was used to explore Chinese perceptions of the impact of national cultural difference (China vs. U.S.) on knowledge sharing activities in global virtual teams. Four cultural dimensions (language, education, technology and material culture, and attitudes and values) were identified. The final results show that language has the most salient impact on an individual's knowledge sharing activities, followed by education, attitudes and values, and technology and material culture. Individual characteristics, organizational culture, time zone problems and leadership style all have a mediated impact on knowledge sharing activities.

1 Introduction

Knowledge sharing has been treated as a key process in knowledge management practices [1-4]. Recent research on knowledge sharing has identified a variety of factors that lead to effective knowledge sharing, such as motivation [5] and culture [4], but few studies have focused on addressing knowledge sharing activities in different team settings [6]. These challenges become more pronounced in virtual teams, which have been considered as one of the most promising ways of working in the future [7, 8].

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Virtual teams are defined as teams that are composed of geographically and/or organizationally dispersed coworkers who are assembled together, mainly by information and communication technologies (ICT), to accomplish one or more organizational tasks [7]. By organizing virtual teams through available ICT (such as email, Internet, videoconferencing, and groupware), organizations can take advantage of the particular skills and expertise of employees without the cost and trouble of traveling and relocating employees [9]. As such, issues concerning virtual teams have received considerable attentions in both the academic and practical world.

Knowledge sharing in virtual teams is different from traditional face-to-face teams. By using ICT, virtual teams can facilitate knowledge sharing in terms of easily organizing diverse backgrounds of the knowledge workers and increasing accessibility to information and knowledge [10, 11]. On the other hand, the geographic, temporal, organizational, and/or cultural discontinuities [12] that may exist in virtual teams can create problems that can hinder knowledge sharing among team members. For example, studies have shown that virtual team settings can create task coordination and communication difficulties [13], dehumanization and social isolation [14], inflexibility of organizational ties [6] , etc.. Although knowledge sharing has many challenges in virtual environments, it has been treated as one of the determinant factors of achieving virtual team effectiveness [8, 15].

A number of factors that can affect knowledge sharing have been examined, such as motivation [5, 16], transactive memory [17], boundary spanning [18, 19], technology infrastructure [20, 21], communication norms [22], trust [23], and learning [24]. Some factors become more prominent for knowledge sharing in virtual teams, such as national culture [4, 25], which is the interest of this paper.

This study investigates individuals' perceptions of national cultural differences on knowledge sharing activities in global virtual teams. Specifically, Chinese team members' perceptions of the cultural differences between China (mainland) and the U.S. are studied. The remainder of this paper is organized into four sections. Section 2 provides a literature review, which is based on three areas: national culture, distributed work and knowledge sharing. The research method is illustrated in section 3. Section 4 provides the results of the study, which is followed by a discussion in section 5. Section 6 concludes the paper.

2 Literature Review

2.1 Knowledge and Knowledge Sharing

Although the concept of knowledge sharing is used frequently in many studies [10, 26], exploring and defining what it exactly means remains difficult due to different opinions about what knowledge is. The perspective of knowledge that one holds underlies the conceptualization of knowledge sharing activities [3]. A review of the literature reveals that the epistemological perspective of knowledge is understood quite differently among scholars. Basically, there are two perspectives: the static perspective and the practice-based perspective.

The static perspective treats knowledge either as a separate, static object that can be easily stored and manipulated or a static state of mind that is difficult to articulate [27]. One of the well-known definitions of knowledge in the static perspective is explicit knowledge and tacit knowledge [28]. The practice-based view posits knowledge as knowing in practice [3, 27] or situated performance [29]. In this perspective, knowledge is enacted in people's everyday practices and is inseparable from daily activities. Knowledge is a situated knowing, constituted and reconstituted in everyday practice.

This paper adopts Alavi and Leidner's [20] definition of knowledge as "personalized information (which may or may not be new, unique, useful, or accurate) related to facts, procedures, concepts, interpretations, ideas, observations, and judgments" (p.109). Knowledge sharing is defined as the exchange of task-related information, know how, and feedback regarding a product or procedure [30].

Knowledge sharing practices are often discussed in traditional collocated environments. Traditionally, knowledge sharing practices have occurred through various means such as personal communication (formal or informal), mentoring, training, job rotation, and staff development [31]. As stated above, a number of factors that can affect knowledge sharing have been examined, but few studies have focused on addressing knowledge sharing activities in different team settings [6]. These challenges are even more pronounced in virtual team settings due to their geographical, organizational, and/or temporal distances and because they mainly rely on ICT to communicate.

2.2 Culture and National Culture

There is no unifying definition of the concept of culture, and it is described in very different ways in the literature: ideas and cognition, symbols and meanings, values and ideologies, rules and norms, behavior patterns, structures and practices, etc [32-34]. This paper has adopted Terpstra and Sarathy's [35] definition of culture:

> Culture is the integrated sum total of learned behavioral traits that are shared by members of a society." One fundamental is that culture is a total pattern of behavior that is consistent and compatible in its components. It is not a collection of random behaviors, but behaviors that are related and integrated. A second fundamental is culture is learned behavior it is not biologically transmitted. It depends on environment, not heredity. It can be called the man-made part of our environment. The third fundamental is that culture is behavior that is shared by a group of people, a society. It can be considered as the distinctive way of life of a people. (p. 90)

There are also different levels of culture, ranging from supranational (regional, ethnic, religious, linguistic), national, professional, organizational level to group level [36], which may shape members' knowledge sharing behavior simultaneously.

The two most frequently studied level of cultures in the literature are national culture and organizational culture [37]. This research will focus on national culture.

2.3 Dimensions of National Culture

The dimensions of national culture identified by Terpstra and Sarathy [35] are used as the basis forming the cultural frame of reference in this paper. Eight dimensions were identified from their research: technology and material culture, language, aesthetics, education, religion, attitudes and values, social organization, and political life. Table 1 lists the definition of each dimension. Although Hofstede's [38] five dimensions (individualism vs. collectivism, power distance, uncertainty avoidance, masculinity vs. femininity, and long-term vs. short-term orientation) are identified as the most popular ones used in IS research [37], Terpstra and Sarathy's dimensions are preferred in this study because they not only include a value-based dimension (which is the focus of Hoftstede's dimensions), but also include other important dimensions such as language [4].

Table 1. Dimensions of Natural Culture [35]

Dimension	Definition
Technology and Material Culture	Material culture includes the tools and artifacts in a society. Technology refers to the techniques or methods of making and using those things.
Language	The native language one speaks
Aesthetics	The ideas in a culture concerning beauty and good taste, as expressed in the arts and the appreciation of color and form.
Education	The process of transmitting skills, ideas, and attitudes, as well as training in particular disciplines
Religion	The religion one holds
Attitudes and values	The belief one holds to help determine what is right, important, desirable, etc.
Social organization	It refers to the way people relate to other people. The primary kind of social organization is based on kinship.
Political life	The political environment around a person

2.4 Theory of Cross Cultural Adaptation

In Figure 1, Gudykunst and Kim's theory of cross cultural adaptation process describes how strangers adapt to a new and unfamiliar cultural environment and how their communication activities influence their adaptation [39]. Enculturation takes place in early childhood when the forms for expressing and comprehending basic social behaviors are internalized by socialization with others. When strangers interact with a new culture, the process of resocializaton, or acculturation occurs. Strangers begin to detect similarities and differences between the two cultures and make necessary changes to adapt to it. Sometimes they need to unlearn old cultural habits, which is called deculturation. Through the interaction of acculturation and deculturation, strangers reach assimilation: a high degree of acculturation into the new culture and a high degree of deculturation of the original culture [39].

Though the theory of cross-cultural adaptation is usually used in traditional communication settings, it can be extended to virtual team settings. Communication is important in this study because it entails knowledge sharing activities between team members among cultures. In global virtual team settings, team members are from different cultural backgrounds. When they work together, their diverse cultural backgrounds may affect their understanding of others' behavior, which in turn will influence the overall team performance. So it is not surprising to expect that team members need to understand others culture, realize the difference between the cultures, and make adaptations if necessary to work together effectively.

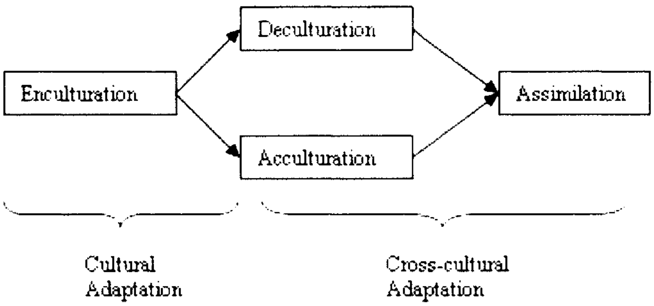

Figure 1. Cross Cultural Adaptation Process [39]

But not all people from the same culture hold the same values and behave in the same way. So it is important to understand individual's perceptions of certain cultural values and how their perceptions of cultural differences influence their behavior, which is the focus of this paper.

3 Research Design

3.1 The Research Setting

An embedded case study approach was used to examine individuals' perceptions of national cultural differences on knowledge sharing activities in global virtual teams [40]. To be specific, the cultural differences between China (mainland) and the U.S. were selected mainly for convenience reasons because the researcher is of Chinese nationality and she is a Ph.D. student in a U.S. university. The case study was conducted in a Chinese site of a knowledge-intensive global organization. A survey conducted in this organization revealed that employees are generally dissatisfied with cross-cultural collaboration. With the help of a senior manager from the site, a technology support engineer working team located in the site was selected for the study. The selected team has 15 employees (and other than two American senior managers, all are Chinese). Most of the Chinese engage in a lot of collaborative work with U.S. colleagues. These Chinese were the research subjects of this study. By focusing on a single organization and a single profession, organizational culture and professional culture variations are controlled, allowing a focus on national cultural differences.

The organization is a global manufacturer of semiconductor chips, servers, and other high-tech products with 80,000 employees worldwide. It has different sites all over the world including the U.S. Russia, Israel, China, India, Malaysia, etc. The working language is English. Beyond being geographically distributed, the organization is also functionally distributed. Coworkers are spread globally, especially in the service areas of finance, information technology, and human resource. The selected work team is from an IT department. The mission of the department is to deliver innovative IT solutions for the product groups in the organization. To provide these services, the work team needs to collaborate closely with other colleagues worldwide.

3.2 Data Collection and Analysis

The data was collected during a period of three months from June 2006 to September 2006 when the researcher worked as an intern at the site. Semi-structured interviews were taken as the primary data collection technique. The interviews were used to collect data on team members' perceptions of the impact of national cultural differences on their knowledge sharing activities with U.S. colleagues. Beyond interview techniques, some secondary methods were also applied to collect supplementary data. First, data about the organization and the team was mainly collected by interviewing the team leaders, attending new employee orientations, and documentation review. The purpose was to understand the organizational culture and team environment in general. On-site observation (chatting with the team members, attending their meetings, and email list observation) was also used to understand the team working style and to develop the interview protocol. The triangulation of various data collection techniques provides richness and depth on the investigated issue [40]. Content analysis [41] was used to analyze the interview data.

The cultural dimensions used in the interview questions were developed by combining previously identified cultural dimensions from the literature [35, 42], results from previous internal research on distributed work in the organization, and informal interviews with the team members. As a result, four cultural dimensions were identified. The definition of each dimension is illustrated in Table 2. Concern for face emphasizes three face concerns: concerns for one's own image, concerns for other's image, and concerns for both parties' images [42]. Concern for face is very deep rooted and influential in China, so here it was chosen as the indicator of attitudes and values. The question "Do you think there are other cultural aspects that influence your knowledge sharing?" was created to capture more cultural attitudes and values that may affect knowledge sharing activities.

Table 2. National Cultural Dimensions Used in the Research

Dimensions	Definitions	Indicators in this research
Technology and Material culture	The techniques or methods of making and using technology tools and artifacts	Technology infrastructure and its use
Language	The native language one speaks	Chinese vs. English
Education	The process of transmitting skills, ideas, and attitudes, as well as training in particular disciplines	Technical knowledge one holds
Attitudes and Values	The belief one holds to help determine what is right, important, desirable, etc.	Concern for face

From the previous research conducted in the organization, time zone differences were identified as an important factor that influences distributed collaborations. So it was added to the interview protocol to explore its effect on knowledge sharing activities. A total of 16 questions around these five issues were developed to guide the interviews. The average time for each interview was about 40 minutes. All interviews were recorded in Chinese and transcribed into English text files. The researcher's native Chinese proficiency enabled her to translate Chinese into English without missing important details. After each interview a simple survey was emailed to the interviewee to collect demographic information and basic communication patterns with U.S. colleagues. It was emailed in English and took less than 2 minutes in general to finish. In total, 10 members accepted the interviews (8 male, 2 female). On average, within the total time they spent on collaboration with their U.S. colleagues, only less than 5% was spent in face-to-face communication (some never met face-to-face), around 17% was spent in teleconferencing, 18% in 1 on 1 phone meetings, and more than 60% of the time was spent in communicating through email and IM tools. The demographic information was listed in Table 3.

Table 3. Demographic Information

	Range	Mean
Tenure in the organization (Months)	8-72	28
Age	27-36	30
Tenure in the position in the team (Months)	6-45	19
Education level	5 Bachelor degrees; 5 Master degrees	
Position held in the team	3 Managers, 7 engineers	

4 Results

This section presents the results of the analysis. First the individuals' perceptions of the importance of each cultural dimension is discussed. Each interviewee's ranking of the four dimensions and the average rank of each dimension are shown in Table 4.

Table 4. Rank of Cultural Dimensions

Cultural Dimensions	Interviewees (No.)										Average
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
language	2	1	1	1	2	1	1	1	1	1	1.2
technical knowledge	3	2	3	3	1	3	2	2	3	2	2.4
technology infrastructure	4	4	4	4	3	4	4	3	4	4	3.8
concern for face	1	3	2	2	4	2	3	4	1	3	2.5

From the table we can see that "language," "technology knowledge," and "technology infrastructure" were ranked relatively consistently across interviewees. Language was seen as the most important cultural dimension that affected knowledge sharing between Chinese and U.S. members. This was followed by technical knowledge. Technology infrastructure was treated as the least important factor that affected knowledge sharing. It is interesting to notice "concern for face," which is seen as deeply rooted in Chinese culture, was ranked diversely by different interviewees. It was ranked as the 3rd on average, close to technical knowledge.

Language. It is not surprising to find that language is the No. 1 factor that impacts knowledge sharing activities between China and U.S. coworkers. Language problems influence knowledge sharing in two ways. First, it affects sharing task-related knowledge. One interviewee complained about not being able to use English to fully express his idea, "In Chinese, I can fully express what I think. But in English, I can only express 70% of what I want. For example, during a meeting, I have 7 points to make, but I only know how to express 4 of them in English. So I would just skip the rest. It is a knowledge loss, right?" Another member made comments regarding meetings in English:

> Sometimes when you are in a meeting, you may think about other things and don't focus on what people are talking about. It is easy in Chinese to return back to the context by listening for a short while. But it is so difficult in English. Once you are lost, you are kind of lost forever. Then it is very impossible for you to jump in and make contributions to the discussion.

More interviewees expressed concern for limitations of using English to exchange social knowledge. One stated that,

> Sharing technical knowledge isn't a very big problem for me. Since we are both doing the same thing, he [the U.S. colleague] will understand me even if I am not using the correct grammar and sentence. But it is really difficult for me to make social conversation with them. I don't know how to make jokes with them. By the way, I am pretty good at it in Chinese. I don't know how to create a relaxed meeting environment. It makes the meeting very dry and boring, which indeed impacts our communication.

So because of this language problem, the team members prefer text communications, through email and IM tools, which help them express their opinions clearly.

Technical Knowledge. "Technical knowledge" was usually ranked 2 or 3 by the interviewees. The major finding here is that technical knowledge determines the direction of knowledge flow. A majority of the interviewees thought that their U.S. colleagues were in control of the core knowledge in their field and that the Chinese side had only relatively periphery knowledge, so the direction of knowledge flow is usually from the U.S. side to the Chinese side:

> There are two situations when communicating with U.S. colleagues. The first is that the U.S. site is the headquarters of a global team or it is in charge of a core technique. In contrary, we are working as a division of the global team or are implementing this technique. Under this situation, we are seeking instructions, consulting, and learning from them. Of course we also provide feedback for them to judge. The other situation is that we are in a peer relationship, working on a same project. Under this situation, we exchange experience. But the percentage of these two situations, I would guess is 95% to 5%. Usually we are in the first situation.

The inequality of knowledge distribution directly influences knowledge sharing activities. Some members mentioned that their U.S. colleagues, "don't want to share knowledge with us" and also that, "sometimes I don't want to ask them questions because I think which may makes me look stupid." Another problem caused by inequality of knowledge distribution is that those on the Chinese site do not know the knowledge map on the U.S. side; that is, they do not know who is good at what, "Even I have a problem and want to ask the other site (U.S. side), I don't know who to ask for. I know exactly who knows what in my site, but not theirs."

Concerns for Face. It is surprising to find that concern for face was ranked so differently by different members. This may indicate that it is a factor that is mostly mediated by individual characteristics. For example, when asking the question "will you ask your U.S. colleagues to repeat what they just said if you don't understand them well?" one interview replied, "No, it will make me stupid and they will think I'm not focusing. I would rather look at the meeting minutes later." While another interviewee stated, "Why not? They are open and direct and I should be too."

Technology Infrastructure. Technology infrastructure was consistently ranked as the last or the second to the last. Most interviewees thought that there were not large differences between their work site and the U.S. site. One interviewee even said, "There is really no difference (regarding the technology infrastructure). We really have very good quality here. You can even get rid of this item from your research. Totally no difference."

One possible reason for this is that in this organization, major international sites mirror the size of the U.S. sites with their large campuses of multiple buildings, and the architecture is standard from building to building.

Time Zone. The issue of different time zones was added to explore the impact of time discontinuities on knowledge sharing activities. Data revealed that time zone differences influence knowledge sharing in three ways. The first is a direct influence in terms of effecting team meeting set up time. As one member said, "It is difficult to set up a meeting with U.S. colleagues. It is usually set up either at their night time or our night time. Nobody wants the night time because you will feel very tired after a whole day's work and don't want to speak."

The second way is through aggravating language problem, "I really don't like meeting at our night time. I feel my listening and oral English are worse at night, maybe because I'm tired?"

The third way is through influencing knowledge sharing channels:

> Because of language problems and time zone issues, I prefer to use email and IM to communicate with my U.S. colleagues. It can allow me to think logically and to express clearly. And since we have 15-hour time difference, it is difficult to just pick up the phone and make calls. If it is not urgent, I will just send the email out and do some other work while waiting for the reply.

5 Discussions

From the above results, we can see that national cultural differences do play an important role in knowledge sharing activities in global virtual teams. Besides these direct influences, the data also reveals some other interesting results, which will be discussed below.

First, the four national cultural dimensions are not independent of each other, especially for "language," "technical knowledge," and "concern for face." They are related to each other to some extent, as noted in the following:

> I think language and concern for face are closely related. I would rank them both first. It's not very helpful to take English courses to improve your English. Even sometime you can understand very well, you still don't want to speak in a meeting because you don't want to make mistakes.

Another member related technical knowledge and concern for face together for the similar reasons. Most previous research has treated cultural dimensions independently. How do different cultural dimensions work together to influence one's knowledge sharing activities in global virtual teams? It is hard to generalize from this case study. Further research is needed to work on this question.

Secondly, the relationships between cultural dimensions and knowledge sharing activities are mediated by individual characteristics, time zone differences, organizational culture, and leadership style. The first two have been illustrated in the results section. Here I will focus on the latter two. The results reveal that organizational culture has a large influence on the knowledge sharing activities of individuals. Almost all the interviewees made comments such as:

> Since you are at XXX [the organization name], you are supposed to behave in its way" and "I have changed a lot since I entered XXX. This corporate environment needs you to be open, to be aggressive, so you either change to adapt to it, or you leave.

From these quotations, we can clearly see the importance of organizational culture over national culture in their working life. A trend is also found between tenure in the organization and the rank of the four cultural dimensions. The longer the time in the organization, the lower "concern for face" was ranked. This result confirms the proposition posed by Karahanna et al. [36] about the relative influence of the different levels of culture on individual behavior. They propose that for behaviors that include a strong social component or include terminal and moral values, supranational and national cultures might have a predominant effect; for behaviors with a strong task component or for those involving competence values or practices, organizational and professional cultures may dominate.

Team leadership style was also found to influence individual behavior. In the team studied, the first line managers are all Chinese. Some interviewees made comments such as, "the current leader himself is aggressive and he required us to behave in that way. So I changed a lot since he became my manager." One interviewee compared the current leader with the previous one, "you know, our previous manager worked in a more traditional Chinese way. I was used to it. But now, our new manager works in a U.S. way and he is also pushing us to work in that way." So there are both negative and positive remarks regarding to the manager's leadership style. Generally, new people made more positive comments while those who had been with the team longer made more negative ones. As a result, we can see that leadership style has a quick influence on the attitudes and values one holds especially for new comers to the team.

Furthermore, the results illustrate how deculturation and acculturation [39] happen in cross-cultural interactions. When team members first had interactions with U.S. colleagues (usually it was a short time after they entered the organization), they held more Chinese values (such as concern for face, being shy, and conservative). But influenced by organizational culture and team leadership style, over time, they learned that some of the values were not suitable to the situation of interacting with U.S. colleagues, especially in virtual team environments, so they are making necessary changes, such as, unlearning some of the old values (deculturation), in order to adapt to the new working environments (acculturation). It is through this interplay between acculturation and deculturation that a person progresses toward assimilation, which makes work more effective. The following comment of one interviewee indicates this cross-cultural adaptation:

> I didn't know how to express disagreement before [when communicating with U.S. colleagues]. But now I know how and I don't hesitate to express it. When I collaborated with them before, I didn't push them because of concern for face. But now I realized it would be my responsibility if the project fails, especially when I am the project manager. So I learned how to push others, and how to be open with them. Anyway, it is also the culture of this organization, right? You need to learn this and adapt to it.

6 Conclusions

A case study approach was used to explore the impact of national cultural differences on knowledge sharing activities in global virtual teams from the individual perspective. Using Terpstra and Sarathy's [35] cultural dimensions as the basis, four cultural dimensions (language, education, technology and material culture, and attitudes and values) were identified. Final results show that language has the most salient impact on individuals' knowledge sharing activities, followed by education, attitudes and values, and technology and material culture. Individual characteristics, organizational culture, time zone differences, and leadership style all have a mediated impact on the knowledge sharing activities.

Theoretically, this research is expected to bridge the gap between the literature on culture and on knowledge sharing in virtual teams. The results will also have practical implications for managers. Understanding knowledge sharing activities in a virtual team environment is important to improve the team's effectiveness. Research has also found that though managers have realized the importance of culture, they find it is difficult or even impossible to "articulate the culture-knowledge relationship in ways that lead to action" [43].The results of this study can therefore provide guidelines for managers and virtual team members to manage culture and technology to foster knowledge sharing activities in virtual settings.

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About the Author

Kangning Wei is a Ph.D. Candidate in Information Science and Technology at the School of Information Studies, Syracuse University. Her research interests address the social impacts of information technology on new organization forms. Specifically her current work focuses on distributed work, knowledge management in distributed settings and cross-cultural issues. Her teaching interests are information systems design and analysis, organizational behavior and human-computer interaction. She holds a B.S. in Information Management and Information Systems and a Master of Management in Management Science and Engineering both from University of Science and Technology of China.

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The Practice of e-Science and e-Social Science

Method, Theory, and Matter

Susan V. Scott and Will Venters
Information Systems Group, Department of Management, London School of Economics. Houghton Street, London, WC2A 2AE, UK.
s.v.scott@lse.ac.uk, w.venters@lse.ac.uk
Personal Websites: http://personal.lse.ac.uk/scottsv/
http://personal.lse.ac.uk/venters

Abstract. Grid technologies are widely regarded as important innovations for drawing together distributed knowledge workers into virtual communities. After reviewing the developments in e-science, we examine the emergence of e-social science and the potential impact on scientific discovery. Grids are currently in a key developmental phase during which the field of information systems can bring significant insight. We consider what is new about the Grid phenomena and discuss the issues raised by this particular approach to the virtualization of research practices. Our analysis is organized into three sub-sections that focus on: developments in e-social science research methods; the theoretical issues involved in pursuing an e-social science agenda; as well as the status and nature of the research materials that it gives rise to in information systems.

1 Introduction

While we are quick to study different kinds of virtual work and virtualization in distinct contexts [1], it is easy to overlook our own work practices as scientific researchers (notable exceptions include [2,3]). The pervasive use of information and communication technologies has enabled new forms of knowledge work of which research is a fundamental example. We should therefore debate the impact of ICTs on our ways of working just as vigorously as we debate organizational changes in other professional contexts. Within the sciences and humanities there is a current

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interest in what has become termed e-science and e-social science, whereby distributed information technology infrastructure is employed to support collaborative research practices. This area is likely to be of considerable interest to those in information systems who have been studying the related topics of collaboratories [4], the use of the Internet by scientists [5], and infrastructure [2].

Is this a new era for social science research method or just an expansion of bandwidth and another instance of the small case letter "e" being put in front of something we already know about? In this paper we discuss the practice of e-science and e-social science in order to consider the insights that the field of information systems can bring to bear on what is a key developmental phase of its emergence. We begin by defining the terms used in the paper and then turn to a discussion about the implication of these technical advances for our methods, the theory that we use to understand them, and their design.

This paper explores the dynamic relationship between method, theory and matter as a means of surfacing their mutual implication. Working from the principle that method cannot be axiomatically neutral, the purpose of our investigation is to raise awareness regarding the theoretical assumptions shaping emerging methods of research and the implications that this has for investment in the standards inscribed into major research infrastructures. In sum, if we acknowledge that neither technology nor method is neutral, then surely the way that they are combined into a research infrastructure matters?

1.1 The Development of e-Science

"e-science is about global collaboration in key areas of science, and the next generation of infrastructure that will enable it."[1] It emerged from the realization that many areas of science were becoming increasingly reliant on new collaborative, multidisciplinary working [6]. In particular e-science centres upon the use of an innovative, powerful computer-based infrastructure called 'Grids' within natural science with the aim of constructing a "cyberinfrastructure" for research collaboration (see www.escience-grid.org.uk and www.globus.org). This endeavor has been defined as the "*intersection* of Grid and collaborative research" [7,original emphasis]. While e-science is not a coherent endeavor and is associated with much rhetoric [8], it can be characterized by scientific mega-projects carried out through distributed global collaborations enabled by Internet technology, very large data collections, massive computing resources, and high performance visualization methods (see www.rcuk.ac.uk/e.science).

Grids predate their association with e-science. The original designers of Grid infrastructure, Ian Foster and Carl Kessleman [9], define Grids as an enabler for Virtual Organizations. They were developed to overcome limitations of IT resources (CPU cycles, disk storage, software programmes, and peripherals) within one

[1] Definition by John Taylor, Director General of Research Councils, Office of Science an Technology. Quoted from http://www.nesc.ac.uk/nesc/define.html. Retrieved 16th February 2007. See also [6].

location by pooling these resources through network connections, in particular the Internet. In other words, the resources can be shared beyond their local domain with a distributed 'Virtual Organisation'. The term Grid was chosen to denote the ability to access computer resources on-demand in a similar way to how electricity is accessed using the power utilities grid. The technological governance of a Grid is managed through its middleware, which represents a formal point of compliance between the Grid context and the application with which the researcher works. The management and use of such a Grid is necessarily collaborative. "Typically, a feature of such collaborative scientific enterprises is that they will require access to very large data collections, very large scale computing resources and high performance visualisation back to the individual user scientists. (Research Councils UK)[2]

The natural sciences (such as particle physics) have a tradition of team-based projects and are often cited as an example of distributed knowledge work [10]. Globally distributed collaboration is prevalent within fields such as particle physics, as is the use of networked computing technology (indeed the World Wide Web was initially developed by and for this community) [8]. It is therefore perhaps unsurprising that these fields provide leading examples of e-science research mediated through Grids. For example the experimental particle physics community pioneered the development of global grids for its research at CERN, and are currently being studied by researchers in the information systems field [11] (see http://pegasus.lse.ac.uk).

The use of Grids, within the natural sciences, presents significant challenges, some of which are well documented, some of which are novel and relate to the particular manifestation of Grid technology with which they are engaged. Within experimental particle physics and astro-physics, grids are employed for extremely large-scale data distribution and storage (www.gridpp.ac.uk & www.astrogrid.org) presenting problems with the storage and network capacity required. Microelectronics groups are employing e-science as a way of approaching the challenges of semiconductor design within which concerns for licensing of software designs and the protection of the intellectual property rights are paramount.[3] Communities such as Biotechnology and Medicine are concerned with the integration of large data sets for analysis and visualisation [12]. Since these fields employ animal experimentation data and patient records they are particularly concerned with privacy and access control (http://www.brc.dcs.gla.ac.uk/projects/bridges/) [13]. In addition to the use of technology, e-science demands collaborative practices among scientists. The Virtual Organisations that are central to Grids "enable disparate groups of organisations and/or individuals to share resources in a controlled fashion, so that members may collaborate to achieve a shared goal" [14]. Such virtual organisations require trust and new approaches to justifying scientific discovery [15]. Within the natural sciences increasingly collaborative research has demanded new forms of organization [16] that become reflected in a Grid's Virtual Organization.

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[2] http://www.nesc.ac.uk/nesc/define.html Retrieved February 2007.

[3] http://labserv.nesc.gla.ac.uk/projects/nanoCMOS/index.html

Within e-science there are projects whose research agenda overlaps with familiar Information Systems concerns. The VOTES project[4] for example is concerned with the clinical trials and epidemiological studies and focuses on issues the Information Systems community may recognize such as patient recruitment, data collection, and the study management of clinical trials. Finally within the e-science community there is a broad concern for the usability of Grids, evidenced by a UK funding council's call for research in this area [17,18]. Although many scientists are comfortable with employing advanced technologies in their research, Grid technology currently requires technical expertise that is not particularly usable. This concern is of crucial importance within e-Social Science where researchers' experiences with advanced and prototype technologies like Grid's is very limited.

1.2 The Emergence of e-Social Science

e-Social science[5] focuses on the adaptation of Grid technologies and tools that have typically been applied in natural science to advance the social sciences. It is important that we consider the differences between e-science and e-social science [15]; whereas natural science is pre-dominantly team based, social science centers on individual effort and can have a strongly interpretive character. The UK's National e-Science Centre notes that before Grid technologies can be widely accepted by the broader social science community, "there are significant obstacles to be overcome. These relate to such issues as the commodification of Grid technologies, the shaping of national infrastructures, and organizational contexts as well as developments in research traditions." (www.nesc.ac.uk/esi/themes/theme_03)

There are pockets of researchers working on these issues around the world pioneering Grid technologies. The tools that they are developing could prove highly relevant for scholars in the field of information systems particularly those interested in exploring research topics that are multi-dimensional, for example data from Blackberries or mobile phones that raise issues of timing and spacing (see "Replayer" in [20] and "SHAKRA" in [21]). Other examples of large data sets that can be gathered might include: activity and/or usage data, multi-channel working (for example, Instant Messaging), audio data from call centres, geographical information systems data on identity card use, or the digital forensics of money laundering.

In addition to the topic-dependent features of data that can be explored, there is a broader range of media that can be stored. There is a new generation of cinematic narratives that can be dynamic and move in time/space; these include wearable ICT and use of mobile networks combined with GPS as well as other sensing technologies. Researchers will have the opportunity to reconfigure the traditional research dynamic by asking research participants to keep their own video/audio

[4] http://labserv.nesc.gla.ac.uk/projects/votes/index.html

[5] [19] notes that some people find the distinction between e-science and e-social science an artificial distinction and would prefer a non-English term like "e-Wissenschaft" to overcome this.

journal entries, fill in PDA activity logs in their own time/place, and/or participate in two-way communication at-a-distance. Information systems researchers will surely be interested in the development of Grid-enabled distributed work practices themselves (see [22] for an example of using Wikis in collaborative ethnography). It is notable that many key figures that have shaped the literature on Computer Supported Cooperative Workgroups (CSCW) and Virtual Organizations (VO) have turned their attention to Grid technologies (Judith and Gary Olson's interest in the idea of "collaboratories" http://www.crew.umich.edu/index.html). In the next section, we consider the implications of e-social science on research methods in more detail.

2 Method

As automation increases and technological costs fall, the opportunities for curation of digital data expand. Organizations dedicated to the acquisition, dissemination, and re-use of qualitative social science research data are emerging (for example, http://www.esds.ac.uk/qualidata/online). Digital curation refers not only to the maintenance of a trusted body of digital data for current and future use, but also involves exploring ways to add value to it (see www.dcc.ac.uk). There are significant challenges associated with combining information from diverse and distributed data sources; the number, complexity, and diversity can be daunting. A recent issue of Information, Technology and People explores the different genres of digital documents (see [23]). Preparing the original material for current use by colleagues distributed around the Grid or for digital curation sometimes places a considerable burden on the field worker or data set owner who must conform to set standards in, for example, transcription or format.

A considerable effort has been put into the development of non-proprietary formats and standards for preserving, searching, and disseminating data (see The Edwardians project at ESDS above). This kind of interoperability is fundamental to the portability and data interchange that underpins the intention of Grid approaches (see http://www.esds.ac.uk/qualidata/online/about/xmlapplication.asp#ten for a draft DTD (document type definition) for a generalised XML qualitative dataset application).

Large scale computing resources provide opportunities for massive data storage and archiving of multiple digital resources (text, video, image, audio), that can enable hyper-ethnographies using video storyboards or video paperbuilders (http://vpb.concord.org). These sensory-rich media forms challenge our current research methods and represent the frontier of pedagogy [24] as well as forming living histories of research practice. However, this only represents a partial realisation of Grid potential. There is capacity for increasingly interactive and dynamic forms of research approach that move beyond catalogue searching and data download to allow web-based free-text and filtered searching, browsing, and retrieval of research data in real time.

Access to archives of qualitative data also presents the opportunity to pursue innovative case study strategies that move beyond snapshot survey methods and transform multiple case research from the preserve of project-based initiatives (or long research careers) into the realm of possibility for individual researchers and doctoral students. Grid technologies could support the further development of social network analysis as well as stimulating a greater variety of qualitative-quantitative methods of data analysis (see [20]). The question of which research methods are more suited to the Grid environment is a contentious one.

For example, the notion of e-social science raises potentially uncomfortable questions for the information systems interpretive research community. In the past, interpretive researchers expended much intellectual energy explicating the differences in their work for the benefit of 'hostiles'. Interpretive research now has a much broader acceptance in the information systems community and is in a phase of constructively examining the interpretive form rather than defending it. Intepretivism is a "set of epistemological assumptions" [25] but whilst we have guidelines for good practice [26] and we follow recognised qualitative research protocols there is still a high level of flexibility in the execution of interpretive practice. The epistemological assumptions that Orlikowski and Baroudi refer to serve both as a broad set of co-ordinates with which the researcher can mark the beginning of an intellectual journey and they steer us in the general direction of inquiry [27]. In the process of appropriating these broad assumptions researchers must interrogate and give meaning to them, for they are not neutral axiomatic principles. Each person's interpretation of the assumptions underlying their research approach will have consequences; it will give them eyes to see certain topics or questions and not others; it will influence the way that their research approach becomes enacted in practice; and it will influence the status and nature of any contribution that they make.

It could be argued that e-social science lends itself more readily to positivist methodological techniques in which researchers aim to triangulate findings with the aim of finding commonalities and scoping out inconsistencies in the data set. In contrast, an interpretive researcher with strong constructivist leanings might build upon contradictions in the data to reveal political narrative and may resist the notion of reducing interviews to codes as the basis for content analysis. Indeed, many established interpretive researchers balk at the suggestion by reviewers that they should explicate formal processes of analysis preferring to stand firmly by the conviction that their findings emerge solely from knowledge of the field arrived at through reflection, insights, and intuitive induction.

This exhumes some tired controversies that have dogged interpretivism, namely lack of critical purchase, its tendency toward relativism, solipsism and over-privileging the inquirer's perspective, the confusion between the psychological/epistemological, and finally, the paradox of how to develop an objective interpretive science of subjective human experience [27]. The creative infusion and adaptation of information systems research methodologies, such as interpretivism, into the e-social science offers opportunities for new forms of rigor and relevance (see the debate in MISQ 1999 23:1). One would hope that there are those among the interpretive IS community that possess a strong will to innovate and experiment, but large scale research practice does present distinctive issues that would be hard to overcome. While it is for each researcher to take their own position on this, it is conceivable that interpretive IS researchers will largely avoid e-social science.

At the IFIP 8.2 working group conference in Manchester [28], senior figures in the IS field called for more extensive use of multi-disciplinary research, and it is possible that a team approach might represent a fruitful possibility for different genres of researchers to engage in e-social science. As we have noted, social science research tends to be a fundamentally individual endeavour. However, there are compelling grounds to consider revising this norm to accommodate other practices. Dennis et al. [29] point out that the IS field "publish elite journal articles at a lower rate than Accounting, yet our promotion and tenure standards are higher" creating a "growing divergence between research performance and research standards." These pressures reduce the quality of work-life experience and job satisfaction for junior colleagues and lead to "increasing faculty turnover, declining influence on university affairs, and lower research productivity" [29]. One way of addressing the issue of research productivity is to explore the teamwork opportunities offered by e-social science. This would require support from established senior researchers to mitigate the risks of such an experiment for those already wrestling with the intensity that now accompanies junior academic careers. Of course, multiple author publications also have to form part of a balanced portfolio alongside single authored articles; however the interaction with a distributed community and teamwork could help overcome the sense of isolation that can accompany individual efforts to produce elite publications.

3 Theory

In this sub-section, we return to the theoretical implications surrounding the development of e-social science. At a session of the 2006 National Centre for e-Social Science (NCeSS) conference, after the presentation of a software tool designed to support the analysis of mobile technologies, a member of the academic audience commented "That's great, but where is the social theory? Where is the e-social science in your approach?" Are Grid technologies about organizing, storing, filing, communicating, and accommodating ICTs into research methods or is there a theoretical question?

From our perspective, the comment made by this conference delegate does not so much set a new design agenda for those developing this software or call for us to develop a theory of e-social science, it poses a challenge with regard to the articulation of the relationship between theory and practice. The social science oriented software-based tools being developed for Grid contexts are not being designed to provide explanation and prediction, they represent a distinctive way of gathering and organizing data. However, we wish to pause here to clarify what might perhaps seem an otherwise common sense observation. Our position is that data are a fundamental part of research practice and as part of the pattern of our work are fundamentally social, expressing (or imbued with) a relationship to theory because that is part of our research practice. This brings us to a reflection on the practice of research and a consideration of whether there is theory in our actions. The study of practices has received considerable attention, including a special issue of the *Information Society* in 2005, and of *Organizational Studies* in 2006 which we draw on briefly to explicate our position on the notion of e-social science research practice.

Following Reckwitz, we define practice as "a routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood" [30]. When we engage with data we are, as Reckwitz says "using particular things in a certain way" and when technologies mediate that use it necessarily shapes practice; they enable and limit "certain bodily and mental activities, certain knowledge and understanding as elements of practices" [30, pp. 252-3].

When social scientists discuss Grid and Grid-focused tools as a context for their work (despite the long discourse in our field on social shaping of technologies) they are drawn into modes of discourse in which it is presented as a sanitary, neutral environment over which they will lay their research practices. As Orlikowski [31] says, it is important to understand both the technological artifact and the technology-in-practice; both have significant implications for understanding developments in research practice. For example, there is regular reference to 'raw data' in the material on e-social science, a notion with which we have taken particular issue. When software products gather data they do so under a number of presuppositions or assumptions encoded in their design, function, and use. It is, for example, extremely unlikely that two e-social science software programmes would select the same data, a simple yet powerful test of this point. Returning to Orlikowski's [31] idea of "in-practice" and "in-use," our point is that it is important to reflect upon the notion of "data-in-practice" and "data-in-use."

Kuhn's [32] analysis of paradigms in scientific inquiry taught us "scientific communities are bound together by conventions and commitments that build upon taken-for-granted assumptions." The development and use of particular research methods can be associated with identifiable groups of scholars or what Wenger calls "communities of practice" [33]. As Kelly and Jones [34] note, much of the communities of practice literature emphasises the notion of communities rather than practice. If we take the proposition that theory is expressed through in our practices seriously then we begin to see how particular research identities could colonise and shape the emergence of Grid technologies and the standards embedded in its infrastructure. Following this through, we also need to draw together a body of research that deconstructs the largely taken-for-granted term of "information infrastructure" [35] and assemble detailed analyses focusing on the emergence of specific infrastructures to support particular research practices. This includes understanding the role of agents of change that move between groups diffusing ideas, working toward the articulation of standards, and encouraging "convergence" [35, p. 82]. How do norms emerge in e-social science? How and where does the structuration and institutionalization of specific research practices take place? In the next sub-section, we consider the conceptual and material structuring of research in more detail.

4 Matter

The development of e-social science is in an interesting definitional phase where its design parameters are relatively open. As dominant research groups emerge we may see the black boxing of both the material basis of the Grid design and the conceptual expression of research methods. Ackoff [36] maintained that the complex phenomena tackled by social science can often seem like "messes." While "assumptions make messes researchable" it is often "at the cost of great over-simplification, and in a way that is highly problematic" [37, p. 377]. Our experience as information systems researchers should put us in a position to acknowledge that on the one hand establishing standards enables interoperability that helps us to built community infrastructures that link up knowledge workers over time and space. However, embedding assumptions about method into research tools designed to enable collaboration creates a new messy problem.

Burrell & Morgan [38] encourage us to analyze and challenge assumptions through map-making activities designed to increase awareness of taken-for-granted assumptions that shape social research. We suggest that Grid technologies enable methods whose assumptions need to be deconstructed in order to understand their relationship to methodology and the design of a research strategy.

Building on this, Gareth Morgan, in *Beyond Method* [37], argues that we need to go beyond a focus on technical methods to reveal the assumptions shaping research:

> A knowledge of technique needs to be complemented by an appreciation of the nature of research as a distinctly human process through which researchers *make* knowledge. Such appreciation stands in contrast to the more common view of research as a neutral, technical process through which researchers simply reveal or discover knowledge [37, p. 377].

In light of this, how far can we draw together groups of researchers and share methods in the way that natural scientists try to do? If we put our best effort into designing these research infrastructures to accommodate many different approaches to research and champion pluralism, how do we achieve the scale required to realize the distinctive opportunities that e-social science presents? On the other hand, if we announce the use of standards and common approaches, what do we lose in the process? Who will become advocates for particular e-social science research strategies, and on what grounds will they claim that we should prefer their approach over others? How will the increased use of ICT in research method shape claims regarding rigour? These are foundational issues and it is important for us to deliberate upon them if we are to seize the possibility of advancing research practice.

5 Conclusion

At this stage in its development, the emergence of e-social science raises many questions for the nature of distributed knowledge work of which research is a key part. As information systems researchers we are uniquely well positioned to interrogate the design of Grid technologies, their virtual organization, and their use, building on a rich research tradition in related areas (Jonathan Grudin [39] presented a seminal paper at a conference in Portland, Oregon, in 1988 examining why collaborative technologies for diverse distributed groups fail and the problems associated with the design and evaluation of CSCW). Grid technologies must overcome adoption and use issues associated with all innovation processes and sustainable applications need to be developed (see www.gridappliance.org). As e-social science tools and methods emerge, we suggest they should be accompanied by the development of forms of evaluation and points of access that render the assumptions underpinning these systems available for critique.

The standards and shared approaches implicit in engaging with e-social science enable the exciting prospect of conducting large scale research in ways not possible before. However, we need to move toward the establishment of research standards and shared e-social science infrastructures with informed awareness of the social shaping process [19] in which they are involved. The potential for a Grid elite or methodological hegemony to emerge should be regularly monitored, and those involved in the developments taking place need to be reflexive about design issues. An important aspect of this is an understanding of the nature of data as well as an appreciation of the relationships between method, theory, and practice. Our interpretation of these relationships matters and will shape research outcomes.

Grid technologies should not be thought of just in narrow terms as the preserve of quantitative or positivistic research. Advances in qualitative and interpretive traditions need to consciously attempt to converge with Grid developments to take advantage of this window of opportunity. Finally, we need to ensure that we don't fall into the trap of fetishising technology and instead remember to nurture the distinctive contributions that come from unconventional, non-standard innovation and openness to diversity of research approaches.

In this paper we focus on e-science and e-social science as a particular instantiation of virtuality with the aim of surfacing questions regarding their future by relating them to the Information Systems literature. We draw attention to the major epistemological influences currently framing e-science, and identify the social constructivist challenges involved in adopting it. Given the potentially major impact that e-science may have on scientific discovery we suggest that the field of information systems needs to become actively engaged in longitudinal studies focusing on the "project of e-science" and its social shaping.

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About the Authors

Susan Scott is a senior lecturer at The London School of Economics where she teaches a Masters course on 'Research Methods' and an undergraduate course called 'Information Systems in Business'. She is a member of the advisory board of an EPSRC e-science funded project researching the development of Grid technology within Particle Physics at CERN (www.pegasus.lse.ac.uk). Beyond this her research also focuses on the role of information systems in the transformation of financial services. Susan has published on: IS and risk management; electronic trading; the strategic organization of post-trade services; and organizational reputation risk. Her background includes a B.A. in History and Politics of Africa (SOAS), MSc. in Analysis, Design and Management of Information Systems (LSE), and a Ph.D. in Management (University of Cambridge).

Will Venters is a lecturer in Information Systems at The London School of Economics. He teaches a Masters course on 'Systems Development' and another on 'Knowledge Organisations and Technology'. He is the principle investigator of an EPSRC e-science funded project researching the development of Grid technology within Particle Physics at CERN (www.pegasus.lse.ac.uk). His research focuses on the development of IT infrastructure by and for distributed groups. He holds a BSc in Computer Science and a PhD in Information Systems.

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From Senses to Sensors

Strategies for Maintaining and Enhancing Competence in a Virtual Organization

Ulrika H. Westergren
Department of Informatics, Umeå University, 901 87 Umeå, Sweden
ulrika.westergren@informatik.umu.se

Abstract. One key dimension of the virtualization of the workplace is the formation of new types of partnerships where organizations let internal functions be handled by an external partner, the so-called outsourcing of services. The formation of an outsourcing partnership imposes the risk of knowledge-drainage on the client organization as specific internal competence decreases when the service provider takes over the technological knowledge and has a significant impact on the business processes in general. The aim of this paper is to address the issue of partnership outsourcing and to explore strategies that are used to keep the competence within the client organization even as it opens itself up to the partnership. Based on the framework of Four Outsourcing Relationship Types provided by Kishore et al. [1], this paper investigates the relationship between a large minerals group, Alpha Corp. and its remote service provider, RDC. Alpha has three different strategies for maintaining competence within the organization while engaging in the outsourcing relationship. The first is exploiting the full potential of its partnership with RDC, the second is heavy investment in information technology, and the third is structured and systematic maintenance. The findings of the study show that the relationship between Alpha and RDC can be characterized as an alliance type relationship and that the only way for Alpha to preserve competence is to maintain an inspired and engaged workforce and fully embrace the partnership in order to create a win-win situation.

1 Introduction

Organizational transformation has been on the research agenda for a long time. Striving for efficient and cost-effective solutions has inevitably led to the extensive

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use of information technology within modern organizations [2]. Over time the research scope has been extended to exploring new kinds of virtual inter-organizational networks [3, 4, 5]. One key dimension of this virtualization of the workplace is the formation of new types of partnerships where organizations let internal functions be handled by an external partner, so called outsourcing of services [3, 4, 6]. Organizing as a partnership suggests that the involved parties have an interest in giving something back to the other organization, which is something different than the traditional customer/vendor relationship of the market economy [6]. A partnership outsourcing relationship is thus likely to have a transformational effect on organizational form and function for those businesses involved [7].

A specific case of partnership outsourcing can be found within the processing industry, where remote monitoring technology is being increasingly used to monitor the machines used in the process line [8]. The maintenance unit, which is responsible for keeping the machines such as mills, crushers, and conveyors up and running, previously relied on the employees' personal skills and use of the senses; their individual ability to detect and correct any errors or problems that arose. Nowadays, these machines are instead often monitored through various sensors and IT-applications, which are continuously logging process data and passing it on for analysis [9, 10]. Such monitoring services are increasingly being outsourced to a remote service provider that uses the client's IT-infrastructure to access the data and perform the subsequent analysis with the aid of sophisticated software. As the service provider and the client organization become intertwined in the partnership, the client relinquishes some of its control over the maintenance work with the subsequent risk of knowledge-drainage on the organization [11]. Thus, a question that arises is how to keep competence within the client organization when the service provider assumes responsibility for the technological knowledge and has a significant impact on the business processes in general. The aim of this paper is to address the issue of partnership outsourcing and to explore strategies that are used to keep the competence within the client organization even as it opens itself up to the partnership.

This paper is focused on a case study of two companies: a large minerals group, Alpha Corp., and its remote service provider, Remote Diagnostics Centre, RDC. Alpha Corp. has in recent years made the move towards outsourcing strategic aspects of its maintenance organization. RDC is the company that was chosen for the partnership. The paper is organized as follows: the following section gives an overview of related research on organizational transformation and virtualization and on partnership outsourcing. Section three describes the research methodology. The actual case study is presented in section four and analyzed in section five. The paper ends with conclusions and suggestions for future research in section six.

2 Related Research

2. 1 Organizational Transformation and Virtualization

In order to understand virtualization and organizational transformation, one must consider both the fields of information technology and organization studies and the impact they have on each other. Kling and Allen [12] made a call for applying organizational informatics in order to understand the relationship between the design and use of information technology and human behavior in organizations. Orlikowski and Barley [13] point to three broad genres of IT research where organization studies have relevance. These are characterized as studies of the impact of IT with regards to social and economic consequences, studies of the design and use of IT, and studies of the organizing and managing of IT services, which includes the sourcing of IT services. Virtualization can be found as a topic of study within all these genres.

One area of research on the concept of virtualization and organizational transformation is virtual work; that is work done from some other place than the traditional office such as distributed work environments and tele-working [14]. Virtual and ad-hoc teams are another aspect of virtualization where traditional organizational boundaries are transcended and transformed [15]. A third area of research is the virtual organization, which consists of networks where the traditional buyer-supplier relationship has evolved into a deeper collaborative effort, leading to internal business processes being outsourced to an external strategic partner [6]. A key concept for all these areas of research is the notion of distance, defined by Chudoba et al. [16, p. 280] as "the challenges people face to communicate, resolve conflicts, and maintain social interactions over time, space or organizational units." A virtual organization thus faces the challenge of managing this distance as it opens itself up to external input. This is made explicit in the case of partnership outsourcing.

2.2 Partnership Outsourcing

The increased globalization, widespread use of new technology, and pressure to be on-line, flexible, and efficient have prompted organizations to rethink and reshape their original forms, and as a result of these demands, strategic alliances, joint-ventures, and partnerships have been formed [6]. These outsourcing partnerships are different from traditional outsourcing in that they presuppose a transformation from the pursuit of self interest in a hierarchically structured relationship to a partnership based on trust [17, 18]. Forming such a relationship changes the organization's view of itself, from client and customer with the right to make high demands, to a partner that has to give something back to the service provider [11].

Kishore et al. [1] suggest a framework of Four Outsourcing Relationship Types (FORT): support, alignment, reliance, and alliance. These four types show various degrees of involvement/ownership substitution and strategic impact of the service provider on the client organization. With both ownership substitution and strategic impact being high, the relationship is characterized as an alliance. In an alliance the monitoring mechanisms are considered high on mutual trust and low on contractual control. Furthermore, an alliance relationship entails common objectives and goal symmetry between the service provider and client. The objective is to engage in mutually beneficial behaviors. This is something very different from a support relationship where both ownership substitution and strategic impact is considered low. This is more consistent with the traditional view on outsourcing where the outsourcing decision has been made on the basis of determining whether the particular IT operation has been seen as a strategic asset or as a commodity. In the latter case, the decision to outsource has been made [19]. This view has been at the center of previous research describing the motive for outsourcing as focusing on core business, cutting costs, and providing a more efficient organization [11, 20, 21]. Partnership outsourcing in the form of an alliance relationship has not yet received equal attention from the research community, but it is growing in scope as organizations seek added value through long-term, mutual relationships with their service providers [22, 23].

Slaughter and Ang [24] claim that IS skills can quickly become obsolete, and that outsourcing is a way to provide a company with a skilled up-to-date workforce. Dyer and Hatch [25] have shown that organizations can gain competitive advantage by developing their network relations, as this enables inter-organizational knowledge sharing. However, partnership outsourcing also opens the organization up for potential knowledge-drainage as skills are moved from residing within the organization to the external supplier, putting the client at the supplier's mercy [11]. The client organization thus needs strategies for how to maintain core competence even while seeking new ways of doing business. In the words of Prahalad and Hamel [20, p. 82]: "Unlike physical assets, which do deteriorate over time, competencies are enhanced as they are applied and shared. But competencies still need to be nurtured and protected; knowledge fades if it is not used." Against this background, we shall examine the case of Alpha Corp.

3 Research Site and Methodology

In order to understand Alpha Corp.'s strategies, for maintaining competence within the organization while engaging in an outsourcing partnership, an interpretive case study [26, 27] was performed at Alpha Corp and Remote Diagnostics Centre (RDC). The rationale behind selecting the research sites was their willingness to cooperate, the availability of multiple sources and the possibility of purposeful sampling [28, 29]. There were two rounds of interviews carried out. The first round occurred in 2003-2004, during which we followed the initial discussions in forming the partnership between Alpha and RDC. The second phase of the study was conducted in 2006, when we revisited the organizations and followed up on the development of the partnership, explored the companies' strategies for maintaining the partnership and establishing trustful relations, and the impact of technology on the organizational transformation.

The author and another project member collected data through a mixture of techniques including semi-structured interviews and document reviews [28]. Together we performed 31 interviews with people from both Alpha Corp. and RDC and visited the industrial sites where the remote monitoring technology was in use. The respondents ranged from technical staff and maintenance personnel to division managers and corporate executive officers from both organizations. The interviews had one structured part with a framework of questions concerning the partnership, the technology, and the organizational impact of the outsourcing solution and technology introduction. Moreover, there was an unstructured element with follow up questions and questions that emerged from previous interviews, documents and meetings. All interviews were recorded and then transcribed. We also examined documents and minutes from internal meetings. The data was read through and cross analyzed before being coded into categories concerning the partnership and the technology and their relation to organizational transformation and strategy. This was done by finding patterns in the data and statements that could be grouped together.

In this paper, the different categories that emerged from the empirical data are presented as three separate strategies used by Alpha Corp. to maintain competence within the organization while opening up for virtualization. Some specific quotes from the interviews are used to highlight certain discussions, but for the most part, the material constitutes the overall findings from the interviews. The conclusions that are drawn are based on the patterns that emerged in the coding process. As recommended by Miles and Huberman [30, p. 278] a preliminary copy of the results was presented to and circulated among the interview respondents to ensure credibility and authenticity of the research.

4 Strategies for Maintaining Competence

Alpha Corp. is an international high-tech minerals group with mines, processing plants, and harbors in Sweden and Norway. The company has about 3500 employees. As a part of a larger reorganization strategy, Alpha Corp. has developed a strategic vision of improving service and maintenance work in order to increase production without investing in new machinery. As a part of this, Alpha has increased spending on equipment monitoring and preventive maintenance from 3 million SEK to 11 million SEK and formed an outsourcing partnership with RDC. Since Alpha's competitive advantage is highly dependent on having a skilled workforce, maintaining a high level of competence is central to Alpha's survival. In order to do this, Alpha has three strategies that are meant to not only maintain but also increase competence. The first is exploiting the full potential of its partnership with RDC, the second is heavy investment in information technology, and the third is structured and systematic maintenance.

4.1 Gaining Competence from the Partnership

RDC was created as a joint venture between Alpha Corp. and two of its long term business partners. Alpha Corp., who initiated the establishment in 2003, owns 20% of the company and is its first customer. RDC's business concept is to provide advanced condition monitoring of machinery and equipment all over the world. Initially Alpha Corp. was the company's only customer, but in the business plan it is clearly stated that within a couple of years RDC should expand and take on new customers. Alpha encourages this planned expansion as they hope that it will lead not only to shared costs but also to an increased level of competence as RDC learns from other organizations and brings that knowledge back to Alpha.

Alpha also expects RDC to be an active partner. Building and verifying knowledge through close inspections of damaged machinery is seen as a way for RDC to increase its competence. Alpha also sees that RDC should be able to maintain a broader competence than Alpha's staff, and RDC is also contracted to educate Alpha's staff on vibration analysis, the method used to detect damages within the machinery. The knowledge that RDC gains from monitoring Alpha's machines is thus brought back to the organization. Furthermore, Alpha expects RDC to provide input when new plants are being built, based on their expertise in remote monitoring. In return, Alpha opens up its organization to RDC and gives them full access to the machines and technological infrastructure. RDC can use Alpha machinery to increase its own level of competence by trying out new methods and technologies in a real setting. In that way, the partnership proves to be mutually beneficial.

When RDC was established, Alpha recruited some of their own employees and moved them to the new company. A reliable member of the group was made CEO. This was a strategic move to establish trust. However, not all of RDC's employees came from Alpha, and a strict business contract was also written to regulate the partnership. Alpha has a designated person who is in charge of the contract with RDC and who is to ensure that they deliver what they have promised. This move of personnel, however, also meant the move of some specific competence from the maintenance organization to RDC. One way that Alpha tries to handle this outflow of competence is by investing in information technology.

4.2 From Senses to Sensors

Alpha's strive to become a leading minerals group has been very technology driven, as there is a strong belief that IT will lower costs and increase production. Preventive maintenance and remote monitoring is seen as one way to increase knowledge and enhance performance. However, although Alpha Corp. recognizes the importance of data collection and analysis they also state that they do not have the time to become good analysts. This is instead outsourced to RDC. Many of the respondents at Alpha want more integration between the two companies. They want a common interface where information is shared, and steps have been made in that direction as RDC will have access to Alpha's new maintenance system. Alpha sees large opportunities for knowledge recycling if the information and experience that now is within RDC is made available to Alpha. Again it is the reciprocity of the partnership that is expected to give both organizations advantages. Increased transparency through the use of a common platform and interface is a step in that direction.

Alpha is also investing a lot of money in sensor technology. In the past 20 years, they have increased the number of measuring parameters from three to 33. They have also increased the number of points of measurement from about 100 to more than 15,000. Currently, Alpha is collecting and storing data from all parts of the production process. By transforming the maintenance organization and making it dependent on sensor technology instead of on the use of the senses, Alpha expects to be less reliant on skilled individuals and instead have the knowledge stored in the maintenance system for the entire workforce to share. This is seen as a strategy to maintain competence but also as a strategy to increase the level of competence as more people gain access to information faster. This is of course dependent on people actually using the system in the way it is intended and performing maintenance in a structured, systematic way.

4.3 Transforming the Maintenance Organization

In recent years Alpha has undergone an extensive maintenance make-over and focused on systematic, preventive, and structured maintenance. For this purpose, Alpha has put a lot of time, money, and effort into creating a single maintenance system that is to be used by everyone that comes into contact with the machinery, including RDC. Structured maintenance also means that everyone should know what is expected of them, which duties to perform, and when they should be done. Predictability is highly regarded as that is seen as a way to avoid costly, unexpected stops. Furthermore, the staff should feel engaged in their work. Again, Alpha expects to be able to use the partnership to achieve this. RDC is seen as a potentially positive influence on Alpha's staff as the company helps put the focus on preventive maintenance and can show how the use of technology can improve maintenance work.

Alpha's staff sees a great potential in how maintenance is organized in the outsourcing partnership. To have the condition monitoring focused in one organization, such as RDC, means that the collective knowledge will be high. It also makes it possible to specialize in this area, which could not be done, when the competence resided within individuals spread across the different production units at Alpha. Thus, by moving the competence from the internal organization to the external service provider, several Alpha employees actually argue that the level of competence has increased. Another benefit is that RDC's staff is constantly available with access to backup. It can of course be argued that Alpha could have created RDC as a service division within the company and gained these same benefits through insourcing instead of outsourcing. However, Alpha strongly insists that since RDC is an external partner, their opinions and analyses have more leverage than if they were an internal division. Several division maintenance managers state that they use RDC reports to exert pressure on their own organization, to ask for more money, and to inspire their staff. They are convinced that this would not have been possible if RDC had not been a separate organization.

5 Discussion

The FORT framework developed by Kishore et al. [1] suggests four different types of outsourcing relationships with varying degrees of involvement/ownership substitution and strategic impact. The first two types of relationships, support and alignment, have a low extent of involvement. Such outsourcing relationships tend to be short termed and project specific: "Clients generally control the specification, design, and implementation aspects of outsourced projects and services and these relationship, therefore, do not entail transfer of skills to the client firm or training of the client firm's personnel" [1, p. 89]. The other two types of outsourcing relationships, reliance and alliance, on the other hand, entail a high extent of ownership substitution. The client organization invests heavily in service provider-specific assets, such as technology, infrastructure and skills. In an alliance type relationship, the strategic impact of the service provider on the client organization is high, which calls for a high degree of mutual inter-organizational trust in order for the relationship to hold. "Moreover, the impact of the alliance relationship on the organization and the degree of lock-in with the particular service provider is so large that it is usually difficult to reverse this relationship" [1, p. 90]. In such a relationship it is therefore crucial to achieve goal symmetry between the two parties so that they engage in mutually beneficial behavior, and to manage the notion of distance as described by Chudoba et al. [16] in order to maintain trust.

This paper attempts to expand and build on the framework provided by Kishore et al. [1]. The findings from the study provide support for the authors' description of an alliance type outsourcing relationship. Alpha Corp. and RDC refer to themselves as strategic partners, the degree of ownership substitution is high and the strategic impact of the partnership is considerable. If RDC fails to do a good job, Alpha risks a complete factory breakdown. As the relationship is difficult to reverse, it is essential that there is mutual trust and understanding between the two organizations. The FORT framework is useful in providing an understanding for the mechanisms of different outsourcing relationships. However, it merely touches upon the issue of competence. When two organizations become intertwined in an alliance type outsourcing relationship, there is an apparent risk of competence-loss from the client organization as skills are moved from residing within the organization to the external supplier. While engaging in such a partnership, it is therefore important to identify and secure strategies for minimizing the knowledge-drainage on the client organization.

Alpha Corp. has three different strategies for maintaining the competence within the organization even while engaging in the outsourcing partnership. The first is a focus on the potential gains from the partnership, where Alpha has high hopes on the benefits of the partnership. The second strategy is a focus on technology, where investment in a common platform and interface is to increase transparency and enable the exchange of knowledge. The third strategy is to maintain a structured and systematic maintenance organization. According Alpha, these three strategies have already been successful, as the number of unplanned maintenance stops have decreased and production has subsequently increased. Furthermore, the partnership has provided Alpha with new insights about its own organization and improved its workforce. Both Alpha and RDC state that they are very happy with the partnership and that they look forward to even closer integration.

However, letting someone else handle a strategic business asset poses a risk as the organization opens up and exposes its core to a third party leaving itself very vulnerable [11]. It has to be a win-win situation in order for the partnership to work, and while client organizations may relatively easily see the benefits of the partnership, service providers might prove to be more skeptical as they enter into a long time commitment [23]. One emergent problem is how to handle issues of responsibility. Alpha prides itself on its structured organization, but as it opens itself up to the partnership it will be increasingly difficult to determine who is responsible for what. A move towards a more integrated relationship also means the blurring of roles and functions. This is something that should not be ignored, as it is potentially detrimental to both organizations.

Gallivan [6] speaks of the virtual organization where internal business processes are outsourced to an external strategic partner in a partnership-like relationship. However, he argues that trust is not a critical element for virtual organizations. Instead, he states, "Given a set of practices to ensure the control, efficiency, predictability and calculability of processes and outcomes in virtual organizations, effective performance may occur in the absence of trust" [6, p. 277]. Based on my study, I disagree with this statement. Alpha has made the move towards a heavy reliance on technology and strives to replace its dependency on individual team members by embracing a new maintenance system that should contain the sum of all individual staff knowledge. The manner of use is highly specified, and one would expect that this given set of practices ensures effective performance. However, Alpha admits to having problems with getting people to use the system. Either they do not enter all relevant data, which means that certain calculations and analyses cannot be performed, or they ignore warnings that the system sends out, since the machines appeared to be working well when they last walked by them. This is attributed to a long preserved distrustful attitude towards technology and towards management. Without trust, there is no efficiency, predictability, or calculability, as workers do not behave in accordance with the control mechanisms. This attitude also initially showed in Alpha's workers' relationship with RDC. The service provider can detect erratic behavior in a machine long before it actually causes a breakdown. Many Alpha workers therefore did not initially believe in RDC's reports and listen to their warnings. However, with the support of the managers, RDC has had the chance to prove that their analyses have been on target, by letting a machine run until it breaks down and then picking it apart and analyzing the cause. This has been a very effective strategy and has led to a certain change of attitude and a trustful climate. As a result, both Alpha and RDC now get more out of the partnership than they initially did as members from the organizations work more as a team than as two separate entities with specific tasks to perform. Although the partnership is regulated with contractual control measures, mutual trust has proven to be very central to the success of the relationship.

The outsourcing of certain services is a way to provide the organization with a skilled, up-to-date workforce [24]. An outsourcing partnership is also a commitment from both parties as the organizations enter into a long-term relationship where mutual dependency increases with the passing of time. The competence that is built up within the partnership is unique to the collaboration and not easily replaced by someone else [25]. For Alpha this poses a slightly higher risk than for RDC. If RDC were to go out of business or move on to another partner, Alpha not only loses a competent partner, the company has no internal resources to turn to. A strategy to prevent this total loss of competence is to make sure that RDC educates Alpha's staff in its methods of measuring and analysis, in line with Prahalad and Hamel's [20, p. 82] claim that, "competencies are enhanced as they are applied and shared." However, most of Alpha's staff state that as long as they have a general idea of what remote monitoring is about, they now see the opportunity to focus on other issues and are not interested in a deeper understanding of what RDC is doing. Chudoba et al. [16] state that distance appears to make it more difficult to maintain trust. However, in the case of Alpha Corp. and RDC it seems as if the trust that has developed between the two organizations might actually help maintain the distance between them and discourage the sharing of competence. This relationship between distance, trust and competence should be further explored in future research.

RDC is currently very satisfied with the partnership with Alpha as they have full access to the different machines where they are free to perform experiments and develop their methods. However, what will be the incentive for maintaining the close ties with Alpha when RDC has evolved and taken on new customers? Today the partnership is in part based on trust, in part based on contracts. Which aspect will be dominant as the partnership evolves and what will this do to the competence level at Alpha? I believe that the answer lies within Alpha's own organization and their capability to engage their co-workers, as it is the only way that they are going to keep competence within instead of doing without. Gaining competence from the partnership, increasing the use of technology, and structuring the maintenance organization all depend on the willingness of Alpha's co-workers to embrace and employ theses strategies. By doing so, the alliance can blossom and competencies can be both nurtured and protected.

6 Conclusions and Suggestions for Future Research

This paper is an illustration of the warning finger raised by Prahalad and Hamel [20, p. 82]: "Unlike physical assets, which do deteriorate over time, competencies are enhanced as they are applied and shared. But competencies still need to be nurtured and protected; knowledge fades if it is not used." The aim of the study was to address the issue of partnership outsourcing as it grows from the use of new technology and to explore strategies that are used to keep the competence within the client organization even as it opens itself up to the partnership. Based on the above discussion, I conclude:

- The outsourcing relationship between Alpha Corp. and RDC follows the characteristics for an alliance-type relationship as described by Kishore et al. [1]. The extent of ownership substitution and strategic impact is high and the relationship is based on mutual trust.
- The way for a client organization to maintain and potentially increase competence, while engaging in a partnership outsourcing relationship with a service provider, is to maintain an inspired and engaged workforce.
- Alpha Corp.'s strategies for maintaining competence can only be successful if the organization fully engages in the partnership and treats it as something of highest strategic importance. In that way the reciprocity of the partnership will help preserve competence.

This study has also shown that as the organizations move towards deeper integration the concepts of trust and control are highly central to the discussion of partnership outsourcing. Future research should therefore be concentrated on exploring these issues in order to better understand the workings of such relationships. The relationship between distance, trust, and competence would also benefit from further research, as would the role of technology in forming and maintaining the partnership, since they are important factors in providing a richer picture of this phenomenon.

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About the Author

Ulrika H. Westergren is a Ph.D. student and junior lecturer at the Department of Informatics, Umeå University, Sweden. She holds an A.B. in International Relations from Bryn Mawr College. Ulrika's research interest lies within the domains of organizational studies and digital business. In her dissertation work she focuses on the impact of information technology on organizational transformation, emergent forms of organizing, and issues of trust and control pertaining to technology introduction and use. She is currently collaborating with a number of companies within the manufacturing and processing industry.

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Expertise Management in a Distributed Context

The Case of Offshore Information Technology Outsourcing

Ilan Oshri[1], Julia Kotlarsky[2], Leslie Willcocks[3] and Paul van Fenema[4]
1 Rotterdam School of Management, Rotterdam, Netherlands
ioshri@rsm.nl
2 Warwick Business School, Gibitt Hill, Coventry, UK
jkotlarsky@wbs.ac.uk
3 London School of Economics and Political Science, London, UK
l.p.willcocks@lse.ac.uk
4 Netherlands Defence Academy, Breda, Netherlands
pfenema@gmail.com

Abstract. This paper explores the management of expertise in offshore outsourcing projects. While the study of expertise development and coordination gained some attention in recent years, much of this research has been on co-located teams. Little is known about the way expertise is managed in distributed contexts and the challenges distributed teams face when attempting to develop and share expertise. To address this gap this paper discusses the notion of expertise management and concludes that it consists of three key processes; namely, development, coordination, and integration. To illustrate the challenges involved in expertise management processes, an in-depth case study of an ABN AMRO – TCS outsourcing project is outlined. In this case study onsite and offshore teams developed, coordinated, and integrated expertise despite geographical distance, time-zone differences, and different local contexts. Evidence from this case suggests that this outsourcing project jointly developed expertise while coordinating and integrating expertise in a distributed manner. Finally, conclusions are made and implications for research are discussed.

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1 Introduction

The offshore outsourcing of information technologies (IT) started in the 1990s, following an outsourcing trend in manufacturing industries. In recent years the scale of outsourcing projects has increased significantly as considerations involved in outsourcing to offshore locations has been extended from contemplating simple and repetitive tasks and processes to those that involve strategic and knowledge intensive activities [1] such as the development and implementation of strategic IT systems.

As outsourcing projects become complex and involve multiple stakeholders, the parties involved need to develop and access distributed expertise such as specialized skills and knowledge. Such capability, (the management of distributed expertise) is considered a key resource for software development [2]. Research has previously reported that experts from different companies and remote sites, specializing in multiple areas, have jointly engaged in sharing expertise in order to innovate and design new products [3]. While such evidence is valuable in understanding knowledge processes in distributed contexts, past studies have, so far, paid little attention to the processes involved in managing expertise in distributed contexts, in general, and in offshore outsourcing settings, in particular. Clearly, a successful software development effort depends on a timely and accurate coordination of expertise [2]. And yet, such expertise is often developed based on local routines for working, training and learning [4]. Furthermore, while solving problems, remote counterparts in offshoring projects are expected to integrate their knowledge and expertise and offer clients innovative ideas to transform their business [5].

Indeed, the study of the management of expertise is wide and diverse. Nonetheless, the vast majority of the studies on expertise management have tended to separate three key components essential for leveraging local expertise; namely, the development, coordination, and integration of expertise. Furthermore, past studies on expertise development have emphasized the role that knowledge creation plays in the development of expertise mainly in co-located contexts [6, 7], while studies on expertise coordination tended to emphasize the role that information plays in bringing together expertise in the form of directories that map out the pool of expertise available within the organization [8]. Considering expertise development processes separately from expertise coordination activities may result in an incomplete theoretical construct that does not explain how knowledge creation activities relate to the cataloging of where expert knowledge lies. To address this gap this paper seeks to link expertise development, coordination, and integration activities by exploring how the knowledge created during expertise development activities is cataloged and made available in the form of a cataloging system that offers pointers to "where knowledge lies." Furthermore, in developing, coordinating, and integrating expertise, globally distributed teams seek, on the one hand, to develop a distributed mode of expertise management to allow the emergence of expertise in remote locations so work can be divided based on the availability of local expertise. And, on the other hand, globally distributed teams may consider a joint mode of expertise development in which the entire global team may benefit from the collective experience embedded in the team. We explore the development of expertise and the coordination of knowledge through a cataloging system by considering either a joint or a distributed approach of expertise management.

Following this introduction, this paper explores the concept of expertise and the theoretical foundation of expertise development, coordination, and integration. This conceptual contribution is followed by an in-depth case study of an offshore outsourcing project in which expertise was managed onsite and offshore. The paper concludes by providing theoretical and practical implications.

2 Understanding the Concept of Expertise Management

Expertise is defined as the ability to act *knowledgeably* within a specific domain of application [9]. Expertise is also often referred to in the literature as *know-how and competence*, which is the ability to apply knowledge to develop and improve products and processes [10] or the ability to achieve skillful performance [11]. In a way, the concept of expertise is closely related to the notion of *knowing in practice* [11].

The concepts of expertise and knowledge indeed relate to each other; however, we maintain that they are not synonymous [12]. For one, we argue that expertise refers to a specific type of knowledge that is dynamic and evolving in nature. In this regard, embodied knowledge and skills possessed by individuals [13] represent the notion of expertise discussed in this paper. Such knowledge is accumulated over years of experience in a specific area. Furthermore, embodied knowledge is context-dependent [13]-situated in a particular setting [11]. Lastly, such knowledge is inseparable from the practice of doing. It is constantly evolving and changing through recurrent practice that involves varying activities and contexts.

In line with past discussions about the dispersedness of knowledge [14, 15], expertise at the team and organizational level is distributed. In this regard, recent years have witnessed further dispersedness of expertise [15, p. 1039]. For example, teams involved in outsourcing projects are often located onsite, offshore, and nearshore. This presents new challenges to the management of expertise as remote counterparts engage in creating and sharing context-dependent knowledge. At the same time, remote counterparts are expected to share and exploit knowledge in a fashion that brings expertise to bear in a timely manner [2] regardless of its origin.

A review of the expertise and knowledge management[1] literature suggests that the management of expertise consists of three major processes; namely, expertise development [6], coordination [2] and integration [16]. While each expertise management process has its distinct characteristics, the three processes depend on each other.

Expertise development involves the acquisition of know-how through learning. With this we mean that expertise is developed when members of a team engage in

[1] In reviewing knowledge management literature we focused on the literature that addresses embodied specialised knowledge and skills embedded in practice (i.e. fits our definition of expertise)

learning and problem solving activities to come up with new products and services. Such expertise can be developed through training sessions and formal education programs. At the same time, by being involved in a particular project, skills and expertise may potentially be enhanced as members of a team interact with their counterparts and confront and solve new problems. In this sense expertise development is the learning process through which individuals and groups develop skills, know-how, identity, and meaning to facilitate their participation in organizational activities.

Expertise coordination refers to team-situated interactions aimed at managing expertise dependencies [2, p. 1555]. In this regard, expertise coordination as a process ensures that individuals at each site have requisite know how and that they know who knows and does what. Therefore, expertise coordination attempts to achieve awareness of the existence of expertise and the alignment of expertise across various experts and tasks in the sense that task dependencies [17, 18] and expertise dependencies are addressed effectively. In this regard, coordination results in concerted awareness of dispersed expertise availability and could potentially enable employing expertise in a timely and accurate manner [2].

Expertise integration is the process that brings together the know-how, in an effective and efficient way, to develop new concepts and innovations. As opposed to expertise coordination that aims at creating awareness of existence expertise, expertise integration assumes value creation through cross-fertilization and interactions between experts [10, 16, 19]. Consequently, experts bring their know-how together (often expertise that is drawn from various disciplines and is based on years of experience) to innovate new concepts, products, and processes. In doing so, the integration of expertise attempts to address future needs (business transformation and innovation) rather than solving present problems (maintenance). In line with the literature on knowledge integration [20], the integration of expertise facilitates the organization's ability to sense, interpret, and respond to new opportunities and threats in a dynamic business environment [16].

There are several aspects relating to the characteristics of expertise and knowledge that affect a firm's ability to develop, coordinate, and integrate expertise. The following section discusses these aspects in depth and aims to identify challenges associated with the management of distributed expertise.

3 The Management of Distributed Expertise: The Dilemma and Its Implications

The management of expertise may face challenges that can be behavioral (lack of motivation [21]), managerial, and technological [22-25] in nature. In the context of a distributed environment, one dilemma could be imperative for the management of expertise; namely, whether to jointly or locally develop expertise. With this we mean that distributed teams can jointly develop expertise by incorporating the entire team in learning activities. On the other hand, distributed teams may pursue an approach in which the development of expertise will be distributed resulting in the specialization of individuals and teams in a particular area. The first approach can be seen as a joint approach to expertise management, whereas the latter would be a distributed approach to developing expertise.

Table 1. Expertise Management: The Dilemma and Its Implications

	Expertise Development	**Expertise Coordination**	**Expertise Integration**
Joint expertise development			
Benefits associated with jointly developing expertise	- Creating common grounds for knowledge sharing. - Facilitating the development of a TMS (that spans beyond the boundaries of co-located).	- Ability to bring expertise to bear beyond a single co-located team by accessing information about "who knows what" and "who does what".	- Knowledge integration of learning generated in past and present projects through intensive formal and informal interactions.
Challenges of jointly developing expertise	- High investment in creating "common grounds" between remote counterparts. - Higher task dependency may result in miscommunications and in design problems. Duplications of existing assets that may result in "reinventing the wheel" - May create high cognitive load on individual team members.		
Distributed expertise development			
Benefits associated with separately developing expertise	- Higher specialization of teams in a particular area. - Avoiding the duplication of existing assets and "reinventing the wheel". Allow fewer dependencies between tasks.	- Because of fewer dependencies between tasks, there is less need to bring expertise to bear beyond the boundaries of a dispersed team. - A TMS can be created within co-located teams and therefore can be easily updated.	- Knowledge integration produces information that is relevant and directly contributing to the line of products and markets within this specific domain and market.
Implications of separately developing expertise	- Difficulties to exploit learning generated in remote locations or other knowledge domains. - An overview perspective of "who knows what" and "who does what" is mainly developed at middle management level. - Little knowledge integration between domains. To integrate knowledge between domains dispersed teams need to rely on well-defined interfaces agreed in advance.		

Taking either a distributed or integrated approach of expertise development may have implications for the coordination and integration of expertise. Coordinating expertise may require the development of an organizational memory system, known as the transactive memory system (TMS). Through this memory system individuals can encode, store, and retrieve information about "who knows what" and "who does what" from codified and personalized directories (reference withheld for blind refereeing). Updating the directories of a TMS is critical for the coordination of expertise as experts may develop new skills and acquire recent information about markets and products. While the joint development of expertise may offer more opportunities to update directories about "who knows what" and "who does what" through interactions between remote counterparts, the investment in creating "common grounds" [26] for knowledge exchanges can be rather costly and problematic to achieve. Furthermore, a joint development of expertise may create unnecessary duplications of expertise across locations and impose information overload on individual team members [15].

The distribution of expertise, on the other hand, offers advantages in terms of division of work, which could offer fewer dependencies between remote counterparts and could prevent miscommunications between them [27]. Indeed, the diversity of perspectives and knowledge asymmetries may increase the global team capability to create new knowledge [15, 28] and enhance the quality of their decision making processes [29]. At the same time, such a distributed approach may result in fewer opportunities to share learning and may create difficulties to integrate expertise due to insufficient mutual understanding induced by team members having different interpretive frameworks and sets of expertise [15, 16, 28]. Based on these literatures, Table 1 summarizes the dilemma and the implications involved in a joint or a distributed approach to developing expertise.

In line with these observations, this paper seeks to explore the approach taken by distributed teams at TCS concerning expertise management and the challenges faced and solutions introduced to cope with the implications presented above.

4 Research Design and Methods

In line with past research [30, 31], a case study method was selected for this research. An in-depth case study of an offshore outsourcing project was carried out, and a qualitative, interpretive approach was adopted.

To explore the management of expertise in offshoring settings, our primary case selection criterion was to find an outsourcing project that was globally distributed and required the development, coordination, and integration of expertise. A key project of TATA Consultancy Services (TCS) was selected and studied in depth in the context of expertise management. This project involved the outsourcing of ABN AMRO IT infrastructure support and the development of new systems by TCS. The project faced complex and challenging expertise development, coordination, and integration activities between onsite and offshore locations. TCS's remote counterparts needed to transfer knowledge while learning about the client systems and engaging in co-development and implementation activities.

Evidence was collected from interviews, project documentation, and observations [30, 31]. Interviews were conducted at two remote sites: the onsite location in Amsterdam (The Netherlands), with TCS and ABN AMRO personnel, and in Mumbai (India), at the offshore location with TCS personnel. Interviewees were included: (1) counterparts working closely at remote locations, and (2) diverse roles such as executives, managers, and developers. In total, 52 interviews were conducted. On average the interviews lasted 1.5 hours, and they were recorded and transcribed in full. A semi-structured interview protocol was applied to allow the researchers to clarify specific issues and follow up with questions.

Data analysis followed several steps. It relied on iterative reading of the data, using open-coding techniques [32], to sort and refine themes emerging from the data [33]. In particular, three themes that represent the concept of expertise management were carefully studied: development, coordination, and integration of expertise. Each process was examined in relation to a joint and distributed approach to expertise management. Statements that were found to correspond with these three themes were selected, coded, and analyzed using Atlas.ti, Qualitative Data Analysis software [33, 34].

5 ABN AMRO Bank-TCS Outsourcing Project: Expertise Management Processes

To understand the complexity involved in managing expertise across dispersed locations, we first elaborate on TCS and the challenges they faced in this project. Following this, the results of the case study will be presented.

5.1 ABN AMRO-TCS Outsourcing Project: Background

The ABN AMRO bank-TCS outsourcing deal was announced in late 2005. In this $1.2bn contract, The Netherlands-based bank contracted five vendors, among them Tata Consultancy Services (TCS), to provide support and application enhancement services. TCS provided these services in cooperation with another Indian company, Patni Computers, and Accenture was the preferred partner for application development. Facilities from TCS involved in the contract are located in Mumbai, Amsterdam, Luxemburg, and Sao Paulo.

The outsourcing project organization of the ABN AMRO-TCS deal consisted of onsite teams at the customer locations in Amsterdam, Luxembourg and Sao Paolo and offshore or nearshore teams at the global delivery centres of TCS in Mumbai, Hungary, and Sao Paolo. The offshore team's organizational structure was a mirror image of the onsite team's organization structure (apart from some minor variations in role names). Typically, team members resided in one location throughout the project, either onsite or offshore, while only a small number of individuals traveled between remote locations for short visits. The entire onsite team was made of project members, project leaders, portfolio managers, program managers, a transition head, a relationship manager, and other functions such as quality assurance, human resources, and organization development personnel. Members of the onsite and offshore teams worked together during the Transition and Steady State phases. In the Transition phase the onsite team learned about the client's systems and transferred this knowledge to the offshore team. In the Steady State phase, mainly the offshore team, but also the onsite team, supported these systems as well as engaged in application development activities. This mode of work required the onsite and offshore teams to develop, coordinate, and integrate expertise. The following section describes the processes involved in managing expertise in this outsourcing project.

5.2 Expertise Development Processes at TCS

There are several domains within which expertise can be developed, such as, technology-orientated, business-orientated, and managerial-orientated expertise. We have observed that when it comes to technology- and business (market)-orientated expertise, TCS followed an approach that promoted a joint development of expertise at the project and the organizational levels. There were several processes and organizational mechanisms that TCS put in place to ensure that expertise was developed in a joint manner; a tightly managed knowledge transfer process between onsite and offshore teams, a global expertise management system, and a joint expertise development program.

The knowledge transfer process between onsite and offshore teams contributed to the development of technological expertise relating to client systems as well as better understanding of ABN AMRO business processes and environment. Members of the onsite and offshore teams jointly learned about client systems and acquired new knowledge regarding maintenance and problem solving concerning the IT infrastructure at the client site. A tightly managed knowledge transfer process between onsite and offshore locations during the Transition phase supported this learning activity. While the teams were distant from each other, processes and structures implemented by TCS ensured that the expertise developed onsite would be shared with the offshore location. For example, the offshore team was organized as a mirror image of the onsite team. This ensured that each offshore expert corresponded and learned from a particular individual who held the same role title in the onsite team. Furthermore, the learning between onsite and offshore teams took place through the application of standardized templates that captured the knowledge held by the client and transferred it to the offshore team. The codification of knowledge through the use of these standardized templates enabled the offshore team to examine and learn about technological aspects involved in supporting the client systems as well as to identify knowledge gaps that had not been properly covered by the onsite team. To ensure that expertise had been properly learned and absorbed and that the knowledge acquired could be appropriately (re)applied in problem solving scenarios, the offshore team "played back" the acquired know-how to the onsite team and solved problems generated by the client. Through such "play back" exercises, the onsite and offshore teams ensured that knowledge gaps, which were in fact the expertise deficiencies of either team, were detected and eliminated. In other words, the teams identified the areas in which expertise had been jointly developed as well as those areas that required additional joint expertise development.

While knowledge transfer processes between onsite and offshore teams enabled a joint development of expertise, other processes within TCS ensured that expertise would be developed in both joint and distributed manner. For example, training activities concerning specific technologies were offered to employees regardless of their geographical locations or association with a particular project or industry. Courses were mainly offered by the Global Learning and Development Group and could be taken on-line or by physically attending a module. In parallel, project leaders could identify an expertise deficiency in a particular area and could request an upgrade of the team's expertise-base to correspond with the level needed by the industry. Consequently, a tailored module that ensured the joint development of expertise in that particular area was offered to the team.

To summarize, expertise development at TCS mainly took place within the outsourcing project team during which the onsite and the offshore teams jointly developed the expertise that was required for future maintenance of the client's systems. Additional activities ensured that expertise was also developed in a distributed manner through training.

5.3 Expertise Coordination Processes at TCS

The coordination of expertise was required to find solutions and answers to either technological or business challenges that were not in the possession of the team. In such situations, team members started looking for the required expertise within their local or global project team or in the other projects. A successful expertise coordination activity often resulted in locating an expert that shared his or her know-how with the information seeker(s). Finding the most appropriate expert in a timely manner has always been a key challenge for dispersed teams. To achieve this, the coordination of expertise at TCS relied on two memory systems. One was a transactive memory system (TMS) that was created within a particular offshoring outsourcing project (between onsite, offshore, and nearshore teams) in which most individuals developed awareness of "who knows what" and "who does what."

The second memory system was a much broader memory system consisting of a corporate-wide Expertise Management System that was put in place and regularly updated by TCS to ensure that expertise could be brought to bear in a timely manner beyond the boundaries of an outsourcing project.

In the ABN AMRO-TCS relationship, as a result of the organization of the team (the mirror image), a cataloging system of the pool of expertise within the outsourcing project was developed.

The organization of the outsourcing project team, in onsite and offshore locations, as a mirror image using almost identical roles and titles for the offshore and onsite teams, created an expertise directory with regard to information about "who knows what" and "who does what." These pointers to expertise holders were created and constantly updated, during the Transition and Steady State phases, as remote counterparts continuously interacted with each other to ensure the joint development of expertise. For example, during a specific knowledge transfer activity, onsite experts would create documents that captured the know-how involved in maintaining a specific system and would make this know-how available to their remote counterparts based offshore. In doing so, the onsite experts first created a pointer in the expertise directory to a particular area of expertise of which they possessed the required knowledge to maintain this system. Following the exchanges of know-how with counterparts from the offshore team, an update of the expertise directory, with regard to where such expertise lies, took place within the entire global team. In other words, through intensive knowledge exchanges between onsite and offshore teams, the types of expertise and their location within the teams were made transparent to the entire global team. The directory of expertise emerged as sets of documents and entries in databases (a codified directory) as well as information stored in people's memory about "who knows what" (a personalized directory). The codified part of this directory was implemented through a project portal accessible through the TCS intranet for members of the project team only. In collaboration with ABM AMRO, a dedicated TCS team created a Project Portal (internally called Knowledge Base) that contained links to all project and system documents created during the knowledge transfer phase. Furthermore, this Knowledge Base contained information about the experts involved in the project, their contact details, and other relevant information. At the time of data collection in Mumbai (June 2006), two TCS associates worked full time on development and maintenance of this system.

In addition, other processes were put in place at TCS to ensure that expertise could be brought to bear in a timely manner from outside the boundaries of an outsourcing project. TCS introduced a system, called Integrated Competency and Learning Management (ICLM), which coordinated expertise across the entire firm. TCS designed and implemented this system to manage employees' competencies, monitor skills adjustments, and offer learning modules and individual development programs according to future needs.

In addition to staffing individuals according to their skills, the ICLM system offered search capabilities for globally expertise available that could not be located through the project-based TMS. In this regard, at the organizational level, the coordination of expertise, in the sense of bringing specific expertise to a particular location in a timely manner, was carried out through the ICLM system. To ensure that the directories of the ICLM system were up-to-date, a dedicated team was put in place in India. This team monitored data entry, handled requests from TCS employees, and issued information to TCS employees about learning modules.

Another vehicle through which expertise was coordinated at TCS was a technical database of reusable components (code) stripped from confidential client data from various projects. A dedicated team checked the entries submitted to this database by individual team members, filtered these entries, and made sure that the most appropriate keywords were assigned to each entry. Individual team members, regardless of their geographical location and project association, who sought solutions to a particular technological problem, could access this database through TCS intranet and search for reusable components. While a reusable solution was the main the outcome of this activity, information seekers were also exposed to the experts who designed the components and were in possession of such expertise.

Therefore, remote counterparts could contact an expert for consultation prior to implementing a reusable component. Similarly, TCS developed a database that contained business history (a brief overview and lessons learned from past projects) that was accessible through the TCS intranet. Through this system team members could find information about projects and contact the individuals involved in these projects for advice.

In conclusion, at TCS the coordination of expertise within a specific outsourcing project relied heavily on the TMS developed during knowledge exchanges between onsite and offshore teams. The joint approach for expertise development of an outsourcing project facilitated expertise coordination processes because it exposed remote counterparts to experts located in other sites (onsite or nearshore). In this regard, within an outsourcing project, the coordination of expertise benefited from the joint expertise development approach pursued by TCS.

When it came to expertise coordination, between and across outsourcing projects, TCS introduced organizational mechanisms in the form of the ICLM system, technical and business databases that offer search mechanisms to information seekers and to ensure that needed expertise is made available in a timely manner.

5.4 Expertise Integration Processes at TCS

Joint development of expertise within ABN AMRO-TCS outsourcing project helped TCS deal with typical expertise integration challenges such as different mindsets and lack of understanding between experts. Interviewees claimed that TCS employees involved in a distributed outsourcing project developed a common understanding of specific systems, concepts, and terminology because of the structures, work practices, and the knowledge transfer process described above.

However, the sharing of learning beyond the boundaries of an outsourcing project and the integration of expertise across projects and domains still posed a challenge to TCS. Indeed, leveraging knowledge and expertise to develop new products and services required the facilitation of learning across functional areas, market knowledge, and various technologies that were globally distributed and sometimes remotely related. To tackle this challenge, TCS introduced various mechanisms to ensure that the know-how and learning generated in one project would be shared in other projects. One vehicle through which expertise was integrated at TCS was Centers of Excellence (CoEs). TCS introduced CoEs in several domains related to technologies–Windows-based technologies, Java-based technologies– and specific practices (market verticals) CoEs–Service Practice CoE, Financials CoE. These CoEs were networks of experts known for their advanced know-how and experience in a particular market or technological domain.

A key role for the CoE was to ensure that expertise and knowledge developed in one place would be re-applied in other projects. In this regard, the CoE facilitated the reapplication and integration of expertise almost from the beginning of the project by offering expertise and solutions developed in other projects and by connecting experts in a particular field with the project team to advise them on best practices and approaches to carry out their outsourcing project.

There are other aspects of expertise integration in which a CoE engaged. For example, when projects did not apply best practices, members of CoEs made sure that the know-how required for the proper execution of an outsourcing project, according to TCS best practices, would be shared with the project team. In this regard, CoEs were responsible to acquire know-how from internal or external sources and share it with project teams.

Another mechanism that TCS employed, for expertise integration across technological and market verticals domains, was knowledge-exchange events and seminars that were organized on a regular basis in different geographical locations. For example, technological fairs were organized a few times a year at major TCS development sites (May 2006 in Mumbai). In this case, experts from different technological domains offered information about different aspects relating to the use and implementation of their technologies. This knowledge exchange event was organized in the form of a traditional trade fair in which TCS employees walked from stand to stand to learn and assess the applicability of existing solutions to their project.

To summarize, the integration of expertise at TCS took place at the project and organizational level. The integration of expertise at the project level relied on a TMS that had been developed and updated through intense interactions between remote counterparts. Indeed, the approach taken by TCS to jointly developed expertise, as described-above, supported the development of a TMS and offered more opportunities for members of the global outsourcing project to integrate their expertise. At the same time, new ideas and innovations were sought outside the boundaries of an outsourcing project through other vehicles such as CoEs, trade fairs, and training. While the use of external sources of knowledge in the form of CoEs is a distributed approach to expertise management, the TMS-based approach can be seen as a joint approach to expertise integration.

6 Discussion and Conclusions

The objective of this paper was to explore expertise management processes in distributed contexts. The case of the ABN AMRO–TCS outsourcing project illustrates the complexity involved in managing distributed expertise. For one, the management of expertise in such projects involves the coordination and integration of expertise that are both locally and globally developed. In addition, the case illustrates aspects relating to project and organization expertise that need to be coordinated and integrated. Similarly, expertise development at TCS involved knowledge codification processes as well as processes that encouraged the sharing of tacit knowledge. The following sections address these aspects starting with the summary of the findings presented above.

The evidence presented above suggests that TCS followed an approach in which expertise was developed both within and across projects. The company, though, invested in supporting a joint approach to expertise development within this outsourcing project. We have learnt from interviewees that the approach taken in this project was applied in other projects at TCS. At the organizational level, TCS encouraged the development of expertise through training activities that upgraded the skill-base of TCS employees regardless of their geographical location. Through such training activities, expertise was also developed in a distributed manner.

In coordinating expertise, TCS has invested in activities that created a TMS within an outsourcing project through which onsite and offshore team members developed awareness about "who knows what" and "who does what." To support the coordination of expertise beyond the boundaries of an outsourcing project, TCS implemented an ICLM system and various mechanisms that offered search mechanisms for knowledge seekers and provided them with access to existing expertise and in-house solutions.

The integration of expertise was mainly evident at the organization level. One key vehicle, through which learnt lessons and insights were shared, was the CoEs. These networks ensured that outsourcing projects were aware of the latest know-how and best practices possessed by TCS. They also made certain that project skill-level was adequate to meet the outsourcing challenge. Expertise integration also took place within an outsourcing project; however, interviewees perceived intra-project expertise integration as limited in its scope. In this regard, CoEs were the forces behind incorporating cutting edge innovative ideas from the industry into project teams. Finally, data suggest that TCS followed an approach of jointly developing expertise within an outsourcing project while investing in upgrading distributed expertise. Consequently, as suggested by the data presented above, coordinating expertise at the project level required little effort from the outsourcing project team (onsite and offshore team members), while coordinating expertise outside the boundaries of a project entailed the application of various mechanisms at the organizational level. The integration of expertise, on the other hand, seemed to be significant at the organizational level, however there was with little impact at the project level. Table 2 summarizes the findings of this study.

Table 2. Expertise Management at Project and Organization Levels

	Expertise development	**Expertise coordination**	**Expertise integration**
Project	Joint developed expertise through tightly managed knowledge transfer processes between onsite and offshore teams and development of Knowledge Base.	A TMS that supports developing a collective awareness of "who knows what"	Expertise integration within an outsourcing project mainly meant reusing existing ideas. Limited in exposure to external innovations
Organization	Distributed mode of expertise development through on-line training and courses.	Information technologies in the form of technological and past projects databases and ICLM system that offered search mechanisms of existing expertise and experts.	Knowledge-exchange events and CoEs that brought in new ideas and innovations from other projects and the industry

Evidence from this case also suggests that interplay took place between the development, coordination, and integration of expertise. In particular, we propose that the joint approach to developing expertise between the onsite and the offshore teams resulted in the development and the update of a TMS [35] that stretched beyond the boundaries of a single team. Indeed, recent studies suggest that a TMS can be expanded within an organization through the application of information systems [8]. This study suggests that a joint development of expertise could, as well, result in expending the boundaries of a TMS as members of a global team encode, store, and retrieve information regarding their expertise through the use of databases, documents, and person-to-person interactions. At the same, we have observed that while the boundaries of such a TMS may have expanded beyond the onsite and the offshore team, the ability to coordinate expertise, beyond the boundaries of a single outsourcing project, is rather limited unless team members have used information systems, in the form of the ICLM system [36], and other search mechanisms to locate needed expertise. In this regard, the joint development of expertise is limited in its impact, and its influence on coordination activities is subject to the interactions among members of the organizations. Lastly, evidence suggests that the integration of expertise does not necessarily rely on the joint development of expertise. Rather, it is driven by the organization's capacity to bring in new ideas through the use of networks of experts. In this regard, the joint development of expertise may, in fact, limit possibilities for expertise integration as project teams would prefer to implement practices developed locally [4] than adopt suggestions made by a network of experts who are not part of the project. To overcome this challenge, TCS gave experts from CoEs the power to evaluate the level of expertise possessed by the outsourcing project and authorized the implementation of best practices regardless of local practices developed by project teams.

6.1 Implications for Researchers

To summarize, evidence suggests that TCS pursued a hybrid approach to expertise development, in which both a joint and distributed approach to expertise development were carried out, and through which the coordination and integration of expertise were supported through intra- and inter-project knowledge integration mechanisms. Our findings confirm observations made by past studies that distributed teams have applied both joint and distributed approaches to expertise development. Yet, this study contributes to the relevant literature by considering the project and organizational levels as two stages within which expertise development can be carried out in a different manner. Indeed, as evidence suggests, TCS pursued a joint approach to expertise development at the project level while developing expertise in a distributed manner at the organizational level.

There are other aspects relating to the management of expertise rising from the ABN AMRO-TCS outsourcing project. For example, the joint development of expertise appeared to rely on the codification of know-how captured by the onsite team. Indeed, evidence suggests that the codification of knowledge, and the documentation of knowledge acquired during knowledge exchanges among onsite and offshore teams, is imperative for creating a knowledge base of expertise needed to maintaining the client's systems. Furthermore, the process of codifying knowledge created a terminology accepted by both onsite and offshore teams concerning the processes and the technologies involved in maintaining client's systems [37]. Lave and Wenger (1991) described in length the practice-based approach to developing expertise. In particular, Lave and Wenger emphasize in their study how expertise is transferred from an expert to a novice (for example, the case of midwifes). Such practice-based processes required the participation of newcomers in activities, problem-solving, and organizational activities through which they gain the know-how required to perform their duties, assume more responsibilities, and gradually shift from the periphery to the center of doing within a team or an organization.

However, our case illustrates a rather different approach to developing expertise in which project members codified the know-how required for carrying out their duties, minimized face-to-face interactions, and relied on standardized procedures when learning about client's processes and technologies. This observation raises the following question: Why does expertise development at TCS present a rather different approach than observed in the relevant literature [6]?

We suggest that distributed teams, such as the TCS outsourcing project team, as opposed to co-located teams, invest in creating the pointers to know-how necessary to carry out specific activities rather than in learning and absorbing the know-how necessary to successfully execute these activities. While past studies mainly focused on the process through which knowledge is created during expertise development processes [38], we suggest that the expertise development processes described above can also be seen as a process through which individuals create information about the location of the know-how and expertise necessary to execute a particular activity. Since in a distributed team interpersonal exchanges as a source of expertise development proves difficult, these teams ensure that expertise can be coordinated when needed and that the pointers to the knowledge are known and can easily be accessed by the entire team. Through the use of standardized templates, documents, and a tight knowledge transfer process, this TCS outsourcing team has indeed built a cataloging system in which pointers to where knowledge and expertise reside was made available to the entire team. In this regard, our findings contribute to the literature on expertise development by considering information processes as part of the process of developing expertise.

6.2 Implications for Practitioners

For practitioners, the evidence presented above raises a question about the preferred approach to managing expertise in the sense of a distributed versus a joint approach to developing expertise. We propose that, on one hand, a distributed approach to expertise development may encourage the exploration of new ideas and acquisition of cutting edge knowledge within a globally distributed project. However, such an explorative approach could produce a distributed expertise-base that is troublesome to map out and manage and result in inabilities to coordinate expertise in a timely manner. On the other hand, pursuing an approach that relies on a joint approach of expertise development may result in the development of an expertise system that is exploitative in nature. As observed in this case, members of an outsourcing project could easily access each other's expertise and bring expertise to bear in a timely manner. However, such an approach can be overly exploitative, lacking innovative ideas to transform the clients' and the vendors' businesses. We propose a hybrid approach, in which the management of expertise encourages the exploitation of expertise, within globally distributed outsourcing projects, and yet explores the development and integration of expertise from external sources of knowledge, to overcome the dilemma presented above. Depending on project characteristics, a shift in emphasis on joint versus distributed expertise development might be appropriate. Such characteristics include the similarity of clients' businesses thus justifying investments in cross project mechanisms and the level of turnover in the vendor teams.

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About the Authors

Ilan Oshri is Assistant Professor of Strategic Management, Rotterdam School of Management Erasmus, The Netherlands. Ilan holds a PhD degree in technological innovation from Warwick Business School (UK). His main research interest lies in the area of knowledge management and innovation. Ilan has widely published his work in journals and books including *IEEE Transactions on Engineering Management, Communications of the ACM, European Journal of Information Systems, Management Learning*, and others.

Julia Kotlarsky is Assistant Professor of Information Systems, Warwick Business School, UK. She holds a PhD degree in Management and IS at Rotterdam School of Management Erasmus (The Netherlands). Her main research interests revolve around social and technical aspects involved in the management of globally distributed IS teams and IT outsourcing. Julia published her work in *Communications of the ACM, European Journal of Information Systems, International Journal of Production Research, Computers & Security, IEEE Security & Privacy*, and a number of book chapters.

Leslie Willcocks is Professor of Technology, Work and Globalization at London School of Economics. He is Associate Fellow at Templeton College, Oxford and holds visiting chairs at Erasmus and Melbourne universities. He has an international reputation for his research, educational and advisory work on outsourcing, IT management, developing IT leaders, IT evaluation and organizational change. Leslie has published over 150 refereed papers in journals such as *Harvard Business Review, Sloan Management Review, California Management Review, MIS Quarterly, MISQ Executive* and *Journal of Management Studies*.

Paul C. van Fenema (Ph.D. RSM Erasmus University) is Associate Professor at the Netherlands Defense Academy. He held positions as Assistant Professor at RSM Erasmus University, and visiting researcher at Florida International University. His research focuses on coordination of global IS projects, distributed social cognition, and high reliability organizations. His work has been published or is forthcoming in, amongst others, *Communications of the ACM, Information Systems Journal, and Cognition Technology & Work.* He has also contributed to *Managing Multinational Teams: Global Perspectives* (Elsevier/JAI, 2005), and *Information Systems at the Core: European Perspectives on Deploying and Managing Information Systems in Business* (Blackhall, 2000).

Section 6

The Role of Fiction in Structuring Virtuality

21

Building Virtual Spaces

Games as Gatekeepers for the IT Workforce

Andrea H. Tapia[1], Magy Seif El-Nasr[2], Ibrahim Yucel[3], Joseph Zupko[4], Edgard Maldonado[5]
1 329G IST Building, 814-865-1524, atapia@ist.psu.edu
2 316E IST Building, 814-865- 6166, magy@ist.psu.edu
3 327 IST Building, 814-863-6822, iyucel@ist.psu.edu
4 327 IST Building, 814-863-6822, jzupko@ist.psu.edu
5 307G IST Building, 814-865-8952, eam264@psu.edu
The College of Information Sciences & Technology
The Pennsylvania State University USA

Abstract. The percentage of young women choosing educational paths leading to science and technology-based employment has been dropping for several years [1, 2]. In our view, the core cause for this phenomenon is a lack of interest and social support on the part of the girls and their families and not a lack of ability. The specific aim of this paper is to evaluate the utility of building virtual environments in influencing girls' interest in computer-related educational paths and careers. This is evaluated through an intervention, or action-research, in the form of a class named *Gaming for Girls*. This class was offered to middle and high school girls three times over the years 2005-2006. We assert playing and developing computer games can lead to the acquisition of tangible IT skills and a higher sense of self-efficacy in terms of computer use. In particular, we discuss intervention methods that aim at changing socialization patterns by bringing girls into an all-girl classroom, reducing game violence by altering the forms of game action, and removing potentially negative character designs by allowing girls to design characters and game interaction themselves. We assert that within the information economy, playing video games is an advantage.

1 Introduction: The Problem

The percentage of young women choosing educational paths leading to science and technology-based employment has been dropping for several years [1, 2]. The

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core cause for this phenomenon is a lack of interest and social support on the part of the girls and their families and not a lack of ability. The specific aim of this paper is to evaluate the utility of building virtual environments in influencing girls' interest in computer-related educational paths and careers. This is evaluated through an intervention, or action-research, in the form of a class named *Gaming for Girls*. This class was offered to middle and high school girls three times over the years 2005-2006. We believe that this intervention is one mechanism to increase middle and high school girls' exposure to computers, programming, and IT employment in order to demystify the technology and IT profession. In so doing, it challenges the prevailing stereotype of IT professionals in a way that would enable girls to 'see themselves' in this career as well. Thus, we define our research questions as follows: (1) Did the use of activities around building virtual environments and experiences motivate and capture the interest and attention of middle and high school female students? (2) Did students gain significant exposure to diverse images of IT education and employment? (3) Did students gain computer skills and increased information literacy? The data presented in this work is drawn from the students and parents involved in these classes.

Currently, we do not understand why women students do not select IT as a career choice. The vast majority of students enrolled in educational programs in information technology and employees in the information technology workforce are male [3-5]. Despite numerous efforts to recruit and retain women students into both educational programs in IT and the IT workforce, these efforts have largely proved unsuccessful. In addition, despite the current availability of high-paying and often prestigious positions in IT, a common observation finds that women remain acutely underrepresented at the higher-paying professional and managerial levels [6-11]. Women now represent a significant proportion of the labor force, yet they are underrepresented in the IT workforce. Women accounted for 46.5% of the American labor force [2] in 2005 and only 32.4% of the IT workforce [2]. ITAA [6] reported that the percentage of women in the overall IT workforce actually dropped from 41% to 34.9% in 2003.

This under representation of women in the IT workforce can be attributed to a "pipeline" issue. Women earn significantly fewer undergraduate degrees in computer science and engineering than their representation in the U.S. population. When examining the participation of women in IT, it is significant to observe that in the US there generally is a decrease in the participation of women in the field of computer and information science in a progression up the ranks of education [3-5]. In turn, this collegiate trend may be traced back to the middle and high school experience for women students. Women students continue to track out of math and science classes, without which they do not have the foundation on which to build IT careers. American cultural expectations and influences often convey the message that women are unsuitable for the IT world [12, 13]. By the time young women reach college, there is evidence of the effects of these social norms and expectations. For example, in years prior to college, research studies have revealed that some women exhibit lower levels of self-efficacy in computing, smaller amounts of informal and voluntary computer exploration in computer camps and clubs, and have misconceptions of IT workers and IT work [14, 15-22].

In the middle and high school setting, young women students are faced with immense forces of cultural reproduction in which the values, norms, attitudes, and beliefs of their predecessors are instilled in the current generation [23, 24]. At times, these cultural agents of socialization may act as gatekeepers for items of social value such as degrees, jobs, social networks, and forms of social capital.

2 Review of Literature

2.1 Games as Gatekeepers

The metaphor of gate-keeping or gatekeepers is ubiquitous across disciplines including communications [25, 26-28], economics [29], education [30-32], political science [33, 34-36], and psychology [37]. Gate-keeping is commonly defined as institutionalized control mechanisms that allow some elements, people, ideas, etc. to pass through to a new status and others not. In most definitions, the gate-keeping function is seen as a passive set of norms, rules, and laws through which some may pass, not unlike a semi-permeable membrane. However, more modern definitions have seen this same function as active and imbued with institutional agency, encouraging and rewarding some elements, people, and ideas over others.

We use the gate-keeping metaphor for computer games because of its relationship with highly useful computer skills that may be gained in the process of playing them. Jobs that require IT skills are wedded to wealth, power, and prestige, and the traditional means of achieving those is through education. However, there exist fast tracks to these skills and employment and gaming is one of those. Youths who play games gain technology skills [38]. We believe that computer games serve a gate-keeping function because by playing games, people learn IT skills they might not otherwise learn. We assert that within the information economy, playing video games is an advantage.

Academics have noted this as well. There is a direct link between playing computer games and successful student performance in computer classes [38]. Several authors have also made the link between computer game play and interest in future careers in computer science or related fields [39-41]. For several authors the connection is straightforward: girls that do not play computer games usually become women that do not use computers [42, 43]. Ritterfeld and Weber state that giving girls the opportunity to develop their own video game could enhance their interest in technology and help overcome gender differences in technological skills [44]. Huff supports this claim by stating "we know now that software design can carry social values, can influence the behavior of others, and may even contribute to influences on career choice" [45, p. 115].

Therefore, playing and developing computer games can lead to the acquisition of tangible IT skills and a higher sense of self-efficacy in terms of computer use. However, as we will discuss below, there are some unidentifiable barriers to engaging girls in games in the same ways boys do. If women are to benefit from the fast tracking aspects of game playing, on-ramps must be built for them so that they can fully engage the space as well.

2.2 Games and Learning

Students learn well when actively engaged in discovering and building their own understanding of new concepts and skills [46, 47]. Constructivist Learning Theories or Learning by Design Theories guide these educational activities using games [48-54]. As students designed their own programs to create games, they developed an informal understanding of mathematics and computer science formalisms [55]. With the recent drop in students entering the computer science and related fields, academic departments have introduced game design into their curricula with the intent of recruiting and retaining new students [56]. The belief is that students' familiarity with games can be used to motivate computer science learning and attract and retain future generations of computer scientists. In one study, students who enrolled in experimental game design courses averaged higher grades than those students who did not enroll (in control-group classrooms). More important, 88% of students registered in game design courses continued in the major compared to 47% for the control groups [57]. Kafai [58, 59] states that by building games, students learned programming and other IT skills. An example of the use of game design and building as a learning activity includes the work on *Alice* at Carnegie Mellon University [60]. *Alice* is a visual programming environment that makes 3D graphics accessible to novices. Due to the massive learning curve for creating games from scratch, several research efforts have been engaged in developing authoring tools to reduce the complexity of programming, thus encouraging novice participation [61-65].

Several recent authors have claimed that a range of skills can be acquired by designing video games, including programming, mathematics, software engineering, project management, and graphical/sound design [55, 66-68]. Games provide a good environment for promoting different types of learning, including problem solving and creative thinking [69]. While learning through design and game design has elicited research interest, few have focused this research lens on learning and design and gender [70, 71]. Perhaps this is caused by the disparity between the percentages of men and women who play games as discussed in the following section.

2.3 Gender and Games

The small growth of the research surrounding computer games and gender has coincided with the massive growth of the computer game industry. In 2001, the computer-game market generated $1 billion more in revenues than the motion picture industry [72]. By 2004, the game industry in the United States reached $9.9 billion in sales [73]. As the game industry has grown, the lack of women consumers and developers is undeniable. Cassell and Jenkins [42] introduced the topic of the gender gap in games and argue that while "games for girls" can be made, the paltry state of research in the area may advance the gender gap rather than alleviate it. Ray [74] argues that if more girls played games, they would be more comfortable with computers in general, which would eliminate a disparity in the video game market. Unfortunately, much of the initial work with gender in games lacked empirical evidence and resulted in mostly anecdotal conjecture. What we do know from this literature is that age and gender are the most important factors in predicting video game use [75], males play more often than females among adolescents [76], and from a marketing standpoint, males are "specifically targeted by the marketing efforts of software firms." [77]

After this first foray into research on gender and games, academics have entered the space and attempted to answer several fundamental questions. The first, and perhaps most pressing question, is "why are women not attracted to video games?" Four main reasons arise from this research: 1) socialization, 2) violence, 3) hyper-sexualized, objectified, and shallow female characters, and 4) male adeptness with technology. Parents do not encourage girls to play video games in the same way they do boys [78], resulting in a problem of socialization. The violent content that is common to games can also deter women. Buchman and Funk [79] suggest that females prefer different types of content than boys (non shooting-type violence), and Gorriz and Medina state that, "girls are more interested in creating than destroying." [40] Several authors state that games depict female characters in unappealing ways using negative stereotypes [39, 80-82]. Finally, Natale [77] gives a biological or cognitive foundation for the disparity, stating that boys have an "innate affinity with technology and lean towards inquisitively figuring out how things work and delves deeper into complex, technical matters." This last point, that the cognitive differences between males and females can explain the disparity between game players and non-players, has been mostly debunked. Kiesler [38] found that while girls generally performed more poorly than boys when they were first exposed to a game, girls played as well as boys after a period of practice.

In the research presented in this paper, we focus on the first 3 potential causes. In particular, we discuss intervention methods that aim at changing socialization patterns by bringing girls into an all-girl classroom, reducing game violence by altering the forms of game action, and removing potentially negative character designs by allowing girls to design characters themselves.

3 Gaming for Girls: The Class and Intervention

We have developed a set of weekend courses for middle and high school girls, called *Gaming for Girls*. In the *Gaming for Girls* courses, girls were taught technology skills, including programming, design, and visual editing, through developing video games [83, 84]. Since this work is primarily an intervention, it can be seen as a form of action research in which we have both research goals and intervention goals. Action research seeks to change something about the environment being studied and involves a cyclical process in which research, action and evaluation are interlinked. The action research process is often conceived as a spiral in which both the researchers and the subjects engage in self-reflective planning, acting, observing, reflecting, and re-planning [85-90]. Our interventional goals for this project are to stem the tide of female attrition from computer-related disciplines, to increase middle and high school girls' exposure to technology and the IT profession, and to challenge the prevailing stereotype of IT professionals in a way that will enable girls to 'see themselves' in this career as well. As stated by The FunWorks/Career Resources Network project, when intending to influence young women to consider careers in science and technology, "a program designed for middle school students should allow the students to explore multiple careers and be deliberately structured to widen their concepts of future possibilities. Counselors should expect the students to arrive with sex-role stereotypes, especially with respect to STEM (science, technology, engineering and math) and vocational careers, and need to explicitly show students how these stereotypes are limiting." [91]

At the time of publication of this work, this class has been offered three times: Fall 2005, Spring 2006, and Summer 2006. Each Fall/Spring class spanned five weeks in four-hour weekend lab sessions (Summer students covered the same materials in a highly intensive week-long camp session). The class is currently being offered (Fall 2006) and is expected to continue to be offered in the future.

During these weekly sessions, students learned how to use specific game building technologies, including Game Maker, RPG Maker XP, and Warcraft III, to build games and interactive stories. Each student was expected to complete a working game by the end of the fifth week. Students engaged in a show-and-tell activity with parents, instructors, and school personnel during the last session. Class size ranged from 20-27 students. Survey data was collected during classes to tackle the research questions discussed previously.

3.1 Data Collection

Our principal research questions are:

1. Did the use of virtual environments and computer gaming motivate and capture the interest and attention of middle and high school female students?
2. Did students gain significant exposure to diverse images of IT education and employment?
3. Did students gain computer skills and increased information literacy?

The principal method of data collection discussed in this paper is through surveys. In the larger research setting observational data and student project analyses were also conducted in later instances of the class, but these data are not included in this paper out of concern for space. During the first two instances of the class (Fall 2005 and Spring 2006), the surveys were administered on paper. The students were asked to answer approximately 50 questions, 10 questions each day, for the five days of the course. During the summer of 2006 the surveys were moved online (surveymonkey.com). The core student questions remained the same, but the surveys evolved to include a parent pre and post survey as well. The data for this paper are drawn from the following sources, student surveys (Fall, 2005, paper), student surveys (Spring, 2006, paper), student surveys (Summer, 2006, online), parent surveys (Summer, 2006, online), and the initial review of current student and parent surveys (Fall, 2006, online). The student surveys included the following sections (1) motivations and influences to take the course, (2) relationships with computer technologies, (3) relationships with computer games, (4) interests, activities, and future plans, (5) demographics, (6) reflections of learning in the course, and (7) perceptions of future applications of skills/course materials. Parent surveys included the following sections, (1) daughter's motivations for taking the course, (2) family computing, (3) daughter's computing activities, and (4) family background and demographics. The data presented in the following sections is descriptive and qualitative in nature, despite having been collected via survey. The data must be seen as micro-case studies of each class instance, aggregated for the purposes of this paper into a useful framework. This data cannot be generalized from this work, but may have implications for future work in this area.

4 Findings and Analysis

We have organized this section around the three research questions listed above. In each subsection below, we make several points and support these with a few illustrative quotes from both parents and students.

4.1 Games: To Capture and Motivate

On the first day of class we asked students to talk about their motivations and hopes for the class. Most students expressed some excitement for creating a game. The most common response was "Making a game!" One student said, "After this morning's class, I'm excited to start working on more RPGs and perhaps even buy the program and make my own RPGs later." Most of the other students expressed a desire to creatively bring their stories and characters to life. Another common response was "Making my story!" A student said she was most interested in, "making my characters talk, building a world, and making an interesting story." From the summer class data, when asked why they decided to take the course they overwhelmingly chose 2 reasons: they stated they liked computers (68%) and games (68%), and they thought the class would be fun (61%). When asked directly how they felt about computers, 83% felt they "Loved them."

One week after the end of the last day of each course parents were asked to take a final survey. When asked what long term effects the class has had on their daughter, slightly more than half of the parents said they had noticed some change. One parent said that the class had, "challenged her in a fun way and she enjoyed it." Another parent stated, "At first she was extremely enthusiastic about pursuing technology as a possible career choice. This is something that I will need to follow-up on to ensure that she is given the opportunity to explore. Additional classes would be of great interest." A mother of one of the students said about her daughter, "She wears her tee-shirt with confidence and talks often about her camp experience. She also talks more about enrolling in the College of IST and would like to explore possible scholarships, grants, and/or funding for that program." Another mother stated that her daughter "has purchased the software and is making new games already." Parents of two students stressed how much fun their daughters had had in the course stating, "That computers can be fun!" and "She learned the math she has been studying in school can have a real application. She learned programming can be fun."

In regards to this first research question, it seems clear that the use of virtual environments and computer gaming motivated and captured the interest and attention of the students in our classes. The results were overwhelmingly positive. The students enrolled in the class because of their interests in computers and gaming and those interests grew during and after the class. The parents perceived that their daughters enjoyed the class and were inspired to do more with what they had learned. These strong positive results must be tempered by the strong limitations of this study. This population was self-selected. The students who enrolled already had an interest in computers and gaming before they enrolled in the class or they would not have been interested. In addition, this self-selected sample also possessed some computer skills before they took the class. All of the students also came from middle class homes in which there existed at least one computer connected to the Internet via broadband. Perhaps the most valuable point from this data was that some of the students were surprised by how much fun they had, by how much they learned, and by their own growing interest in the field of computers and gaming. While the data can say nothing about the effects this class might have on a truly general population, it obviously had some positive effect on this narrow, self-selected sample. This question obviously demands further research. If the question was truly to be answered, without limitation, it would have to encompass several classes of random, conscripted students (non self-selected). Ideally, this random sample would encompass students who felt both negatively and positively oriented toward computers and gaming, as well as those of diverse skill levels and socioeconomic backgrounds. However, to ensure this coverage, a more stratified random (quota sample) sample could be drawn among several populations.

4.2 Exposure to Diverse Images of IT Education and Employment

On the last day of class we asked the students their opinions concerning their experiences in the class. Most said they had fun and learned a lot. However, one third stated that it inspired them to think more about computer related fields as a career. One student said, "It was so fun and I like working with computers now." Another student said, "I realized that computers are more awesome than I originally thought." Another student said she loved the class because, "I love computers, so I plan on going to IST when I go to college." From the summer class data, 52% of the students predicted that after college they would use computers in their work "as a tool to do something else" while 32% stated they would use computers as the focus of their work, 30% predicted they would get a 4-year degree, and an additional 42% predicted they would go on for a professional degree.

On the last day of class we asked the students to describe what kind of job someone might get with a degree from a school like IST. The majority of the students responded with "There are too many to list," or something like, "All of them, of course." A few students expounded on this sentiment and named particular jobs. One student said with an IST degree you could hold the jobs of, "computer programming, game design, computer maintenance, computer sales, working with computers for science experiments or business, operating a computer for business." Another student said, "Computer technician, network admin, computer programmer, data manipulator, accountant, graphic artist, computer science teacher, software tester and a lot more other jobs." One student said, "I don't know . . . I suppose all kinds. I'd assume it'd be easy to get a job in low-paying jobs, but they'd also be able to get jobs in good things, like computer repair/help, information booths, game design, website design, etc., etc."

Before the course began, we asked the parents what they hoped their daughter would get out of the class. From both summer and fall data, 30% hoped that the class would "spark her interest in math, science or technology." Additionally, in second place parents hoped their daughter would "Eventually choose a career using computers" (20%) and "learn how to make computer games" (20%). One parent stated that she hoped her daughter:

> will learn about programming without thinking she is doing something difficult like taking a class in programming but will be doing this as she is having fun. I also hope the class will introduce her to possible careers using a computer as she is talented in this area but may not know how to apply these skills to a career of her liking.

However, few of the parents actually thought that the class would influence their daughter's choice of a computer related career (16%). However, it is worth noting that some parents included some textual responses in which they expressed the hope that their daughter would, "become more interested in computers" or "she will decide if she would like to pursue further computer studies in high school, possibly leading to college study." One parents stated, "I hope that she will learn that working with computers can be as much fun as playing with them I hope that she will learn about IST careers."

One week after the course had ended parents were surveyed again. Drawing from summer data, 88% of parents felt that the camp may have influenced their daughters' perceptions of working with computers. One father stated about his daughter, "I believe [my daughter] learned that IST is not just fixing computers or writing software programs, she learned different ways IST applies to many areas, including artistic avenues which she is interested in pursuing as a career." One parent stated, "I believe she learned there is more to technology especially information technologies than hardware and software, that there are many other useful and interesting applications."

In terms of the second research question, did students gain significant exposure to diverse images of IT education and employment, the results here are more mixed. Both parents and students alike expressed the belief that the class had inspired them or their daughters to think about education and a future career using computers. However, in many cases because of the self-selected nature of the sample, these efforts may have just reinforced previously existing education and career interests. One of the goals of this research was to eliminate the negative stereotypes that prevail concerning IT work, predominantly those that portray the work as male-dominated, solitary, boring, and non-creative. In this light the effort was successful. The students left the class seeing IT work as creative and fun, a team effort, and obviously done by women. However, while accomplishing this goal the class showed the students an alternative image of IT work, not the diversity of it. Perhaps if more breadth of IT work options had been shown it would have inspired more of the students to think about computer oriented education and work paths. If this class is ever expanded to a non self-selected sample, this change would be essential.

4.3 Increased IT Skills and Self Efficacy

On the first day of class the students were asked several questions to determine their confidence level with computers and their perceived self-efficacy. Twenty-four percent felt they knew a lot about computers, 48% felt they knew [somewhat] a lot about computers. Fewer claimed they knew a lot about computer games (60%). Fewer still felt they knew very little about programming (80%). Several expressed some concern about being able to manage the programming aspects of the course. One student stated, "Learning to Learning to use programming to create a game." Another group of students expressed concerns with being able to finish the project in the time allotted. She said, "I don't know if I'll be able to finish a whole video game in 4 more days."

On this same day we asked the students what they hoped to learn. The most common answer was "To build video games." However, about a third of the students responded with the desire to learn more programming or computer skills. One student stated, "I hope to learn to program computers. Learn more about computers." Another student said she would like to learn, "How to make an awesome video game. I want to learn everything about technology or at least more than I did." Another student stated that she simply wanted to learn, "how to be able to fix minor problems on my family's computer."

On the last day of class we asked the students similar questions about competency and self-efficacy. Sixty-four percent of the students responded that they felt more confident about their abilities than they had on the first day, with 36% more stating they felt somewhat more confident. Ninety-six percent felt they had learned a lot from the class, 48% felt they understood more about computer programming than on the first day with an additional 40% stating they felt somewhat more confident in their programming abilities. Fifty-two percent felt they clearly understood how a computer game is built, with an additional 48% giving more cautious assent. Sixty percent felt very confident they could build a computer game in the future with an additional 24% feeling somewhat confident. Sixty-six percent felt they had enough time outside of class to complete their projects and had not felt time pressured. Perhaps most importantly, 76% claimed they would like to take a computer programming class.

Before the course began, parents were surveyed as to the hopes they had for the impact of the *Gaming for Girls* class on their daughters. The majority of the parents hoped that their daughters would learn how to make a computer game (32%) or how to program a computer (28%). When the parents were asked what they imagined their daughters would be doing in the class, the answer was unanimously that learning how to create computer games using programming tools. When asked what they imagined their daughters would be doing one parent stated, "My hope is that she learns programming skills and has a lot of fun doing it . . . I also hope that she might get an idea of the wide range of interesting things that can be done with good advanced computer skills." Another parent said, "I hope that she will gain a greater understanding of how computers work, especially how games are developed I imagine she will learn some basic programming skills."

One week after the course had ended parents were surveyed again. Drawing from summer data, 88% of parents felt that the camp might have influenced their daughters' perception of working with computers, as well as influenced their daughters' confidence level with computers. When asked what long-term effects the class has had on their daughters, slightly more than half of the parents said they had noticed some change. One parent stated, "She's a lot more confident with computers." A mother stated that her daughter:

> has always been fairly comfortable with computers but she talks more about getting a Dell or converting one of our Macs with a PC emulator. The camp was clearly a confidence booster–something immeasurably important to girls of this age group. Also, I think that exposure to the wonderful facilities, environment and resources of the University further reinforces the desire to do well in school and get into a good university.

The parents also felt their daughters had gained some technical skills. A mother of a student said, "She learned the basics of how games are made. She learned about various applications of computer technology and how computers are used in various areas." Another parent agreed by stating, "She learned basic techniques in game design theory, plus the operation of a role-playing game design application. It appears she also learned some things about teamwork."

Perhaps most positive were the responses to our third research question, did students gain computer skills and increased information literacy? Both parents and students felt that the class improved the computer skills of the students involved and in turn raised the students' levels of self-efficacy in regards to computer abilities. In this case, these complimented each other and worked in a circular fashion in that as the students learned more skills they made fewer mistakes, as they made few mistakes they grew more confident, and as their confidence grew they experimented more and thus learned more skills. The students learned several IT-based skills including basic programming, design, scheduling, and event programming.

5 Discussion and Conclusions

As mentioned in the previous section, one of our principal goals with this action research was to engage girls' interest in computing education and careers by engaging them in building their own games. This effort is both supported and challenged by the literature. There exists strong evidence to support the fact that students learn computer-related skills through engaging with designing and building their own tools and games. However, simultaneously, the evidence states that girls do not play games, giving both reasons found in culture and socialization, and reasons found in the games themselves—violence and poor characters. Therefore, to assuage this dissonance, changes must be made in middle and high school girls' culture and socialization that allow for more girls to play games and be supported in that action by their social networks, and/or changes must be made to games that realistically reflect girls' interests, not merely creating games that reify gender stereotypes.

Since the literature states that there are multiple causes for the lack of women gamers, the *Gaming for Girls* class was intended to address all of them (socialization, game violence, and female character). Middle and high school girls are at a stage in their lives when they are most reliant on their social networks for the creation of their identities. If those who posses the strongest influence over the lives and identities of these girls are unsupportive of their interest and interaction with technology, then they are likely to find alternate interests. *Gaming for Girls* provided an environment in which being interested in computers, programming, and games was both normal and natural. With this class, we sought to foster more formalized and sustainable support networks, such as clubs, mentoring programs, and tutoring programs that focus on technology that will either counteract the absence of other technical support groups or support those that may already exist. We also expected the social support for the girls' technological interests to extend beyond the class, at least into their families and close friends. In some cases the excitement of the class did translate, with parents almost universally attending the final day of class to witness their daughter's project demonstration. Several of the students also became repeat customers, enrolling in a second offering of the class. Several others convinced some of their friends who had not taken the class before to enroll. However, most of the students reported that their parents, siblings, and friends did not assist them with their projects at home (helping with class homework) leaving us wondering how strong the social support may have gone. In terms of using the class to address the other causes for why girls may not play games as much as boys (game violence and female character design), the essence of the class was to allow the girls to design their own games, reflecting their own images, characters, and storylines. When they created their own virtual environments, they created acceptable forms of competition, violence, and gender clues in characters, thus eliminating the cultural distaste as described by the literature.

Through the offering of such classes as the *Gaming for Girls* class, we believe we have the beginnings of a model that with repetition, critical reflection, and further development, may both encourage girls to become more engaged with games and encourage girls to use games in their gate-keeping function to provide a fast track toward IT skills, education, and careers.

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About the Authors

Dr. Andrea Tapia is an Assistant Professor at the College of Information Sciences and Technology at Pennsylvania State University. Dr. Tapia is a Sociologist whose work encompasses the study of both public and private complex organizations in which information and communication technologies have been used to reframe power relations within the organizational structure and culture. Dr. Tapia is a scholar with expertise in social research methods and social theory applied to the study of information and communication technologies (ICT) and their context of development, implementation, and use.

Dr. Magy Seif El-Nasr, is an Assistant Professor in the College of Information Sciences and Technology at Pennsylvania State University, where she is also the co-director of RAEL (Real time Aesthetics and Experience Lab). Dr. Seif El-Nasr's work focuses on building tools that facilitate and accelerate the development of 3-D interactive environments used for training, education, or entertainment. Her research interests include believable agents, interactive narrative, and integrating cinematic theories for enhancing visual 3-D experiences.

Ibrahim Yucel is a Ph.D. Candidate in the College of Information Sciences and Technology at Pennsylvania State University. He has four years of IT education experience, working for both the Morgan Academic Support Center for Student Athletes and The College of IST. He graduated with a BS in Information Science and Technology, with a minor in Digital Arts. He is part of the Real-time Aesthetics and Experience lab at IST working under Dr. Magy Seif El-Nasr researching games and education. He has also interned for Miramax Films' advertising department.

Joseph Zupko is a Ph.D. Candidate in the College of Information Sciences and Technology at Pennsylvania State University. His research involves sound in interactive applications, specifically unpredictability and managing pacing. Joe has a B.S. in Computer Science from PSU, six years of amateur and professional live technical theatre experience, and a longtime fascination with video games and the potentials of video game technology for more than just entertainment.

Edgar Maldonado is a Ph.D. Candidate in the College of Information Sciences and Technology at Pennsylvania State University. He has an undergraduate degree in Electronic Engineering from Simón Bolívar University in Caracas, Venezuela. Before entering graduate school, Edgar worked as a software support engineer for banking networks, with projects in Venezuela, Trinidad and Tobago, Panamá, Guatemala, and Cyman Islands. Edgar's research include policies of Open Source Software adoption in developing countries, education policies, and their influence in the development of knowledge based societies and economies and learning theories for information technologies.

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Reframing Online Games

Synthetic Worlds as Media for Organizational Communication

Ulrike Schultze[1] and Julie Rennecker[2]
1 Information Technology and Operations Management Department
Southern Methodist University, P.O. Box 750333, Dallas TX 75275
Uschultz@smu.edu
2 Rennecker Research & Consulting, P.O. Box 26263, Austin, TX 78755
julie.rennecker@mac.com

Abstract. Massively-multiplayer online games, or "synthetic worlds," represent a rapidly-growing industry with far-reaching social, technical, and economic implications. In this position paper, we draw on literature from anthropology, sociology, and film to challenge long-standing misconceptions of "games" and "work" and of "virtuality" and "reality" as dualisms that have obscured synthetic worlds from serious consideration by IS scholars. Building on this work and recent reports of businesses, nonprofits, entrepreneurs, and educational institutions incorporating synthetic worlds into their day-to-day practices, we argue that synthetic worlds represent a legitimate arena for IS research. We begin by offering a framework for characterizing the nature and structure of the social activity occurring in the diverse array of synthetic worlds currently available. Then we illustrate our position by considering synthetic worlds from the perspective of organizational communication, a substantive area with a rich tradition in IS research. Employing a genre lens as an illustrative example, we identify phenomena and raise research questions the IS community is uniquely positioned to explore.

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1 Introduction

"Synthetic worlds"[1] are graphically rich, three-dimensional, electronic environments where players assume an embodied persona and engage in socializing, competitive quests, and economic transactions with globally-distributed others. Also known in the gaming industry as "massively multi-player online games" (MMOGs), hundreds and even thousands of people play simultaneously, interacting with one another via their respective personas, called "avatars." Game themes and complexity range from war games, such as *World of Warcraft*, with pre-designed landscapes and player identities, to relatively unscripted electronic spaces, such as *Second Life*, which provide a platform and tools to support player-to-player communication and player-created content, such as buildings, clothing, videos, and artwork. The number of "virtual worlds" doubles approximately every two years [1] making it difficult to obtain an accurate count of participants, but estimates, of more than 90 million people world-wide, are considered reasonable [2]. In addition, within the past year, dozens of for-profit and not-for-profit organizations have joined in. The most widely reported examples are of corporate (re)presentations in *Second Life.* For instance, Sun Microsystems has created a virtual pavilion where they have hosted press conferences; Reuter's has established a virtual office with a full-time staff member; and National Public Radio show host John Hockenberry interviewed Kurt Vonnegut, both in avatar form, in front of an avatar audience.

While media and film scholars have long recognized synthetic worlds as a new class of mass media [3, 4], many business scholars have been dismissive of online games as irrelevant to both real life and scholarship [1, 2, 5]. One reason more information systems and communication scholars are not studying synthetic worlds is that the characterization of these social arenas as "games" and as "virtual realities" places them outside the bounds of what we traditionally consider to be legitimate arenas of inquiry, for example, "real" phenomena associated with productive "work"-like activities. However, organizational uses of these "game" environments as a medium for common business communication activities, such as press conferences, meetings, and public events, directly challenge the common notions of games and work and of virtuality and reality as mutually-exclusive social arenas, and scholars in anthropology [5], film [3] and game studies [6] have already shown that the game-work and virtual-real dualisms [7] are better understood as dualities [8].

Addressing the game-work dichotomy, Malaby [5] highlights that in industrialized Western societies, "play" and "work" are typically cast as distinct and incommensurate modes of human activity. In contrast to work, games are typically characterized as *separable* from real life, *safe* (inconsequential for real life) and *fun.* These perspectives that have been encoded into common parlance in such expressions as, "Relax, it's only a game!" Drawing on his own studies of gambling in Greece and other anthropologists' work in other societies, Malaby shows that these characterizations of games do not hold empirically. Game participation often plays an integral role in other aspects of social life, affecting identity, reputation, and social connections, in addition to any financial stakes that may be at play [6].

Scholars studying synthetic worlds also challenge the game-work dichotomy. Pearce [9] points out that player-generated content in virtual environments like *Second Life* is reflective of productive, value-generating activity, even though it is not performed for wages. Yee's [10] study goes a step further by showing how games can become indistinguishable from work. In one game, *Star Wars Galaxies*, players choose among "careers" including pharmaceutical manufacturing, bioengineering, and cooking. They then spend, on average, 22 hours per week performing activities, such as supply chain management, that parallel those of real-world professionals. Some players even experience burnout.

Similar to the habitual contrasting of games and work that has been encoded into our language and thinking, "much of the social commentary around virtual worlds implicitly reinscribes a split" [7] between "virtuality," which is associated with information, the mind, and fantasy, and "reality," which is associated with materiality and the body. Under closer examination, however, this split also implodes. In Taylor's [11] study of the creation and use of avatars in *DreamScape*, for instance, many *DreamScape* players said their avatar became a (re)presentation of their 'real' self. Indeed, some noted that their avatar was a truer reflection of their self [11]. Furthermore, some *DreamScape* players explained that their ability to see themselves (albeit in avatar form) as others do facilitated reflection on and exploration of their real-world personas.

We build on these authors' conceptualizations of game-work and virtuality-reality as dualities, or mutually constitutive experiences, to recast synthetic worlds as an emergent form of organizational communication both worthy and needful of IS research. Our aim is to bridge the mythical divide between technologies of work and technologies of play to show that information and communication technology (ICT) researchers have unique contributions to make to the design and policy discussions surrounding this new medium that is being increasingly integrated into (and consequently transforming) existing institutions.

We begin by presenting a framework for classifying synthetic worlds based on a synthesis of work by anthropologists, sociologists and film scholars. We then consider the diverse social arenas outlined in the framework from the perspective of communication, a social process that occurs in all synthetic worlds and that has been a focus of significant prior IS research. We employ genre analysis [12, 13] as a lens to illustrate how existing IS and organizational communication theory and analytic tools might be employed to generate unique research questions and insights that would not be surfaced by other disciplinary perspectives. We hope this demonstration and the questions we raise will stimulate IS research on synthetic worlds and the intended and unintended consequences of these new media on organizational work and life.

2 Synthetic Worlds

Synthetic worlds include a wide array of online games and virtual environments. In order to make sense of this new media space, we develop a classification scheme

(Figure 1) that characterizes synthetic worlds in terms of two dimensions: the game's rule structure [6] and its correspondence to reality [3]. Whereas the rules dimension sets up the distinction between "games" and "virtual worlds," the dimension dealing with the correspondence to reality sets up the distinction between "reality" and "fantasy." Combining these two dimensions orthogonally creates a space within which we identify four broad classes of synthetic worlds: simulation games, fantasy games, virtual fantasy, and virtual reality. Below, we discuss the two dimensions and then use specific examples to illustrate the four classes of synthetic worlds.

2.1 Rules: Progression to Emergence

The first dimension, represented by the horizontal axis, is the degree of structure built into the game code that the players experience as the game rules. Juul [6] differentiates between two approaches to structuring games and providing challenges to players[1]: *progression* and *emergence*. The progression structure is characterized by a highly scripted, typically quest-driven, narrative. The player has to perform a predefined set of actions to progress and succeed in the game. For instance, after successfully accomplishing a particular set of tasks, such as slaying a monster and finding a clue for locating a hidden treasure, a player will automatically advance to the next "level" and face greater challenges, but the player will also be endowed with greater "powers." The objectives, rewards, and outcomes of the game are clearly defined: the player knows the goal (to win), what winning looks like, and what it means with regard to rewards. Since the game designers control the narrative of progression, this structure yields much of the game's control to the designer. The player, in contrast, submits to the designers' narrative and logic of progression through role-play.

In the emergence structure, the game is specified as a small number of rules, which when enacted, yield a large number of game variations. Juul found this structure in sports, board, and strategy games, but it also applies to virtual reality and virtual fantasy environments such as *Second Life*. Virtual worlds with emergent structure are highly dependent on the interplay between the rules of the game, the game objects, and the players' interactions. Thus, while a game built on a progression structure does not *preclude* interaction between multiple players, a synthetic world built on an emergent rule structure *requires* player interaction to co-produce the content and action of the game. In contrast to progression-structured games, the control in emergent-structured games resides primarily with the players. In such "autoludic cultures," the play environments in which players feel empowered to make the game their own [9], the rules of the game increasingly take the form of social norms [14]. Furthermore, players have the choice of role-playing or of being themselves.

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[1] Even though Juul focuses exclusively on games, i.e., the left hand side of our framework, the poles he identified can be applied to synthetic worlds in general. We therefore adopt, but also expand on, Juul's conceptualization.

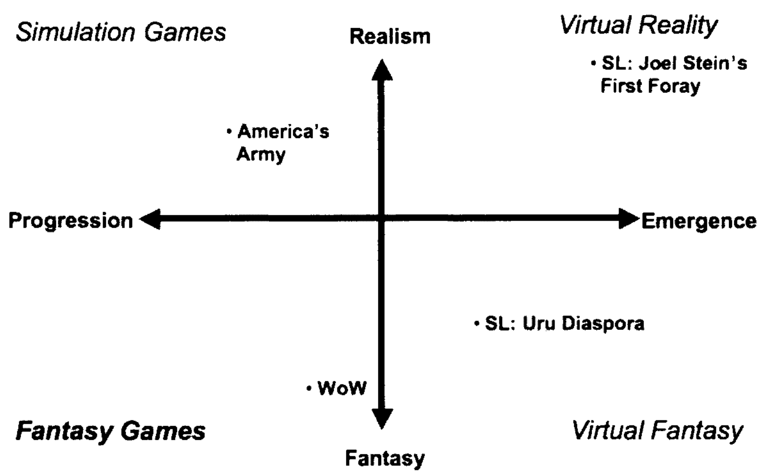

Figure 1. A Framework of Synthetic Worlds

Even though we have discussed only the opposing poles on the rules dimension, it is important to recognize that most synthetic worlds are located on the continuum between these two extremes. The multi-player nature of these gaming environments implies that the enactment of the game is a social accomplishment involving the material aspects of the game, its rules, the persistent player-constructed norms, and the actions and interactions between players [15]. Nevertheless, while the more game-like synthetic worlds are more conducive to players interested in "acting"–taking action or doing things–the more emergent worlds are more conducive to "interacting"–developing relationships with and in the synthetic world [16].

2.2 Realisticness: Realism to Fantasy

Another way of classifying synthetic worlds is based on the degree to which these worlds correspond with reality [3]. Whereas some games rely on representations and narrative structures that are obviously fantastical (*WoW*, *EverQuest*), others seek a close correspondence to reality (*America's Army*, *SOCOM*, *Madden NFL*). For instance, *SOCOM* supposedly represents life as a real Navy Seal, and *Madden NFL* is about the real National Football League.

In our framework, we call this dimension *realisticness*, which refers to the verisimilitude of the synthetic world's representation to real life. Given that games are enacted environments, and, therefore rely on players taking action, it is not enough to rate the realisticness of a game on the fidelity of its graphics and the correspondence of its landscapes and characters with real places and people. Instead, the credibility of the synthetic world's narrative structure and rules also form part of a game's realisticness. However, since believability is highly dependent on culture, another aspect of realisticness is the degree to which the game components (landscapes, characters, and narrative) correspond with a player's particular social reality. For instance, while social realism might be achieved by an American youth playing *America's Army*, the same would not be true for a Muslim youth in the Middle East. For the latter, the game *Special Forces*, published by Hizbullah, is likely to be more realistic.

Galloway stresses that a synthetic world's realisticness is a matter of degree:

> For instance, listening to music, ordering, pizza and so on in The Sims is most probably closer to the narrative of normal life than is storming an enemy base in *SOCOM*, despite the fact that the actual visual imagery in *SOCOM* is more realistically rendered than . . . *The Sims*. [3]

Realism, the highest degree of realisticness, is reached when the representation of the physical setting (the social context and the characters, as well as its narrative logic of the game) corresponds to the player's everyday social reality. It is only then, when "congruence" [3] between the in-world representation of life and the player's real-world experience is reached, that the synthetic world has the potential of becoming an extension of the player's world.

Fantasy, on the other hand, is a genre of storytelling that creates a make-believe world or an alternate reality that is credible to the player even though it is presented as separate and distinct from the player's material world. Thus, for fantasy to be effective, the fictional world must be a coherent, possible world that the player can imagine, cognitively inhabit and complete [6]. To create a coherent fantasy, game designers frequently draw on myths and legends for characters (trolls, fairies, wizards), settings (castles, dungeons), plot themes (quests), social structures (guilds), and artifacts (rings, gems, and magic swords).

2.3 Four Classes of Synthetic Worlds

Simulation Games are characterized by progressive rules and a high degree of correspondence with reality. Examples of games in this quadrant include *America's Army* and *SOCOM: U.S. Navy Seals*. Our example, *America's Army* (*AA*), is a "first-person shooter" game that relies on realistic graphics and real-life settings such that the visual and acoustic representation of combat is fairly authentic. In fact, its creator, the U.S. Army, uses the game as a recruiting tool, holding it up as a realistic representation of American army life, though it has been criticized for omitting the gore typically associated with combat [3]. Therefore, while realistic, *AA* fails to achieve the highest degree of realism.

With regard to rules, *AA* relies on progressive rules, including the completion of missions and the need for experience points to achieve levels that allow the player to participate in multi-player combat. The game also includes "Rules of Engagement" based on rewards (for killing enemies) and punishments (for friendly fire). Nevertheless, due to the multi-player nature of this game, some rules emerge through the play. Consequently, we locate *AA* in the middle of the game zone in Figure 1 for both realisticness and rule structure.

Virtual Reality worlds are characterized by emergent rules and a high degree of correspondence with reality. Examples of synthetic worlds fitting this profile are *There*, *Active Worlds*, and *Second Life* (*SL*). Given the amount of media attention *SL* has received, we use it to illustrate this class of virtual worlds. Except for one park-like landscape with instructional signs and objects designed to orient newcomers, the content of *SL* is constructed entirely by its members or "residents." Unlike simulation games, *SL* does not contain rules that set specific missions or quests for the residents. Instead, the rules regulate the *SL* economy. By granting ownership, copying, and modification rights to the individual creators of virtual objects and services (houses, clothes, and dances), Linden Labs, the creators of *SL*, has created a virtual economy that motivates residents to produce content that can be sold, rented, or licensed to other residents. Such transactions are completed in Linden Dollars, *SL*'s own currency, whose exchange rate fluctuates against the U.S. dollar. While some residents in *SL* make a 'real' living from their 'virtual' work, *SL* can be conceived of more broadly as an unstructured environment for interaction [16]. While some of this interaction is transactional, residents also spend a great deal of time engaging with other residents in social interaction and public events, for example, live musical performances. Whether one is engaged in economic or social activity, however, the rules are few, and the resulting game structure is very emergent.

To illustrate *SL*'s use as a social environment that corresponds closely to reality, we rely on *Time* reporter Joel Stein's description of his first foray into *SL* [17]. While his description highlights the ways in which *SL* differs from real life (avatars can fly), he also focuses on the ways in which *SL* mimics real life. For instance, as a "newbie," Stein meets Cristal Beese, a "hottie" avatar who takes him on a tour that includes dancing. In addition to the strong resemblance of Cristal's avatar to her offline self, Stein notes many parallels between their time together and a real-life first date, including waiting for her to get ready, getting to know each other, making out, and meeting jealous boyfriends. All of these examples suggest a high degree of realism, which is why we position this example of *SL*'s use close to the realism pole of our realisticness dimension. Depending on a player's use, however, *SL* can also be an example of virtual fantasy as we show in the next section.

Virtual Fantasy environments are characterized by a high degree of fantasy and emergent rules. For an example of a virtual fantasy world, we again present a specific case of *SL* use, the Uru Diaspora, described by Pearce [9]. The fantasy game *Uru: Ages Beyond Myst* had been shut down. After its closure, some of the 10,000 'homeless' *Uru* players re-constructed an exact replica of major portions of the original game in *SL*. This simulation of *Uru* within *SL*, itself a simulated world, included minutely detailed aspects of *Uru* such as swarms of fireflies that follow players around. In addition, a group of *Uru* and *Myst* players created a new world (called an "Age" in *Myst* and *Uru*) in *SL*, complete with puzzles, poems that contain clues, and machines to activate. Both the simulation of the original *Uru* and the new

Uru-inspired game are popular destinations for the residents of *SL*. Given the mix of fantastical contents of the *Uru* game in *SL*, as well as the introduction of the more progressive game rules typically associated with fantasy games like *Uru*, we locate the Uru Diaspora example in the middle of the fantasy zone and the middle of the emergent rules zone in our framework.

Fantasy Games are characterized by a high degree of fantasy and a progressive rule structure. Examples of fantasy games include *WoW*, *EverQuest*, and *Lineage*. We focus here on *WoW*, a game set in the fictional "Warcraft Universe," within which exist fantasy worlds like Azeroth (an earth-like planet that is home to most in-game species) and Draenor (home of the orcs). Many of the races and places in the game are based on fantasy worlds created by Tolkien. Thus, we position *WoW* close to the fantasy pole of the realisticness dimension.

The game rules revolve around players completing quests (such as fighting monsters). The successful completion of a quest is rewarded by money, possessions, and experience points, which allow the player to "level" (advance) to the next stage of game-play. While players can play solo at low to medium stages of play, more challenging play, especially "raids," require collaboration with other players. "Guilds" are one of the key game structures that provide the social cohesion to help coordinate such collaborative action. Given the high degree of sociality in this MMOG and the emergent social norms that develop around the designer-intended rules as the game is enacted [14], we position *WoW* close to the middle of our rules dimension to acknowledge the blending of progressive and emergent rules.

These examples are intended primarily to illustrate the diversity of synthetic worlds currently in use to provide context for our discussion of synthetic worlds as a medium for organizational communication.

3 Synthetic Worlds as Media for Organizational Communication

A variety of organizations are either experimenting with synthetic worlds or have incorporated them into their day-to-day practice. Educators are integrating online game environments into the classroom (the ECON 201 course at the University of North Carolina Greensboro) while researchers are designing and using games to test social theory (the "Synthetic Worlds Initiative" at Indiana University). Apparel companies, hotel chains, and automakers have all taken advantage of synthetic worlds as a new marketing outlet, and at least one organization, PA Consulting, has integrated *Second Life* into its recruiting process, giving potential recruits a virtual tour of its London headquarters and globally-distributed centers [18].

Many of the corporate appropriations of synthetic worlds, however, have been for the purpose of communication, whether with customers, collaborators, or even within their own organizations. Indeed, Sun Microsystems' chief gaming officer, Chris Melissinos, was quoted as saying that Sun's exploration of *SL* was to understanding "what is going on in terms of the next mode of communication" [18]. IBM seems to have similar interests. They used *SL* to host a reunion [19] and are reported to be on the verge of holding regular meetings of globally distributed managers in a secure *SL* conference room [20].

Communication in synthetic worlds has also been a focus for business innovation. Metaverse Technology, which developed a suite of communications and collaboration tools to facilitate business meetings and other gatherings in *SL*, recently won second place in a *SL*-sponsored business plan competition [21].

All of theses examples of the appropriation of synthetic worlds for organizational communication map onto the virtual reality quadrant of our synthetic worlds typology (Figure 1). In other words, they all appear to be striving for a high degree of congruence with the 'real' world of business and organizational work. This raises questions about the more fantasy-oriented synthetic worlds and their appropriability for organizational communication. The researchers and educators mentioned earlier are employing more fantastical worlds–the bottom two quadrants of Figure 1–and game proponents argue that online game participants learn valuable business skills regardless of the degree of realism [2].

Can we anticipate that, over time, fantastical worlds may be added to the corporate world's game repertoire? Both Sun Microsystems and IBM representatives have indicated that they expect their organizations will build their own synthetic world platforms in the foreseeable future (personal communication). If they proceed with these plans, will they limit those worlds to replications of the material world or might they consider allowing more fantastical elements? If so, how might business meetings change if participants were able to take on the form of a dragon, a wizard, or an elf? How might the role-playing (or play acting) that is typically associated with fantasy games and virtual fantasy environments impact interactions among colleagues or with customers?

Information systems and computer-mediated communication scholars are uniquely poised to address these and related questions, providing guidance to organizations about the effectiveness of current synthetic world appropriations and the potential for new uses as well as technology design features and social practices that could enhance or detract from their intended objective(s). To demonstrate, we will revisit our framework through a genre analysis lens, one of many existing IS perspectives on organizational communication that could be used to offer new insights into the implications of using synthetic worlds as media for organizational communication.

3.1 Synthetic Worlds through a Genre Lens

The notion of genre from rhetoric and literary criticism [22] has been useful for studying patterns of communicative action, and the related social processes, in other electronic media [12, 13]. Viewing organizational communication as communicative acts structured by genres, that is, socially recognizable communicative forms, studies have identified a host of business-related genres including meetings, reports, memos, and letters of recommendation [22]. While genres do not dictate how members of an organization (or community) interact, they do create a set of expectations about the purpose, content, format, place, and time of the interaction. More succinctly, these expectations can be characterized as the why, what, how, where, when, and who of organizational communication [13].

In this section, we apply the six genre dimensions to synthetic worlds in order to highlight their affordances and their implications for organizational communication. By so doing, we raise questions and concerns that IS research is uniquely positioned to address. We start our discussion with those dimensions of the genre framework along which synthetic worlds fundamentally distinguish themselves from more established business media (the how, who and where), as these have implications for the other dimensions (the what, why and when), with which we will close this section.

How: The how dimension deals with the medium, format, and language use in the communicative act. Given that synthetic worlds represent a new medium for organizational communication, we focus on the affordance that presents the most dramatic departure from more 'traditional' media, namely *embodiment*. In synthetic worlds, participants take on a bodily form (their avatar), and objects obey physical laws such as gravity and opacity. It is through embodiment that people, places, and things are made concrete and tangible, thus enabling an immersive experience. Specifically, embodiment enables "practices of the body" [11], such as body language and facial expressions, which are generally associated with more material worlds. Embodiment also reintroduces placement, perspective, and presence into mediated communication.

Taylor's [11] research on *DreamScape* explores the significance of embodiment in online social life. She highlights that physical proximity (or distance) between avatars and their relative orientations toward each other–facing towards or away from each other–carry information and meaning, expanding the modes of expression available to players beyond the seemingly 'lean' chat used explicitly for communication. Thus, embodiment expands players' expressive capabilities.

Unlike real-world non-verbal communication, however, the body language in synthetic worlds is purely intentional and completely under the players' control. Indeed, the players not only have to use a command to 'turn on' a facial expression or a physical pose, they might even have to program it first. Thus, there are no unintended frowns, sighs, or crossed arms that could give away a communicator's unconscious reactions. Instead, non-verbal communication in synthetic worlds is more likely to be as strategic and self-monitored as verbal communication. This raises several questions. Under what conditions and to what degree are non-verbal cues important to communicators in synthetic worlds? Specifically, when and why will communicators put effort into changing their facial expressions or poses and programming unique ones?

Some researchers have decried the rational, cognitive, and linguistic representation of events and human experience in information technology applications [24] because they fail to capture the role of the body in action and interaction with people, things and places, as key to human development and learning [25]. On the one hand, it seems that synthetic worlds could address this concern by enabling the embodied, physical dimension of cognition that people gain through their interaction with the 'real' world. On the other hand, the form of embodiment offered by synthetic worlds differs in that the actions and interactions it supports are not bound by the physical constraints of the real world, including the experience of (social) time and distance or the finality of death. This raises questions about the efficacy of this form of embodiment with respect to cognition and learning. In what ways do bodily experiences gained in a synthetic environment differ from those gained in a material environment? How does the degree of congruence between the limitation-constrained 'real' and the unconstrained synthetic world impact embodied cognition and learning?

Another way embodiment might influence cognition is by affording perspective. Players can move to achieve a shared perspective or, by observing others' placement, can appreciate their relative perspectives. This suggests that synthetic worlds might offer new opportunities for achieving shared perspectives. Building on Boland and Tenkasi's [26] notions of perspective making and perspective taking, we might explore how placement of avatars, vis-à-vis others and objects, can be used strategically, for instance, to reach agreement in organizational decisions.

Who: The who dimension addresses expectations regarding participation in a communicative action (for example, who will initiate the communication, who will receive it, what is the relationship between the communicators, etc.). Applying the who dimension to synthetic worlds, and especially the affordance of embodiment, we focus our discussion here on presence, placement, and self-representation.

As Taylor puts it, "bodies root us and make us present, to ourselves and others" [11, p.41]. An avatar indicates that there is a real person—the avatar owner/player—present and actively engaged with the world, making it impossible to forget or be unaware of others that are inhabiting the space, as can happen in audio-conferences and video-conferences. In fact, some synthetic worlds signal when a player is "away from keyboard (afk)." For instance, avatars in *SL* go to 'sleep' (their heads drop forward), when the people they represent are not actively managing their presence.

However, presence is not merely established through the creation of an avatar, "it is instead through the *use* of the body as *material* in the dynamic performance of identity and social life that users come to be 'made real'" (11 p. 42 (emphasis as in original)]. Thus, by placing themselves in relation to others, players engage not only in social activity but also express who they are in relation to others through their relative proximity to and actions toward others.

Another aspect of perspective revolves around the participants' ability to see themselves the way that others see them, creating a reflexive environment in which players can learn and experiment with their concept of self [11]. Depending on the particular synthetic world, embodiment affords players considerable control over their (re)presentation of self. Avatars do not have to be simulations of the player they represent. In fact, they do not even have to be in human form. The consciously chosen and/or purposefully designed nature of avatar bodies allows participants to focus on specific aspects of their character, emphasizing a mood or competence and downplaying other characteristics. As Juul [6] highlights, virtual spaces and avatars—just like cartoons—are made effective by de-emphasizing the appearance of the physical world in favor of the world of ideas and concepts. Thus, omitting physical details (the extraneous information that is a necessary part of real life) controls the information "noise" that can be distracting in a rich media like video. It is therefore not surprising that some participants in *DreamScape* reported that their avatar was a truer representation of their selves than their own bodies [11].

A player's choice of avatar, however, is likely to have significant implications for the nature of his/her interactions with people and things in the synthetic world. For instance, one *DreamScape* player noted that a human avatar face tended to afford deeper and more meaningful interactions with others than did animal faces [11]. This raises important questions about the appropriateness of avatar designs for organizational communication. In many gaming environments, the participants' real identity remains hidden as they get to know each other as characters in a game. Indeed, at game conventions where players actually meet face-to-face they typically relate to one another by their in-game names rather than their real ones [14]. In organizational settings, however, participants are likely to deal with and get to know one another in both material and synthetic worlds in parallel, raising questions about the opportunities and risks of one's avatar choice. What if the CEO dons a dragon avatar for a shareholder meeting? Or an analyst, with a girl-next-door look in 'real' life, represents herself as a Lara-Croft-like avatar, believing it to be an expression of her true self? How will these avatar choices affect organizational communication overall, the communicator, and the audience? When and what types of avatar-based forms of self-expression enable (or disrupt) organizational communication?

Where: The where dimension addresses expectations related to the location of a communicative action. For instance, the genre "team meeting" creates an expectation of a location conducive to collaboration. The embodiment supported by synthetic worlds allows interactions to be "staged" [27], or purposefully placed, just like a team meeting in the material world. Similarly, spontaneous "in-world" interactions also occur in a 'place' that forms part of the context for interaction.

There is little prior research that specifically addressees the implications of place for social behavior in synthetic worlds, but the field of ecological psychology [28, 29] and Goffman's [27] studies of face-to-face interaction have both demonstrated how social actors actively monitor, respond to, and even engage the setting in material-world contexts. However, prior studies, documenting the "psychological immersion" synthetic world participants' experiences [1, 14], suggest that synthetic world settings might similarly influence in-world social activity. Considering again the dimensions of Figure 1, what role might the realisticness of the setting have on the communication that occurs there? How might a team meeting in a fantastical setting, such a medieval castle or futuristic city, influence the meeting process and outcome? Under what conditions might such non-traditional meeting spaces be conducive to 'out-of-the-box' thinking and innovation? Under what conditions might they be counter-productive by either distracting participants or enticing them to engage in behavior (say, the treatment of women) consistent with the synthetic setting but unacceptable in a modern organization? Furthermore, what setting characteristics either facilitate or complicate the enactment of particular organizational communication genres?

What: The what dimension focuses on the content of the communication. Since we have already touched on some of the content issues relating to avatar choice–that a non-human form tends to generate more playful and superficial interactions between players [11]–we will focus on the implications of forging a new genre of embodied organizational communication, which forces participants to continuously confront questions about the content's authenticity and factuality. As Taylor and Kolko [30] note, however, the need to continuously negotiate the fact-fiction and authenticity-artificiality boundaries are not unique to synthetic worlds but are endemic to Internet-mediated communication, which mixes authentic information with staged fictions, destabilizing knowledge, relationships, and identity.

Nevertheless, their research on *Majestic*, a highly innovative game that sought to remove the game-space boundaries by, among other things, blurring the lines between content based on authoritative knowledge and conspiracy-theories endorsed by the fringe, serves as a cautionary tale about some of the pitfalls of relying on a genre-boundary defying strategy. For instance, the game mixed fictitious and factual websites, intruded on players' off-line lives though the use of emails, phone calls, and faxes to convey game-related information, and incorporated real-world events, such as those of September 11, 2001, into the game's narrative. The authors claim that the game ultimately collapse–10 months after its launch–under "the weight of its own heightened toying with truth" [30, p. 511].

These content-related issues prompt questions such as how participants might signal to others when their actions and words are more game- than work-like, more artificial than authentic, or more factual than fictitious? How best is such meta-data communicated? And what are the implications for using information obtained in a conversation tagged as "artificial"?

Why: This dimension relates to the socially recognized purpose of the communicative act, and it serves as a way of drawing together and aligning the other genre elements into a coherent whole. At a high level, each quadrant in our synthetic worlds' typology (Figure 1) can be viewed as a genre or genre system,[2] distinguishable by its predominant purpose. For instance, the purpose of "games" (left two quadrants) is acting, whereas the purpose of "virtual environments" (right two quadrants) is interacting. Furthermore, the differentiating purpose of fantasy worlds (bottom half) is role-playing, while the predominant purpose of realistic worlds (top half) is practice.[3] Even though these purposes are not mutually exclusive, but rather inextricably intertwined, the why dimension does provide the participants with a set of high-level expectations around each game-type's purpose, which ultimately guides their own communicative acts as well as their interpretation of others' communication. The questions raised by the why dimension concern the

[2] Genre systems are "a series of genres comprising a social activity and enacted by all the parties involved" [13: 16], such as meetings or collaborative authoring. In fantasy games, players rely on a host of genres ranging from in-game play to back-channel whispering to fan-generated game websites.

[3] "Practice" is used here to mean both the repetitive activity associated with learning and the enactment of one's professional self.

opportunities, risks, and limits of blurring the boundaries between fantasy worlds (or genres of play) and realistic worlds (or genres of authentic communication) illustrated by *Majestic*'s demise discussed earlier. Is it possible that the fantasy game genre's purpose and its related expectations for communicative action are so orthogonal to the expectations of organizational communication, that combining them would result in an unstable genre that is likely to collapse, just like *Majestic*? In other words, at what point does it become either impossible or too burdensome for a participant in embodied organizational communication to constantly negotiate and disambiguate communicative acts in such a genre mix?

When: The when dimension relates to the temporal expectations of a communicative act. It includes both deadlines and the sequencing of communicative actions into a coherent system. "When" questions related to the appropriation of synthetic worlds for organizational communication include when and how interactions in synthetic worlds might be integrated into or interleaved with more traditional genres such as audio conferences, email, or discussion boards? Are there situations when synthetic worlds should be avoided or others when they might be preferred? How might interactions in different types of synthetic worlds, such as a simulation game, a virtual meeting in *Second Life*, and a brainstorming session in a fantasy world be sequenced to achieve the desired outcomes?

3.2 Synthetic Worlds: Limits

It is no accident, of course, that all of us are not already using synthetic worlds for our day-to-day interaction. All media have limitations. In their current forms, synthetic worlds still require significant investments of time and attention to build one's avatar, to learn how to participate in the world, and to develop proficiency at moving and interacting within the environment.[4] In addition, synthetic worlds still have many technical constraints. Despite announcements of large-scale events such as press conferences and concerts, processing capacity and bandwidth limitations constrain the number of avatars that can be gathered in one location for an event. The lack of audio support for voice communication in most synthetic worlds[5] also means that most communication occurs through chat-style typing, which may be considered both a feature and a limitation. Chat allows many people to communicate simultaneously, it provides a record, and it allows players to hide identifying characteristics such as gender, but it is also cumbersome.

In addition, despite the affordances of embodiment, as compared to traditional "disembodied" organizational communication media (email, audioconferencing), Taylor [11] also observes that a game design can constrain full expression. In many cases, users push back and invent creative ways of achieving their communicative goals through positioning and movement of their avatars to achieve their desired

[4] At Sun's press conference in Spring 2006, many attendees had not yet learned how to make their avatars sit in the pavilion seats—a source of humor and confusion (private communication).

[5] Second Life started beta testing voice chat in March 2007 [31].

communicative goals, but the expressive constraints of any particular world would need to be taken into consideration during an analysis.

4 Conclusion

In this paper, we have provided an overview of the psychologically immersive online game environments known as "synthetic worlds" or "massively multi-player online games" (MMOGs) and drawn on research from other disciplines to show their broader social implications. A particular aspect of these worlds that remains unexamined is their use as media for organizational communication, a phenomenon the IS community is uniquely positioned to explore. Applying a genre lens, we offer a few broad categories of questions to provoke thought, discussion, and IS research. We look forward to future research that studies synthetic worlds as embodied organizational communication genres.

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About the Authors

Ulrike Schultze is Associate Professor in Information Technology and Operations Management at Southern Methodist University. Her research focuses on the impact of information technology on work practices and she is particularly interested in knowledge work. Her more recent research projects are in the area of Internet-based technologies and their implications for customer co- and peer-production. Dr. Schultze frequently relies on multi-method research designs, which include ethnographic observations, interviews and surveys. Her research has been published in, among others, *ISR, MIS Quarterly*, and *Information & Organizations*. She has served as an Associate Editor at *MIS Quarterly* and *ISR*.

Julie Rennecker is a qualitative researcher in private practice, studying social influences on the design, use, and consequences of information and communication technologies in practice. Prior work includes studies of virtual teams, flexible organizational designs, and instant messaging with particular emphasis on unanticipated consequences related to the interplay of online and offline actions and conditions. Her work has been published in *Information and Organization*, *The Handbook of Information Systems Research*, *Interdisciplinary Studies of Work Teams*, and presented at various conferences including Academy of Management, INFORMS, CIST, and HICSS. Her current work explores the role(s) of virtual worlds in for-profit organizations.

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Virtualizing the Virtual

Neil C. Ramiller
School of Business Administration, Portland State University
P.O. Box 751, Portland, OR, USA 97207-0751
neilr@sba.pdx.edu
WWW home page:
http://www.sba.pdx.edu/faculty/neilr/nraccess/webpage_main.htm

Abstract. This essay advances a supplementary definition of "the virtual" that is aimed at helping our research community speak more clearly to the organizational changes and the place-time reinventions taking place in connection with the virtual in the more customary sense(s) of that term. The intent in linking the issue of definition to organizational transformation is not to make proposals about the specific forms, functions, and reinventions that might, or ought to, appear, but rather to reflect on the *processes* through which such changes, whatever their character, come about. Adapting Deleuze's conceptualization of the virtual, I extend virtuality to include the imaginary and fictitious. The focus, in particular, is on the kind of fiction that, in Latour's phrasing, is "seeking to come true"; thus, our interest is in the fictionalizations in which real actors engage as they struggle discursively to construct their future realities. This calls for attention to the social and political context and, more specifically, to the manner in which the privileges of "author-ity," for fictionalization, impact what is actualized as organizational structure and practice. The paper concludes with a consideration of the implications for research practice of viewing IT-enabled change, like that which is producing virtual work and virtual organizations, as a form of authorship.

1 Introduction

it cannot be denied that many stories, especially those called novels, may be regarded as possible, even if they do not actually take place in this particular sequence of the universe which god has chosen . . .

Leibniz, quoted by David Harvey [1]

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The conference's Call for Papers employs some familiar characterizations of the virtual, but also advances as one of the possible topics for discussion, "defining virtuality." In this paper I propose to amplify and extend the definition of the virtual (and virtuality) in a way that can help us speak more clearly to two of the other suggested topics, "virtuality and changing organizational form and function" and "reinvention of place and time associated with virtualization." The intent in linking the issue of definition to these latter concerns will not be to make proposals about specific forms, functions, and reinventions that might, or ought to, appear, but rather to reflect on the *process* through which such changes, whatever their character, come about.

What I aim to do is to take the concept of the virtual beyond the confined reach of its usual realist connotations and, as such, beyond the boundaries of everyday space and time, to add a dimension that extends the virtual to include the imaginary and fictitious. This is not nearly as outlandish as it might sound. Seeing why will depend on understanding the relationship that fiction, in the context of organizational innovation, has to the (re)constitution of the future—including reinvention and change of the sort that the Call for Papers invokes in the name of the virtual.

The discussion proceeds as follows. We begin by reviewing the customary meanings for virtuality, and then introduce the additional dimension, drawing on the philosopher Gilles Deleuze's treatment of the virtual. Next, we consider the connection between this latter kind of virtuality and concepts associated with the discursive and narrative construction of reality. With these philosophical foundations in place, we turn to the social and political context in order to consider how the privileges of author-ity, when it comes to creating effective fiction about the future, impact what is in due course actualized as organizational structure and practice. Application to virtuality in the more conventional sense (for example, virtual work and virtual organization) is weighed. The paper concludes with a preliminary consideration of the implications for research practice of viewing IT-enabled change as a form of "authorship."

2 Extending "The Virtual"

2.1 The "Virtual" in the Usual Sense(s)

The most prevalent notion of the virtual these days is probably that associated with the phrase "virtual reality." And, this meaning has some obvious relevance in studies of organization and work, because of the way in which the electronic mediations that technology provides, for communication and interaction, simulate older, material processes in various ways. In short, people can be said to experience the virtual when they "work in cyberspace"—although, of course, this really entails the skilled deployment of delegates (documents, images, etc.) by means of the technology, rather than a literal occupation by people of cyberspace. Virtuality, of course, has other meanings in the organizational context, which are linked to the broader capabilities and effects of information technology. The term refers, for example, to the significantly increased dispersion of work tasks, both geographically and temporally. Also, as reflected in the concept of "the virtual organization," virtuality describes the reordering of relationships between workers and organizations and among organizations. In particular, what makes the virtual organization virtual is the systematic and IT-enabled shift of many tasks and exchanges to a position outside the boundaries of the firm's vertically-integrated structure and away from the traditional employment contract.

These experiential, spatial, temporal, and organizational-structural aspects of virtuality are without question important to understand, and will likely occupy much of the participants' attention at the Portland conference[1]. But also of interest is *how organizations and society are creating and entering* this new world of the virtual. It will be the argument in this essay that virtuality, in an expanded sense, is crucial to this very accomplishment.

2.2 The "Virtual" Extended

What we want to consider is the virtuality reflected in the anticipations and imaginings of the future that precede and shape the actions that people pursue in order to create that very future. This is akin to Heidegger's concept of *projection* [2], which is commonly rendered as "a throwing of existence ahead of itself" [3]. Deleuze, we find, quite literally labels this *virtuality*. Deleuze's virtual, however, does not represent the merely possible—which would embrace the myriad (indeed, arguably infinite) worlds entailed in the quotation from Leibniz with which this paper opens. Rather, the virtual is a part of what is real, but not (yet) actual. According to Deleuze, then, mere possibilities must undergo *realization* in order to become real, while the virtual, being already a part of the real, undergoes *actualization* in order to produce the objects of the everyday world [4][2]. Where a technological innovation is concerned, then, the virtual represents for the social collective a "discursive desire" that arises in the cultural circumstances of past and present time that precedes and anticipates the "coming-to-presence" of the focal technology and practice [4]. Hence, the virtual is (per Roe) "not quite the future as such but preceding it and yet still being ahead of the present."

The virtual, moreover, is not simply anticipatory and prescient, but also generative. Because virtuality can be said to help produce the corresponding actuality, a technological innovation can, in an apparent (but only apparent) paradox, be seen necessarily to precede itself. Bucciarelli invokes this phenomenon, in his study of engineering design, when he observes that for much of the design period, "the object the language points to does not exist" [5].

[1] There are additional meanings from physics (e.g., virtual image) and computer technology (e.g., virtual memory) that are farther afield from the concerns of this conference.

[2] Like Proust's characterization of the past, the virtual is "real without being actual, ideal without being abstract." (Noted in the Wikipedia entry for "virtuality"; original source is Volume 7 of Proust's *Remembrance of Things Past*, "Time Regained.")

In due course, actualization does take place; that is, the technological innovation becomes an object and practice in everyday space and time. However, the virtual does not vanish at this point but rather *inheres* in the object that has come into being. This persistence of the virtual is necessary because actualization—or what many of us would liken to "reproduction" [6]—is on going. The continued existence of the actual technology depends on the persistence of the idea that the virtual contains and conveys. Moreover, there is also a "continuous iterative structure" or "virtual-actual circuit" [4] through which the virtual takes up and incorporates the specificities of its actualization and evolves along with it. As such, the virtual is not once-and-for-all but rather dynamic, in the same way that the world it helps to generate is dynamic.

2.3 The Virtual through Narrative

The virtual "describes an unsettled region, a zone of potential, that nonetheless contains the real material or content, and above all the idea" [4] of what will become the technology-enabled innovation in organization and/or practice. The actual emerges from the virtual through struggles within the larger culture to formulate in depth and richness of specificity this "discursive desire." As such, a key aspect of the overall collective endeavor is "a struggle for language which would be adequate to the [very] task" [4] of discursively constituting the virtual. Bucciarelli's observation, noted above, also invokes the central place of language in shaping the coming-to-presence of the future and actual world. Here, we can find a link between the virtual, in this Deleuzian sense, and the role of narrative in producing socio-technical reality.

That narrative helps to represent and to make sense of passing and prior events is a familiar idea [7-9]. Moreover, action itself is seen to take on narrative qualities [10]. The narrativity of action is at the root of historical understanding, because the traces of action (in documentary evidence, eyewitness reports, direct observation, and so on) can be understood as, and rendered in, narrative form. But narrative is also at the foundation of projected future action, a principle that Fairclough has identified through reference to "imaginaries" in discourse [11].[3] This points to an inversion of the *action-then-account* relationship involved when people <u>write</u> history; this is an *account-then-action* relationship that is fundamental to what happens when people produce history.

Bruno Latour offered a simple but compelling illustration of this inversion, at an IFIP 8.2 meeting a decade ago [12], when he spoke about a pair of acquaintances planning a get-together in London. In making their arrangements, in effect, they *co-authored a story*. Their collaborative narrative enlisted an array of actors (human and non-human), outlined a sequence of activities, and assigned a variety of essential commitments to themselves and the other actors. Their story, then, became the basis for the actions that would create from the plan a reality in fact.

[3] "Discourses not only represent the world as it is (or rather is seen to be), they are also projective, imaginaries, representing possible worlds which are different from the actual world, and tied in to projects to change the world in particular directions." [11]

This simple tale points to the profound importance that narrative plays in the constitution of the future. We tell stories not only about our past and present, in order to make sense of where and who we are today, but also about the future, in order to bring into being the kinds of futures we desire [13]. Indeed, within constraints people and organizations enact their futures based on narratives of action, events, and identities yet-to-be [14,15]. So where a more ambitious undertaking is involved, such as a technology-related organizational change project, the technological innovation in question is quite literally "a fiction seeking to come true" [16]. The manner in which it does so entails a dialectical process in which cycles of discourse and material action transform the world, both as it is built and as it is experienced [1,11].

In certain forms (for example, science fiction), storytelling about the future may entertain only *the possible*, notwithstanding that it may have larger illuminative, hortatory, or moralistic purposes. On the other hand, narrative offered in the service of *the virtual*, in Deleuze's sense, is generative in intent and effect. In short, it aims for actualization. It is certainly and necessarily fiction, as Latour implies. However, it entails a kind of *fictionalization* that is intended to pull the world toward a particular future state. In a temporal reversal of the usual sense of the word, this fictionalization precedes and is, indeed, a prerequisite to actualization.[4] But of course, the relationship is more complex and nuanced that this. Although the fiction is indeed deployed ahead of action, the production of such fictional narrative, as an on-going and adaptive vehicle for conveying the virtual-actual circuit, iteratively reflects upon and takes up the object reality that is produced as actualization unfolds.

3 Virtualizing the Virtual: Authority, Participation, and Voice

To contest a dominant notion of spatio-temporality is to contest the process that produced it and to redefine, in thought, alternative possible worlds of being.

David Harvey [1]

3.1 Occupying the Virtual

If the virtual is an "unsettled region" (see Roe's observation quoted above), then the fictionalization we are considering is inherently a subversive challenge to the established order. As such, it works to draw the participants exposed to it away from the familiar and toward a condition of *liminality*, a twilight zone between the taken-for-granted present and an unknown future.

Liminality means to be situated on a threshold or in a transitional state. Appropriated and enriched by anthropologists (notably Victor Turner), liminality has come to encapsulate transitions, such as rites of passage, in which the normal limits on perception and cognition are transcended, in which established social relations and conventions are relaxed, and in which given identities dissolve [17,18]. The

[4] Fictionalization usually means to use an actual event as the basis for creating a piece of fiction, such as a play or novel.

attendant ambiguity and disorientation make liminal territory dangerous, but the associated indeterminancy is also rich in opportunity.

In the context of technology-enabled organizational innovation, the experience of liminality is part and parcel of the encounter with the virtual. The anticipation that occurs at the threshold of actualization induces: *liminality in time*, between the known present and the uncertain and to-be-transformed future; *liminality in place*, because of the undoing and redoing of the organizational context of artifacts, structures, and practices; and *liminality in identity*, as interests, roles, expectations, and skill demands are displaced and shifted.

These modes of liminality characterize all innovation, to some degree. Certainly, where the innovation in question involves the "virtuality" of virtual work and virtual organizations, these modes can be especially worthy of notice. The often-cited effects of engagement with "cyberspace" in translating work in space and time, and on transforming the conceptualization and representation of self, speak to this fact. But it is also important to recognize that such effects are not unique to virtualization in the more conventional sense.[5] Hence, the "virtual" of virtual reality, virtual work, and virtual organization—or what I shall henceforth, for convenience, call "the electronic-virtual"—depends for its actualization on the narrative virtuality we are considering here. The reverse is not the case.

In entertaining the three modes of liminality, and especially the unsettling of identity, we are compelled to move beyond the largely philosophical issue of the relationship between Deleuzian virtuality, discourse, and actualization and begin to entertain the political. This is so, because while the experience of liminality motivates actors to seek resolution through the actualization of a new (and relatively) stable terrain, it can also place those actors in complex, ambiguous, and contentious relationships with one another.

3.2 The Politics of Virtuality

In the unsettled, liminal region of the narrative-virtual, the fiction that is—or rather becomes—a real organizational innovation reflects, for a considerable period of time, an uneasy and dynamic mix of discourse and material activity. Precisely because of the power that discourse has in constituting reality,[6] the narrative-virtual becomes the site of social engagement, as heterogeneous interests struggle with, and for, position and identity.

We must also consider situations in which the expected engagement, and even conflict, does not take place where we might well expect to see it. In these circumstances, the pressing question becomes why certain voices are missing, among those who have a stake in those fictionalizations that point toward the future world. Where the creation of the electronic-virtual, specifically, is the focus of people's

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[5] Roe, for example, uses the historical emergence of photography in the 19th century to illustrate virtuality in the Deleuzian sense [3].

[6] "In sum, texts have causal effects upon, and contribute to changes in, people (beliefs, attitudes, etc.), actions, social relations, and the material world" [11].

discursive attention, the potential scope in the reconstitution of place, time, and identity is such that the issues of who has "voice," and why that is so, become crucial.[7]

These issues are crucial not merely from the point of view of sociological understanding, but also when it comes to practical accomplishment. Harvey remarks [1], "The preservation or construction of a sense of place is . . . an active moment in the passage from memory to hope, from past to future."

Such construction creates an on-going need for adequate "narrative structures" [1] not just for making sense of the present and past but also for fictionalizing the future, in the sense that Latour invokes (see the earlier quote). This is the activity that produces the all-important imaginaries [11] that carry actors to the threshold of the narrative-virtual and henceforth into actualization. As Harvey, quoting Bachelard, states, "Imagination separates us from the past as well as from reality: it faces the future" [1].

In entertaining the question of "adequacy" in imaginative and productive narrative structures, however, it is necessary to recognize that an organization's efforts to fictionalize the future can be better or worse. The *effectiveness* of the fiction is in part a function of who has voice and access to audience; who, having voice, is entitled to represent or speak on behalf of others; and what implications follow from leaving others bereft of their own narrative. As such, the roles that authority, the structure of participation, and the privilege of representation play in the constitution of the narrative-virtual are central issues for research.[8]

When it comes to the electronic-virtual, there is the commonly held view that the associated innovations in work practice are linked to significant transformations of space and time. In this context, while it is true that "actors are . . . 'concretely producing their own spacetime'"[9] [1], they do so subject to constraints that have been actualized by others. Such constraints arise, in part, through the design of the very technologies used in carrying out the work and mediating workplace interactions, as well as through directed changes in the organization of the work itself. In this we truly witness the "*social* 'production' of space and time" [1]. These outcomes are obviously of considerable interest to scholars of the electronic-virtual, but here we recognize that such designs (and constraints) originate first in the narrative-virtual, to which access in a given social order is uneven and unequal.

The *privilege of narrative* is constructed and perpetuated to an important degree through and within the narrative process itself, which assigns the requisite authority

[7] Harvey points in particular to the way that "time-space compression" leads to "rootlessness" and "the fear of a loss of identity (understood as an identification with place) as the space-time coordinates of social life become unstable" [1].

[8] I am indebted to a reviewer for pointing out that the effectiveness of such fiction must also depend on qualities associated with the content, such as verisimilitude. Here, literary scholarship is likely to be a helpful guide in evaluating effectiveness.

[9] Latour's story, recounted earlier, includes examples of the two participants employing shared understandings and producing joint specifications of space and time. Their naming of specific elements of space and time is integral to creating the prospective and generative "map" that helps to produce the future action.

as a right of *authorship*. Moreover, in performing its generative function, the narrative-virtual positions not just those who participate as authors (or designers) but also other actors who fall within the scope of the socio-technical vision being promulgated by the narrative. This authorial positioning, as one aspect of the Deleuzian actualization of reality, is accomplished through the interplay of three functions of the narrative text [11]: *identity*, by means of which authors situate themselves and others both in the future world and in roles that appear along the path toward its accomplishment [19]; the *representational*, which discursively casts the future material setting of artifacts, structures, and practices; and *action*, which leverages language's capacity for defining and fostering commitments [20].

Of course, authorship in the context of world-building is not monolithic. Since creating the future is invariably a collective and dynamic undertaking, so too is the storytelling associated with it. Those having voice, or author-ity, will produce and amend their own storylines in ways that respond inter-textually [11] to the stories of others. Notwithstanding the collective nature of the enterprise, however, the distribution of author-ity for the narrative-virtual remains uneven and problematic.

This is a matter not simply of academic interest but also of social and ethical import. As workers and other actors subjected to IT-enabled change confront the liminality of identity, their opportunities and abilities to put themselves into the stories they tell about their own work can have a crucial bearing on the qualities of the community that results. Harvey remarks [1]:

> For if . . . we get at the end . . . a result which is the product of our imaginations at the beginning, then how we imagine communities and places of the future and how we talk about them becomes part of the jigsaw of what our future can be . . . . And even if . . . there is many a slip between imagination and realization and a whole host of unintended consequences to be countered and discounted on the path, the question of how we imagine the future of places and with what seriousness we invest in it is always on the agenda.

When he concludes, then, that "our future places are for us to make" [1], the hope he expresses depends on the inclusiveness of the "us" and the qualities of the collective fictionalizing we have considered here. Neither can be taken for granted. At the same time, however, this invites the question of the scholar's potential contribution to this process. We consider that issue next.

4 Narrative Virtualization and Critical Scholarship

> *How can one reduce the great peril, the great danger with which fiction threatens our world?*
>
> Michel Foucault [21]

We are all familiar with engineering metaphors for the creation and implementation of information systems. These have been facilely applied in scholarly analyses of the design and construction of application software (for example, "software engineering"), databases, and supporting technology infrastructure (for example, "network architecture"). And engineering metaphors have been extended more broadly, as in "process (re)engineering," to the reshaping of organizational form and participation. The engineering framing in the domain of IT management scholarship has encouraged the pursuit of research that involves building and testing models replete with factors and causal relationships that might provide, in projects, predictability and control over the particulars of technical and organizational design and, in operations, the smooth and steady conduct of the IT enterprise.

By contrast, this essay invites the use of a different, if potentially complementary, metaphor for information systems practice—that of authorship. And yet, it is something more than metaphor. As we have argued here, narrative activity is indispensable in the effort to create the future. How, then, might we need to supplement our more conventional strategies for analysis? What ought scholarly inquiry to look like, when narrative virtuality becomes a subject of consideration? And what, from an applied perspective, would be a meaningful contribution by scholars to the constitution of future worlds? Here I can only begin to suggest some basic directions, and so I leave it mainly for further discussion to explore more fully the possibilities.

I will start with the quote from Foucault, given above.[10] In this bit of unabashed hyperbole, Foucault invokes the power of fiction to transform reality, much as we have been pondering in this essay. The rampant significations of texts, loosed upon the world, tend not to rest with possibilities merely, but to extend themselves to the narrative-virtual and then to the actual, changing the material ground upon which future significations arise. However, it is precisely in the construction of the author and authorship that the power of fiction can be constrained [21]:

> [The author] is a certain functional principle by which, in our culture, one limits, excludes, and chooses; in short, by which one impedes the free circulation, the free manipulation, the free composition, decomposition, and re-composition of fiction . . . The author is therefore the ideological figure by which one marks the manner in which we fear the proliferation of meaning.

The author—which for our purposes need not be an individual or singular author in the conventional literary sense but could be, for example, an organizational or institutional actor—becomes the means of localizing, relativizing, and even transfixing the significations of a text, which might otherwise roam the world freely and command inordinate sway over the narrative-virtual. Thereby anchored to context, the text's substantive claims to represent, and hence instantiate, reality can be related to its associated *regime of truth* [22], that is, its particular "institutional infrastructure for the production and circulation of truth claims" [23]. The scholar, then, enjoys an advantageous position from which to investigate and expose the

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[10] I must thank another reviewer for recommending consideration of Foucault's work on the concept of the author. The quote alone made following this advice highly worthwhile.

interdependencies among institutional constraints and power and the language deployed in efforts to (re)constitute the world. Of particular interest, perhaps, is the manner in which the possibilities for even "visionary" authorship are shaped and delimited by existing discursive formations [24].

I believe this contextualization of authorship provides one way to answer Czarniawska's call for organizational scholars to engage in "literary work" [25], "Human sciences should join philosophy, art, and history: 'modes of experience in which a truth is communicated that cannot be verified by the methodological means proper to science' (quoting Gadamer [26])." In a similar vein Zald, when he outlines the benefits to be gained from a fuller rapprochement in organizational studies between the social sciences and the humanities, recommends attention to literary theory and history, both streams of inquiry that speak to the creation of stories [27]. He calls, specifically for the use of narrative and literary techniques, "to aid policy analysts in constructing better criteria for evaluating policy alternatives. Essentially, the techniques . . . allow one to evaluate the many story lines and voices surrounding a policy issue and thereby to suggest alternatives." [27]. And, he remarks, "For organizational studies, narrative analysis provides a tool for a deeper understanding of the decision-choice process." [27] To this we might add, also, the *sense-making* process, in cognizance of Weick's observation that "what is needed in sensemaking is a good story" [15].

But this in turn transports us, as scholars, from an endeavor focused on understanding and explanation to one concerned with evaluation. What are the standards for determining what, in fact, is a "good story" or *effective fiction*—compelling and legitimate discourse [11] that can constitute the narrative-virtual? What are the conditions and processes associated with the creation of such fiction? Among other issues, the matter of participation and voice introduced here would clearly deserve attention, as would the responsibilities of management to help foster favorable circumstances for narrative. However, it is not clear that our discipline is, as yet, well-equipped to conduct this kind of evaluation. In this regard, research on the narrative-virtual might be envisioned to look rather like literary criticism, as Czarniawska and Zald hint.[11,12]

Amplified by criticism, our science would engage in meta-narration about our subjects' fictionalizations, as the latter do their work to bring-to-presence the socio-technical actuality that becomes the expression of their authors' ambitions, dreams,

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[11] "Literary criticism is the study, discussion, evaluation, and interpretation of literature," where literature, under the sway of contemporary cultural studies, "can potentially refer to any use of language" and a great variety of "texts" (Wikipedia, entries for *literary criticism* and *literary theory*).

[12] There may be something to be said, also, for scholars creating their own fictions that could be usefully deployed in constituting the future (Liz Davidson, p.c.). This appears to be a part of what Latour is suggesting, when he writes that we should "count on the human sciences offering the actors multiple and *rapidly revised* versions that allow us to understand the collective experience in which we are all engaged. All the '-logies,' '-graphies,' and '-nomies' then become indispensable if they serve to propose constantly, to the collective, new versions of what it might be" [28].

and imaginings. Such meta-narration would entail the assessment of how well, and by what manner, the fictions created by organizationally-situated actors transform the merely *possible*, in Deleuze's terms, into the *virtual*. That is, what does fictionalization need in order to convince, induce commitments, and ultimately contribute to the constitution of the material world? In short, our new literary research, in taking our subjects' storytelling as a process subject to systematic and critical study, would become a science of possible worlds.

5 Conclusion

> *Jose Arcadio Buendia did not succeed in deciphering the dream of houses with mirror walls until the day he discovered ice. Then he thought he understood its deep meaning. He thought that in the near future they would be able to manufacture blocks of ice on a large scale from such a common material as water and with them build the new houses of the village. Macondo would no longer be a burning place, where the hinges and doorknockers twisted with the heat, but would be changed into a wintry city.*[13]
>
> Gabriel Garcia Marquez [31]

As scholars of organizations who are especially concerned with innovation, our engagement with our subject matter necessarily carries us beyond studying the past merely in order to understand how things have come about. It sets us instead on the transcendent path of producing knowledge that is useful in effecting change. Of course that also puts us in the position of attempting to make knowledge claims about the future in the curious circumstances where the world that would provide the surest evidence of our claims does not yet exist. But we do not have to fall back on our grasp of the past and rely on the paradoxical hope that the future will be enough like the past to allow us to make predictions. To the contrary, our research subjects' own activities, in predicting and indeed constructing the future, point the way out of this bind.

When it comes to the manner in which our subjects have constituted, and continue to evolve, such innovative forms and practices as virtual organizations and virtual work, I have argued here that attention to the virtual in another and more fundamental sense can provide our scholarly community with opportunities to contribute, in partnership with our subjects, to the creation of future worlds and our respective identities within them. That species of virtuality, the narrative-virtual,

[13] I include this final quote in a somewhat mischievous nod to the literary. As an example of the magical-realist genre, it represents one "narrative mode, or a way of thinking in its most expansive form" [29]. In fact, magical realism is a genre that is specifically noted for its capacity to induce liminality: Magical realism "is a mode suited to exploring—and transgressing—boundaries, whether the boundaries are ontological, political, geographical, or generic", and it "often facilitates the fusion or coexistence of possible worlds, spaces, systems that would be irreconcilable in other modes of fiction . . . . The propensity of magical realist texts to admit a plurality of worlds means that they often situate themselves on liminal territory between or among these worlds" [30].

provides the foundation for the (re)constitution of work and organization in ways that can have the properties more commonly and popularly associated with the term "virtual." But our engagement as scholars in the narrative-virtual will require us to expand our vision of our own practice and, hence, to fictionalize about our own future in the way that our subjects must, and do, about their own.

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About the Author

Neil Ramiller is an Associate Professor in Information Systems Management and the Ahlbrandt Professor in the Management of Innovation & Technology at Portland State University's School of Business Administration. He holds a Ph.D. from UCLA's Anderson School of Management. His primary research activities address the management of information-technology innovations, with a focus on the role that rhetoric, narrative, and discourse play in shaping innovation processes within organizations and across institutional fields. He also conducts work on the social construction of information technology scholarship, and the implementation of the "linguistic turn" in information technology studies. Dr. Ramiller has presented his work at a variety of national and international conferences, and published articles in a number of journals, including *MIS Quarterly*, *Information & Organization, Information Technology & People, Organization Science, The Journal of Management Information Systems, Communications of the AIS, Information Systems Research, the Journal of Information Technology Theory & Applications*, and the *Journal of Information Systems Education*. His paper with E. Burton Swanson, "Innovating Mindfully with Information Technology," won the 2004 Best Paper Award from *MIS Quarterly*. In 2006, Dr. Ramiller's paper "Hype! Toward a theory of exaggeration in information technology innovation" was awarded the Best Paper prize from the Organizational Communications & Information Systems (OCIS) division of the Academy of Management. Dr. Ramiller is an associate editor for *MIS Quarterly* and a member of the editorial board for *Information Technology & People*.

Section 7

Panels

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Virtualization and Institutions

Reflections on Recent Developments in Institutional Theory for a Multi-Level Analysis

Michael Barrett[1], Elizabeth Davidson[2], Leiser Silva[3], and Geoff Walsham[4]

1 University of Cambridge, Judge Business School, Trumpington Street Cambridge CB2 1AG, UK m.barrett@jbs.cam.ac.uk

2 University of Hawai'i at Manoa, Shidler School of Business, Honolulu, HI 96822, Elizabeth.Davidson@hawaii.edu

3 University of Houston, C.T. Bauer School of Business, Houston, TX, 77204-6021, lsilva@uh.edu

4 University of Cambridge, Judge Business School, Trumpington Street, Cambridge CB2 1AG, UK g.walsham@jbs.cam.ac.uk

Abstract. This panel explores the value of institutional theory in understanding 'virtualization (in its varieties of meanings) and the impact on work practices, organizations and society.' In 2001, Orlikowski and Barley made an initial appeal in this direction suggesting that IS research could benefit from institutional theory and that organization theory could also learn from IS research in taking the materiality of technology seriously. Since this earlier call, there have been significant developments in institutional theory from within organizational theory, particularly at the micro-level of analysis. However, apart from some notable exceptions at the macro-level, IS research is yet to explore the value of institutional theory for understanding virtualization of work practices. A particular focus of this panel, therefore, is to explore the potential of micro and macro level developments in institutional theory, and the value of a multilevel approach for the virtualization of work.

1 Introduction

Research on technological change has long recognized technology as an occasion for institutional change through temporal orderings between occupational groups and shifts in work practices [1]. However, as Orlikowski and Barley [2] note, IS research has been slower to examine how institutions influence virtualization—the design,

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use, and consequences of IT for time-space distanciation of work practices within or across organizations [3]. They note, along with others more recently, the strengths that institutional theory may offer to IS research by providing a lens to 'simultaneously understand the role of human agency as embedded in institutional contexts as well as the constraints and affordances of technologies as material systems' [4, p. 158]. However, to date little research in IS [5,6] has focused on the political/regulative, normative systems and cultural frameworks shaping the design, use and eventual institutionalization of information systems [7].

Institutional theory approaches to virtualization are useful at different levels and across levels of social analysis. The macro-level concept of *institutional logics* is helpful for examining change and stability in work practices and the challenges that virtuality poses within professions, organizations, and fields. Scott [8, p. 139] defines institutional logics as the "belief systems and related practices that predominate in an organizational field" and notes that systems of logic vary across fields in content, penetration, linkage and exclusiveness. A close examination of field logics can help explain the varying degrees of acceptance of virtual work practices within different organizational fields [3] and the potential conflict between systems of logic when virtual practices diffuse across fields, particularly into fields in which institutional logics have deep penetration and exclusivity. Such analysis is also useful to investigate the interplay of field-level and organization-level change [9] and the possibilities for innovation in virtual work practices within or across social levels.

Recent developments by organizational theorists on institutional theory at the micro-level provide a wealth of potential opportunities for IS research. In particular, institutional entrepreneurship has emerged to deepen our understanding of institutional change [10,11,12]. Institutional entrepreneurs are actors who mobilize resources to create new institutions or transform existing ones. Institutional entrepreneurship has also been recognized as a discursive activity which changes the discourses upon which institutions depend through the production of influential texts as a strategic activity [13]. Through such strategies they seek to increase their legitimacy, resources, authority, and centrality to produce new institutions and in the process de-legitimate existing institutions.

What can we as an IS community learn from these and other developments in institutional theory for understanding the ongoing innovations in the virtualization of work? In exploring the opportunities and challenges of utilizing institutional theory for research on virtualization at the micro and macro levels, our panel will also examine how a multi-level approach and analysis [14] may be adopted.

While panelists share a common view on exploring a multi-level analysis using institutional theory, they will present different positions, arguing either for a bias at the micro or macro level in order to stimulate discussion by contrasting viewpoints. We will seek to represent opposing points of view on the following issues:

- Should macro level concepts of institutional theory be given primacy over micro level aspects in exploring virtualization?
- Do micro level aspects of institutional theory have better explanatory power than macro level concepts in exploring virtualization?

- How would one develop a mixed level approach to institutional theory in exploring virtualization?
- What are the challenges and limitations in using institutional theory for examining virtualization?

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About the Panelists

Michael Barrett is a University Senior Lecturer in Information Systems and Innovation at Judge Business School, Cambridge University. His research interests center on IS innovation and change, and the implications for work practices within and between organizations. Michael will emphasize recent developments at the micro-level on institutional entrepreneurship and the role of discourse in understanding virtualization. By drawing on a case study on telecommuting he will explore how such micro-level developments of institutional theory are valuable in understanding this phenomenon.

Elizabeth Davidson is an Associate Professor of Information Technology Management at the Shidler College of Business, University of Hawaii at Manoa. Her research investigates sensemaking in organizations around technology development and technology-enabled organizational change. Elizabeth will focus on the interplay of institutional logics that predominate in an organizational field and organizational-level sensemaking and action. She will draw on Scott's (1994) top-down and bottom-up process model for institutional creation and diffusion to explore the tensions between diffusion versus invention, imposition versus negotiation, and socialization versus interpretation of virtual work practices. Elizabeth will illustrate these institutional change processes with examples from her research on healthcare information technologies.

Leiser Silva is an Assistant Professor in Information Systems at the C.T. Bauer College of Business, University of Houston. His research interests concern issues of power and politics in the adoption and implementation of information systems. In addition, he is looking at managerial facets of information systems, specifically, contextual and institutional aspects. Leiser will draw on his current research that examines the profound impact of ERP on the way work tasks are distributed and controlled in organizations. The degree of control over distributed work make ERPs the archetypes of what Zuboff (1988) saw as the panopticon features of information technology in a virtual work environment. He will draw on macro-level aspects of institutional theory and a mixed level analysis to highlight ERP adoption and implementation as the result of mimetic and market forces, as well as discourses of legitimation. In so doing, he will shed light on situations in which theories based exclusively on individual perceptions could not explain the adoption of systems that are deemed as unfriendly and whose usefulness is questioned.

Geoff Walsham is Professor of Management Studies at Judge Business School, University of Cambridge. His research is concerned with the human consequences of computerisation in a global context, including both industrialised and developing countries. Geoff has worked with a number of theoretical approaches including structuration theory and actor-network theory, but is a relative newcomer with respect to institutional theory. However, he is currently exploring the use of institutional theory with particular reference to health information systems in developing countries. He will outline some of this work at the panel, and he will aim to draw from it to discuss some of the strengths and weaknesses of the theory as a way of conceptualising the virtualization of work practices.

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Exploring the Nature of Virtuality

An Interplay of Global and Local Interactions

Niki Panteli[1], Mike Chiasson[2], Lin Yan[3], Angeliki Poulymenakou[4], Anthony Papargyris[5]
1 University of Bath, UK; N.Panteli@bath.ac.uk
2 Lancaster University, UK; m.chiasson@lancaster.ac.uk
3 University of Wales Lampeter, UK; l.yan@lamp.ac.uk
4 Athens University of Economics and Business, Greece,akp@aueb.gr
5 Athens University of Economics and Business, Greece, apaparg@aueb.gr

1 Panel Theme

There has been considerable interest in the topic of virtuality over the last few years among both academics and practitioners. The focus of attention has generally been on how to improve collaboration and knowledge sharing, how to develop trust and cohesiveness within virtual organizations, virtual teams and virtual communities, and how to best support virtual interactions. Underlying this research area is the assumption that we possess sufficient understanding about the nature of virtuality and that we know how to distinguish 'what is virtual' to 'what is not virtual'. Even though several of us have attempted on various occasions to make a contribution in this field, we increasingly recognize that the nature of virtuality has not been well conceptualized in the literature. Part of the reason for this is that researchers, including us, often have the tendency to compare the virtual (distributed and CMC-based) to the traditional (collocated, and face-to-face) environment. We question this purely technological distinction, but recognize that virtuality, as an IT-enabled phenomenon, is increasingly extending its reach, becoming more global and more pervasive across all spheres of society. The theme of this panel is to examine, appreciate, and debate the multi-dimensional nature of what virtuality has been, is, and may become–specifically, its global and local dimensions, including the different interpretations that are and should be given to these dimensions.

Virtuality enables us to expand our global reach and to lay the foundations for a fundamental shift in the way knowledge is shared, created, and disseminated as well

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as transform our basic notion of boundaries and space. Nevertheless, virtuality regardless of its reach centers around human cooperation and flows of information that bring together and separate, at the same time, their dispersed segments [3]. Therefore, discontinuity, temporality, but also locality still remain key characteristics of the virtual space. As Woolgar [8] has argued, successful virtual interactions at the global level require attention to the local setting, because it is expected to influence the local ways for managing and using the technology as well as virtual behavioral patterns. The local and the global can be interpreted in different ways including but not limited to geographical, cultural, and political. Accordingly, in this panel, we argue that as the study of and interest in virtuality grows, an analysis of the interplay between its global and local aspects offers an insightful way to reflect on and unearth the multi-level, multi-dimensional, and transdisciplinary character of virtuality, and how it can be used to explore the individual, organizational, and community struggles in developing and maintaining collaborative virtual interactions.

The aim of the panel is to examine, to appreciate, and to debate the nature of virtuality, exploring its pervasiveness at both the global and local levels and examining their co-existence. In order to best capture this co-existence, we will adopt the 'intertwine' concept. This concept was first used as a metaphor by Robey et al [5] to explore the synergy between the virtual and material world. Thus, our panel focuses on how the intertwining of the global and the local aspects of virtuality can be used to illuminate understanding of the multiplex character of virtuality. We believe that this issue is of direct relevance to the theme of the IFIP W.G. 8.2. All panelists have extensive research experience in the virtuality field and have all made a commitment to attend the conference and serve on the panel.

1.1 Panel Format

The Panel Chair, Niki Panteli, will frame the issues to be discussed with a short introduction. This will be followed by a presentation by each panelist. All panelists will aim to examine the interplay between the global and local aspects of virtuality and how this generates value to our understanding of virtuality and to our research agenda. After the presentations, the Chair will summarize the key points and the audience will have the opportunity to discuss these and other relevant issues with the panel discussants.

2 Panel Presentations

Mike Chiasson will draw upon Shield's [6] definition of the virtual in order to present virtual dynamics in a number of traditional (virtual teams) and non-traditional areas (viewing a painting in an art museum). In doing so, he will highlight different possibilities of the virtual, and its interaction with various notions of the real, and consider how information technology is both an extension and a transformation of these other real-virtual moments. He will conclude that IT is increasingly obscuring the need for a real, and that virtual representations are themselves guiding and perhaps becoming the real. To demonstrate this, he will draw upon some of his work examining e-commerce fraud and courtroom discussions to highlight the increasing complexity between the real and the virtual.

Lin Yan will adopt a cultural perspective in an attempt to explore the local and global dimensions of virtuality and subsequently discuss the 'Cultures' Consequences' (if any) in Virtual Collaborations. The construct of culture, from Hofstede's thesis [1] has traditionally been used to illustrate the differences between the 'local' and the 'global'. How do these established theories on Cross-Cultural Management inform, or indeed limit, our understanding of virtual collaborations? This contribution is an attempt to revisit culture in the context of virtuality. Through a longitudinal case study in a Born Global organization, findings indicated that professional culture overtook national culture in individuals' grouping and identification over distance. Lin will suggest that this is not only a reflection of the 'inefficiency' of current cross-cultural analysis, but it also highlights the issue of level of analysis, particularly for virtual collaborations.

Angeliki Poulymenakou & Anthony Papargyris will jointly present the notion of 'collectiveness' in virtual environments and in particular what they call massive virtual communities. They will argue that while most contemporary research on virtual communities is carried out in organizational and other work-related contexts, beyond such boundaries there is an abundance of massive, multinational virtual communities that practice communication, learning, business, and entertainment online [4] and have remained unexplored. Their members find value in their membership and meaning in their virtual spaces of socialization. A case of such communities is that of Massively Multiplayer Online Games (MMOGs). These games present to their users an alternate persistent world, where they can cooperate or compete, trade and consume virtual goods, practice new modes of expressions, and participate in joint activities. Previous research in such communities emphasized the phenomenon of the players' identity transformation [2, 7]. Indeed, anonymity and lack of physical contact encourages individuals to become less inhibited and provides ample room for individuals to express unexplored parts of themselves. Their fieldwork further suggests that inside such virtual spaces, players seek a deeper understanding of the virtual worlds meaningful structure and they are continuously experiment with different forms of social organization and interaction. In their presentation, they will discuss the key findings of their research on virtual communities of MMOGs, by focusing on the collective practices of meaning construction and negotiation.

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About the Panelists

Mike Chiasson is a Senior Lecturer at Lancaster University, in the Department of Management Science. His work examines the implementation and use of information technology in healthcare, professional work, virtual organisations, and crime. To examine these topics, his work draws upon various social theories which touch on various aspects of virtuality: communicative action, structuration theory, deconstruction, potentialities, ethnomethodology, identify formation, and postmodernism.

Niki Panteli is a Senior Lecturer in Information Systems, University of Bath School of Management. She holds a PhD in Information Systems from Warwick Business School (1996). Broadly defined, her research lies in the field of information and communication technologies and emergent organizational arrangements. During the last 6 years her research has taken a specific focus on virtuality, virtual teams and computer-mediated communication systems. Within this field, she has studied issues of trust, conflict and collaborations in virtual, geographically-dispersed environments. She is the Chair of the IFIP- International Federation of Information Processing- W.G. 9.5 on Virtuality & Society.

Anthony Papargyris is a PhD candidate in the Department of Management Science & Technology of Athens University of Economics and Business (AUEB). He holds a first degree in Business Computing (Teesside, UK), and an MSc degree in Information Systems (AUEB). His current research is focusing on collective action and meaning construction, virtual communities, and learning. His general research interests are in online interactive learning games, philosophy of science and Information Systems, and Knowledge Management.

Angeliki Poulymenakou is an Assistant Professor in Information Systems Management. She holds a PhD degree in Information Systems from the London School of Economics. Her current research interests focus information technology enabled change and particularly on the study of technological intervention in the areas of organisational learning and knowledge management, and on the study of dynamic organisational networks from an Information Systems perspective. She is currently the scientific coordinator of European funded projects in socio-economic research within the IST programme in the areas of organisational networks and learning. She has served as a member of the scientific committee of four international conferences in information systems (ICIS, ECIS, IFIP) and has acted as a referee in several international journals in the field. In 2003 she chaired the organisation of the IFIP joint WG8.2 and 9.4 Conference on Information Systems and Globalisation, in Athens.

Lin Yan is a Lecturer at the Department of Management and Information Technology and Centre for Chinese Studies, at the University of Wales Lampeter, UK. She holds an MPhil and a PhD in Management Studies from the Judge Business School, University of Cambridge, after a career in consultancy on Cross-Cultural Management. Lin's current research is in the areas of virtuality, international management, and Chinese Management. She is a member of the Academy of Management, European Group for Organizational Studies (EGOS), International Federation for Information Processing (IFIP), the British Association for Chinese Studies, and a reviewer for Leverhulm Trust and Palgrave Publishing.

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The Social in the Virtual

Jan Chong, Ingrid Erickson, Kathy J. Lee and Rosanne Siino
Center for Work, Technology and Organization
Department of Management Science and Engineering
Stanford University
Stanford, California USA 94305-4024
{jchong,ierick,kathyjl,rsiino}@stanford.edu

Abstract. Virtuality is often defined solely as that which lacks or is not material reality, and as such, much of the social order that is uniquely engendered within technologically-mediated realities has been inadequately described. This panel attempts to define virtuality on its own terms, instead of as reality-negative, by showcasing four perspectives of social interaction in virtual space. Panelists Elizabeth Churchill, Thomas Erickson, Cliff Lampe, and Rosanne Siino will share insights into the social orders in the virtualities of their interests. Presentations will be followed by a discussion among panelists and panel participants.

1 Panel Description

In the last fifteen years it has often seemed that to label something "virtual" was to fully define it. The fact that it was other than "real," in the ways that we understood our physical and material reality, seemed to serve as a sufficient description of its nature. However now, some years on, we can see that this moniker is inappropriately dimensionless, disguising qualities of online environments and computer-mediated activity too simplistically. In an effort to open the 'black box' of virtuality, we contend that virtual environments can be both as complex and as organized as material situations. Like Smith [1], Wellman [2, 3], Turkle [4] and Hinds [5, 6], we suggest that online worlds possess multifaceted social patterns and structures that are very much worth studying further.

This panel will explore some of the under-investigated social elements of virtual environments by inviting a set of diverse scholars and practitioners to address the following questions:

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- How are virtual spaces social?
- How do people "come together" in virtual environments?
- How do social presence, influence, and awareness operate in virtual environments?
- Do separate social norms, behaviors, and expectations develop in virtual environments or are they inevitably imported from the material world?
- More broadly, what is the interplay between social patterns and structures in the physical and the virtual?

Each of our invited panelists offers a distinct position from which to answer these queries. Both Rosanne Siino and Cliff Lampe have done extensive empirical investigations of virtual settings. They will bring complementary perspectives to bear on analyses of audio-only teleconference interactions and "massive" online communities, respectively. Tom Erickson and Elizabeth Churchill will not only offer insights from their years in industry, they also pair well in their differing perspectives on social virtual space. Erickson seeks to understand social presence and "virtual" interactions in small groups, while Churchill takes a cultural and anthropological look at larger media spaces.

The structure of the panel will consist of four ten minute presentations and a twenty minute discussion. We will ask each of the panelists to prepare brief comments ahead of time synthesizing their ideas with the other three panelists and will begin the discussion with these statements.

Our ultimate desire in organizing this panel is to provide a deep interrogation of virtual social orders. In particular, we hope to discover whether virtual spaces afford new forms of interaction, and, if so, how these new interaction patterns arise and how they are maintained. In striving toward these goals, we expect to touch on aspects of what it means to be part of a virtual group or community, how agency and identity are expressed virtually, and what is implied by the representation of others in virtual spaces.

2 Panel Participants

The following have committed to being participants on this panel:

Elizabeth Churchill, Principal Research Scientist, Yahoo! Research, is currently working on social networking, social computing and social media. A psychologist by training, for the past 15 years she has drawn on diverse areas to consider how to design effective communication situations, both face-to-face and technologically-mediated. Influences on her work include psychology, sociology, anthropology, cultural studies, architecture, and film studies. Her current work considers the augmentation of social spaces with community generated digital content.

Thomas Erickson is a Research Staff Member at the IBM T.J. Watson Research Center. Tom's research involves exploring the design and use of social proxies, minimalist graphical visualizations of people, and activities in online environments.

He claims that making people and their activities mutually visible to one another enables the social processes (such as imitation, norming, and peer pressure) that make our face-to-face interactions coherent, productive, and engaging, to come into play in online interactions. He has contributed to the design of many products, and authored about 50 publications on topics ranging from personal electronic notebooks and information retrieval systems to pattern languages and virtual community.

Cliff Lampe is Assistant Professor of Telecommunication, Information Studies and Media, Michigan State University. In his research, Cliff works with online communities, including Facebook, Slashdot, SourceForge, and Newstrust. A subset of that interest is the use of recommender and reputation systems to guide massively scaled online interactions. He is the co-author, with Paul Resnick, of "Slash(dot) and burn: distributed moderation in a large online conversation space," which was presented at the Conference on Human Factors in Computing Systems (CHI) in Vienna, Austria in 2004.

Rosanne Siino is a Doctoral Candidate, Center for Work, Technology and Organization, Stanford University. Rosanne's interests center on the socio-emotional effects of digital technologies on how people work. Her two research streams reflect these interests. The first focuses on social interaction patterns and identity implications of geographically distributed group and team work, and the second explores the socio-emotional impact of increasingly autonomous and agent-oriented digital technologies in the workplace—technologies that seemingly make decisions for workers. Rosanne previously spent 16 years in the communications field, serving as Netscape's Vice President of Corporate Communications, from the company's founding until its purchase by AOL.

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About the Panel Organizers

Jan Chong is a PhD Candidate at the Center for Work, Technology & Organization at Stanford University where she works with Professor Diane Bailey. Jan is interested in knowledge-based aspects of collaboration, particularly in the realm of collaborative software development. Jan has an MS and a BS in Computer Science from Stanford University.

Ingrid Erickson is a PhD student at the Center for Work, Technology & Organization at Stanford University where she works with Professor Diane Bailey. Ingrid is interested in the implications of ubiquitous computing and locative technologies on social practices, new dimensions of place and space, organizational and cultural rhetoric, and interorganizational collaboration. She has conducted research with the Social Computing Group at IBM's T J Watson Research Center and at Boeing's Phantom Works research division. Ingrid has an MS in Information from the School of Information at University of Michigan and an MA in Religious Studies from University of Chicago Divinity School.

Kathy Lee is a PhD student at the Center for Work, Technology & Organization at Stanford University. Kathy's interested in the new and different ways of sharing/organizing online, and about what these possibilities might mean towards enriching social interaction. More recently, she's also become interested in the design practices that bring these new technologies about within large organizations. Kathy received her MS in Human-Computer Interaction at the University of Michigan and her BS in Mechanical Engineering at MIT.

Rosanne Siino, Doctoral Candidate, Center for Work, Technology and Organization, Stanford University. Please see above.

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The Role of Shapers in Knowledge-Sharing

Ann Majchrzak[1], Chris Wagner[2], Dirk Riehle[3], Peter Thoeny[4], Sunir Shah[5], and Ward Cunningham[6]
1 University of Southern California, majchrza@usc.edu
2 City University of Hong Kong, iscw@city.edu.hk
3 SAP, dirk.riehle@sap.com
4 StructuredWikis LLC, peter@Structuredwikis.com
5 Meatball, sunir@sunir.org
6. Eclipse Foundation & Cunningham & Cunningham, Inc, ward@c2.com

Abstract. Wikis are a collaborative technology that allows for new ways of working and sharing knowledge. While most firms today have been experimenting with wikis, an important element of the use of wikis that has generally been ignored is the role of the people who shape the wiki pages. Shapers ensure the sustainability of a wiki community by helping to ensure that new ideas and contributions are made and organized. This panel consists of four practitioners who play critical shaping roles in their wiki communities, and two academics who will begin, moderate, and summarize the session. The panel of practitioners will share their thoughts on why they shape, how they shape, and how other communities can help to encourage participants to adopt the shaping role.

1 Introduction

Web 2.0 technologies such as wikis permit participants in virtual practice networks to engage in what we call "shaping" the content that has been posted onto a collaborative webpage. Shaping, also referred to as "gardening," involves dynamically editing, integrating, distilling, refactoring, identifying areas of convergence and discrepancies, identifying topics receiving little attention in the community, and significantly rewriting the contributions of others. Shaping has a variety of expected consequences to the community's knowledge asset: it can help to

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ensure that the "signal" doesn't get lost from the knowledge noise, help to make it easier for contributors to find knowledge, and help to encourage innovative contributions by making it easier for contributors to find different perspectives and information on different aspects of a topic. While there has been much research on why people contribute their personal knowledge to a community's knowledge asset, there is little research on those who contribute by shaping the contributions of others. In particular, the following questions have not been addressed in the research literature:

- What exactly are they doing when they shape? Is the activity more than simply editing or are they in fact trying to shape an argument, discourse, or dialogue? When might they do one (for example, just editing) vs. shaping?
- Why do people choose to shape? What are their personal motivations for shaping? What benefits do they expect to derive from shaping?
- What expectations do they have for their impact on the community? Are there specific success stories of the impact of shapers on the community's knowledge impact? Are there cases when wikis have succeeded without anyone serving a shaping role?
- Are there characteristics of shapers that distinguish them from participants in an online community that choose not to shape? What skills do they bring to bear when they shape?
- Are there characteristics of a community that are more or less appropriate for shaping?
- Are there best practice shaping activities; what are these? Are these best practices applicable for all online communities?
- Shaping has the potential of negative effects when someone attempts to move a community into directions that may not be appropriate? Has this ever happened? Is this a concern? How can a community protect itself from this happening?
- How can shaping be encouraged in a community?

This panel will address these questions. The panel is unusual as it consists of professionals both in industry and academia. The industry participants have extensive shaping experience and will address these questions by sharing their personal experiences as shapers. The academic participants have conducted research studies on shapers and will share their research results.

The panel will follow a 90-minute format in which there will be a 10-minute introduction about wikis and the wiki way, including examples of wikis, a definition of shaping, and a display of questions we are interested in addressing

Following an introduction about wikis and the wiki way, each practitioner will talk about the wikis they have been involved in shaping and provide examples of the types of shaping activities in which they have been engaged. The panelists will then be asked to address why they shape, what impacts their shaping has had on their communities, what are the characteristics of shapers that distinguish them from participants who do not shape, etc. The audience will be asked to participate in these questioning.

Finally, Dr. Wagner will summarize the discussion in a presentation on research conducted for the Society for Information Management's Advanced Practices Council on corporate wiki use and the role of shapers.

2 Panel Members

The four practitioners are well known within their wiki communities as shapers that have been instrumental in the success of their communities. They are:

- Dirk Riehle, SAP Research,
- Peter Thoeny, Founder TWiki.org & Co-founder StructuredWikis LLC
- Sunir Shah, Meatball
- Ward Cunningham, Cunningham and Cunningham, Inc & Eclipse Foundation Inc

The panel facilitators are Ann Majchrzak and Chris Wagner.

About the Panelists

Ann Majchrzak is a Professor of Information and Operations Management at the University of Southern California's Marshall School of Business. She is a specialist in the design and management of technology change. Her focus is on the development of change plans that optimize the synergy between computer-based technology, human capabilities, organizational structure, and strategic needs. She has conducted research on this synergy as well as developed tools to help technology and organizational designers, which have been used in Europe, Australia, and South and North America, with companies such as Hewlett-Packard, General Motors, Texas Instruments, Hughes, and Digital Equipment Corporation Dr. Majchrzak has written seven books, including *The Human Side of Factory Automation, Human Aspects of Computer-Aided Design*, and *A Reference Book for Performing a HITOP Analysis*. She has written over 30 refereed research articles in such scholarly journals such as *MIS Quarterly, Management Science, Information Systems Research, IEEE Transactions in Engineering Management, Organization Science*, and has two publications in the *Harvard Business Review*. She has been the principal or coinvestigator for over $3,800,000 in research grants from the National Science Foundation, the National Center for Manufacturing Sciences, Russell Sage Foundation, Kellogg Foundation, Office of Technology Assessment, and private industry.

Christian Wagner is a Professor of Information Systems and Associate Dean at the City University of Hong Kong's Faculty of Business. His research focuses on the design, implementation and evaluation of information systems to support decision making and problem solving. Dr. Wagner has written over 30 refereed articles in journals such as *Management Science, Journal of Management Information Systems, IEEE Transactions on Knowledge and Data Engineering, Decision Support Systems, Communications of the ACM*, and the *International Journal of Human Computer Studies*. He has received research funding from organizations including the National Science Foundation, Hong Kong's Research Grants Council, and the German Academic Exchange Service. Wagner's most recent research focuses on the development and evaluation of conversational knowledge management systems, especially wikis and weblogs. Wagner is the principal investigator on a Society of Information Management (SIM) Advanced Practices Council project on the corporate use of wikis, whose results are described, in part, in this article. Previously he also co-founded, and served as board member and chief technology officer of a venture capital funded software start-up firm.

Peter Theony is the founder of TWiki, the leading wiki for corporate collaboration and knowledge management. Managing the open-sourced project for the last seven years, Peter invented the concept of structured wikis - where free form wiki content can be structured with tailored wiki applications. He is a recognized thought-leader in Wikis and social software, featured in numerous articles and technology conferences including LinuxWorld, Business Week, Wall Street Journal and more. A software developer with over 15 years experience, Peter specializes in software architecture, user interface design and web technology. He graduated from the Swiss Federal Institute of Technology in Zurich, lived in Japan for 8 years working as an engineering manager for Denso building CASE tools, and managed the Knowledge Engineering group at Wind River for several years.

Dirk Riehle is a research scientist leading the open-source research group at SAP Research, the research arm of SAP AG. Dirk received his MBA from Stanford Graduate School of Business and a Doctor of Technical Sciences from the Swiss Federal Institute of Technology, Zurich. Before joining SAP, he co-founded an on-demand business software company. He is an active researcher about open source, wikis, and all things called "collective intelligence." Dirk is also a co-founder of the Wiki Symposium (WikiSym) and a shaper of the WikiSym wiki site, a forum for research on wikis.

Sunir Shah is the instigator and shaper of Meatball, a meta-community, as well as DesignBibliography, a reference wikisite for usability design. Sunir is a proponent and implementer of participative design approaches to web-based technologies, using wikis to facilitate the inclusion of users and providing web services to usability designers.

Ward Cunningham is the "father" of the WikiWiki concept, co-authoring the seminal book, *The Wiki Way: Quick Collaboration on the Web* (Addison-Wesley 2001). Ward received his master's degree in computer science from Purdue University. As part of Cunningham & Cunningham Inc, Ward teaches people to use objects, having developed the practice called Extreme Programming. Ward created the CRC design method that helps teams find core objects for their software applications. Ward has served as Director of R&D for Wyatt Software, Principal Engineer at Tektronix Computer Research Laboratory, member of the patterns and practices group at Microsoft Corporation, founder of the Hillside Group, major contributor to the Portland Pattern Repository, and is currently the Director of Committer Community Development at the Eclipse Foundation.

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Game Architecture and Virtual Teamwork

Esther Baldwin[1], Cynthia Pickering[2], David Smith[3], David Abecassis[4], Aaron Molenaur[5]
1 IT Strategy, Architecture & Innovation, Intel Corporation
2 IT Collaboratory, Intel Corporation
3 Qwaq Inc.
4 Alloy Ventures Corporation
5 Engineering Computing, Intel Corporation

Abstract. The panel will provide some variety to the general conference content in the sense that it represents technology solutions and experiences that are socially aware. At this point, technologies and capabilities have advanced to the point that many previous socially-oriented issues have been overcome without this necessarily being widely known. This is the point for a good conjuncture of social informatics perspectives and technological developments. The audience is strongly encouraged to pose questions from their own frameworks for the enlightenment of all, bringing together some disparate disciplines in a common conversation.

1 Panelists' Statements

Esther Baldwin: As corporations move towards more and more globally distributed work, they depend increasingly on tools to support remote collaboration. The basic framework for those tools today traces its origins to tools that were supplemental in nature, not central to everyday productivity. Especially as critical large-scale work artifacts are produced in virtual teams, is it important to review the basic underpinnings of how we conceptualize remote collaboration. This review must extend not just to necessary capabilities, their configuration, proportion and usability, but as well to basic beliefs and habits regarding user interfaces and technical architectures. As well, there are games now that mimic certain corporate activities in

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terms of game-like markets for transaction costs in a system. Finally, we have yet to make the full translation between gaming experience and work experience. This panel will discuss:

- A usage model for a distributed collaboration tool for design engineers working on large complex projects across the globe;
- The Miramar 3D object-oriented user interface that enables managing complexity;
- The Croquet peer-to-peer object-based game architecture that makes the new user model scalable for large projects and file sizes;
- The Serios corporate e-mail game;
- Testimony from the trenches from a software engineer who has applied his game insights to his work life.

Some of the qualities missing in existing remote collaboration tools are present in gaming: multi-tasking through objects, multi-teaming through context switching and "rooms", stimulating visuals and action environments. Neurological and heartrate research by Reeves et al, corresponding to "flow" theory of Cziktsentmihalyi, shows that limbic system and heart rate are both affected by properties of games, both visual and action-oriented. These properties can also obviously apply to productive teamwork.

Cynthia Pickering: Over a period of several years we have worked at scoping collaboration models that fit our corporate experience, using Intel technology and studies of our workforce. Tracking studies of how "virtual" Intel is, how our design engineering needs were not met by conventional tools, combined with a re-use of a context-retaining object-based 3D tool invented in the former Intel Architecture Labs have led us to the prototype tool called Miramar. We have further collaborated with Croquet developers to make Miramar scalable to a large distributed environment. The talk will present the identified needs and why we chose the solutions that we did.

David Smith: Qwaq Forums are persistent web-based virtual spaces for real collaborative work. Like offices and meeting rooms, Qwaq Forums are places where users can go to work, interact with others, share documents, chat using voice and text, and mutually identify and solve issues. Qwaq Forums are built on top of Croquet and are a high-powered, secure, behind-the-firewall solution for the distributed enterprise.

Croquet is a powerful open source software development environment that supports synchronous communication, collaboration, resource sharing and computation among large numbers of users on multiple platforms and multiple devices. The key to the system is TeaTime a replicated computation model that enables perfect sharing of even complex simulations and interactions.

David Abecassis: Games comprise a fascinating laboratory in which both the game and player created organizations (clans, guilds, corporations) strive to capture player attention. The power of marketplaces, feedback, and reputation are applicable to the organization of information work. As the workplace becomes increasingly virtualized, businesses may more readily emulate the success of wholly virtual online games. Our first product, Attent, aims to solve the problem of overloaded inboxes by creating a synthetic economy for email.

Aaron Molenaur: Gaming software is useful as a tool for collaboration in software engineering efforts.

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The IT Artifact and Telecommuting

France Bélanger[1], Mary Beth Watson-Manheim[2], Susan Harrington[3], Nancy Johnson[4], and Derrick Neufeld[5]
1 Virginia Tech, belanger@vt.edu
2 University of Illinois at Chicago, mbwm@uic.edu
3 Macon State College, sharrington@mail.maconstate.edu
4 Metropolitan State University, nancy.jo.johnson@att.net
5 University of Western Ontario, dneufeld@ivey.uwo.ca,

Abstract. Research on the concept of telecommuting or telework, as it is known in various areas of the world, has appeared in information systems (IS) and non-IS publications for more than 20 years. Research areas with respect to telecommuting are quite varied, from Information and Communication Technologies (ICT) use, to transportation, managerial control, work-life issues, and more. A significant number of these studies have taken into account the role of technology in enabling telecommuting. However, recent awareness of the IT artifact issue [1] has raised concerns for some authors, reviewers, and editors as to when the technology component is significant enough to consider some of the telecommuting research as IS research. Others, meanwhile, believe that by definition telecommuting addresses the IT artifact issue, and that this should not be a concern. In this panel, we explore the question of whether the IT artifact is an issue in IS-related telecommuting research by examining topics from multiple and sometimes competing perspectives.

1 Panel Description

Research on the concept of telecommuting has appeared in information systems (IS) and non-IS publications for more than 20 years. A significant number of studies have taken into account the role of technology in enabling telecommuting. However, recent awareness of the IT artifact issue [1] has raised concerns for some authors, reviewers, and editors as to when the technology component is significant enough to consider some of the telecommuting research as IS research. Others, meanwhile, believe that by definition telecommuting addresses the IT artifact issue, and that this

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should not be a concern. The panel is composed of well renowned academics who have extensively conducted and published research on telecommuting. The panel discussion will focus on the question of whether the IT artifact is an issue in IS-related telecommuting research by examining topics from multiple and sometimes competing perspectives. Individual panelists will present different perspectives, and hear feedback on these positions from the other panelists and the audience. Below are some of the discussions to be presented by the panel.

Question 1. Is telecommuting research part of the IS body of research when it does not explicitly study the IT artifact but rather focuses on non-ICT issues such as "transportation, managerial control, work-life issues" etc?

In 2003, Benbasat and Zmud [2] argued that for an article to be considered IS research it must address the immediate nomological net of the "IT artifact" (the interaction among information technology applications, structures, and contexts). This essentially normative position, rooted in the Aristotelian laws of formal, didactic logic, presumes that the identity of our field is in danger, and that we need to safeguard our identity by erecting a set of definitive boundaries to establish what is in, and what is out. In sharp contrast, an alternative descriptive conception of the identity of our field has been voiced by other thought leaders, for example, King and Lyytinen [3],. The descriptive perspective, based in an epistemology of dialectical logic, contends that IS research is comprised of whatever IS researchers do, and that the identity of the field is pragmatically and inclusively defined by the sum total of whatever the body of IS scholars chooses to investigate, however focused or diversified. To answer the question presented above, Benbasat and Zmud [2] would say no. Their argument would lead to the conclusion that these aspects of telecommuting are not in the immediate nomological net and are best left to researchers familiar with organizational management, organizational culture, and psychology. Moreover, use of IT to support telecommuting is not an IT per se but a conglomeration of technologies that are used to facilitate remote work. So immediately one would say that telecommuting fails the test of an IT artifact in the strict approach of Benbasat and Zmud. Alternatively, the contrasting approach of King and Lyytinen [3] would suggest that telecommuting research, even when focusing on secondary "non-ICT" issues, is part of the body of IS research.

Question 2. Is there enough discussion of IT in IS telecommuting research?

IS-related telecommuting research often focuses on the management, organizational culture, and behavioral sides of telecommuting implementation. Depending on the definition of IT artifact and the nomological net that is appropriate for IS research, there may or may not be enough discussion of IT in telecommuting research. However, if an IT is perceived as an information processing tool or a social relations tool [1], then telecommuting meets the criteria. Orlikowski and Iacono [1] look at IT broadly and describe telecommuting as an artifact in need of new theories to make sense of the techno-social processes surrounding it, "because IT artifacts are designed, constructed, and used by people, they are shaped by the interests, values, and assumptions of a wide variety of communities of developers, investors, users, etc." (p. 131). Moreover, IT artifacts are usually made up of many often fragile and fragmentary components, are rarely flawless and unfailing, and are not static but are instead dynamic and changing. Without looking at the broader context and changing techno-social processes, we cannot understand the IT artifact.

Question 3. Is the definition of telecommuting as an IT-enabled concept sufficient for addressing IT artifact concerns?

Again this point is debatable and it could easily be argued that the telecommuting body of research has stretched too far into the context and non-IT subject areas that are not IT issues per se. Rarely do telecommuting researchers look at the precise implementation details or how those are managed from an operational perspective. Questions of what precise technologies (e-mail, chat, video connections, etc.) are used, how are they implemented and managed, and how the technologies are related to the purposes of telework are not usually the focus of telecommuting research nor collected as data. From that perspective, we have probably failed to focus on the IT artifact to the fullest extent possible – leaving a potential contribution to the IS field wanting. As a case in point, for years we have been wondering why telecommuting has not "taken off" as predicted yet, it may be that the ICTs available have not met the needs of the work to be performed. Now it appears that more and more telework is occurring in the form of outsourcing, not only to countries like India but in the form of "homesourcing" to housewives at home in Utah [4]. Have we missed a potential contribution to our field by focusing on non-IT issues when, had we analyzed the evolution of ICT technologies, we may have either predicted or designed new technologies that would facilitate telecommuting implementation?

Question 4. There are important issues that should be more likely to occur to IS researchers than those in other fields, e.g., security. Understanding behaviors and context can inform security procedures, but is this an IT artifact?

It could be argued that if we truly look at the tools or conglomeration of technologies in detail, we may have to include security, performance, ease of use, compatibility with existing systems, and most certainly their implementation. So the question we ask is what are the attributes of the IT and are these attributes part of the IT artifact? If security is an attribute of an IT, as it arguably is, then security is most certainly worthy of study. However, many of the attributes of an IT are perceptions, and perceptions of users and management influence the adoption and implementation of ICTs. Telecommuting is a prime example and so much of the research has focused on perceptions of trust, proper management, etc. Perceptions and context therefore are closely tied to the attributes of the IT. In the case of security, management's perception of security risks may thwart a telecommuting implementation. So it would appear that since security is an attribute of a telecommuting implementation, security concerns inform behaviors and context, and leads to the argument that yes, the context is part of the IT artifact. From an attribute perspective, we can argue that certain issues such as security and understanding the context and behaviors surrounding telecommuting implementation are part of the IT artifact. Moreover, the use of ICT by telecommuters is integral to the work environment but also reflexively influences how telecommuting is carried out, and how the work environment is structured. The IT artifact notion places bounds on what is to be studied and may unintentionally limit the contribution of the IS field in areas where it has significant expertise. In the case of security, uses of ICT can lead to innovative ways of working and managing that may have information security implications but are indirectly related to ICT. For example, recent research has found that remote team members are not always aware of the bounds of the total team membership [5]. While this finding may not be considered an issue related to the IT artifact, it clearly has information security implications (are members sure of the identity of the person they are giving information to?). Humans add an element of dynamism that increases the security concerns and make security issues dynamic. Because of the flow of information and the potential threat to that flow that evolving security issues pose, security is a part of the IT artifact. This type of argument shows that humans' use of the IT is an essential part of the IT artifact. But are behaviors made possible by the use of IT, and are their consequences still considered a part of the IT artifact?

2 Panel Members

Panel Facilitator: Mary Beth Watson-Manheim

Panelists: France Bélanger, Susan Harrington, Nancy Johnson, and Derrick Neufeld

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About the Panelists

Dr. Mary Beth Watson-Manheim is Associate Professor of IS in the Information Decision Sciences Department at the University of Illinois at Chicago. Dr. Watson-Manheim's research interests include impact of information and communication technologies on work; managerial, social, and technological implications of virtual work environments; and IT-enabled organizational change. Her research has been published in such journals as *MIS*

Quarterly, Journal of Management Information Systems, IEEE Journal of Professional Communications, Information Systems Journal, Group Decision and Negotiation, Information Technology and People, and others. Her research has been funded by Intel Corporation, IBM Center for the Business of Government, and Lotus Development Corporation.

Dr. France Bélanger is Associate Professor and Alumni Research Fellow of Information Systems at Virginia Tech. She is Associate Editor of *MIS Quarterly* and the *Journal of Electronic Commerce in Organizations*. Dr. Bélanger's research focuses on the use of telecommunication technologies in organizations, in particular for distributed work and electronic commerce. She is widely published in IS journals such as *Information Systems Research, MIS Quarterly, Communications of the ACM, IEEE Transactions on Professional Communication, Information Systems Journal*, and many others. She has co-authored two books. Her work has been funded by the National Science Foundation, Department of Education, and several corporations and research centers. She held a Fulbright Distinguished Chair in MIS in 2006.

Dr. Susan J. Harrington is professor and interim chair of the Information Technology Division at Macon State College. She was a professor of IS at Georgia College & State University from 1994-2005 and at Kent State University-Stark campus from 1986-1994. She has 13 years of IS experience in industry. Her research interests include ethical decision making in organizations, IT adoption and diffusion, telecommuting/telework, information requirements analysis, trust, and corporate culture. She has studied the behavioral and managerial aspects of telework. She has published in *MIS Quarterly, e-Service Journal, IEEE Transactions on Professional Communication, Journal of Business Ethics, DATABASE, Information & Organisation*, and several management journals.

Dr. Nancy Johnson has worked in academia for over twenty years, and in industry for twenty years. She is an adjunct faculty at Metropolitan State University, St. Mary's University, the Fielding Institute, and Potchefstroom University (South Africa). She was a faculty, Director of residential colloquia, and Associate Dean of Business at the School of Technology of Capella University. She was faculty at Metropolitan State University from 1991-2000. Author of five book chapters and numerous articles, she was guest editor for an issue on telecommuting of *Journal of End User Computing* and editor of a book on virtual offices. She was a Fulbright Scholar in 1992 in Malaysia. Her interests include human factors in successful change management, distance education, justification methodologies of IT investment in the public sector, and international use of IT.

Dr. Derrick Neufeld is Associate Professor of IS at the Richard Ivey School of Business. Dr. Neufeld's research is focused on the ways in which virtual organization impacts individuals, teams and managers. He is currently studying the effects and effectiveness of such topics as telecommuting (working at a distance), e-mail (communicating at a distance), group support systems (team-working at a distance) and remote leadership (managing others at a distance). His research has been published in *Leadership Quarterly, Information & Management, DATA BASE, Journal of Engineering and Technology Management*, and *Journal of Computer Information Systems*.

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Virtual Patients

Virtuality and Virtualization in Health Care

Bonnie Kaplan[1], Peter L. Elkin[2], Paul N. Gorman[3], Ross Koppel[4], Frank Sites[5], and Jan Talmon[6]

1 Yale Center for Medical Informatics, Yale University, New Haven, CT; Department of Biomedical & Health Information Sciences, University of Illinois at Chicago, Chicago, IL; Kaplan Associates, Hamden, CT
bonnie.kaplan@yale.edu
WWW home page: http://ycmi.med.yale.edu/people/kaplan.html

2 Department of Internal Medicine, Mayo Clinic College of Medicine, Rochester, MN, Elkin.Peter@mayo.edu

3 Department of Medical Informatics and Clinical Epidemiology, School of Medicine, Oregon Health & Science University, Portland, OR
gormanp@ohsu.edu

4 Department of Sociology; and Center for Clinical Epidemiology and Biostatistics, School of Medicine; University of Pennsylvania, Philadelphia, PA, rkoppel@sas.upenn.edu

5 Operations Director, Penn E-lert eICU, University of Pennsylvania Health System, Philadelphia, PA, Frank.Sites@uphs.upenn.edu

6 Department of Medical Informatics, Faculty of Health, Medicine and Life Sciences, Maastricht University, Maastricht, The Netherlands
Talmon@mi.unimaas.nl

Abstract. In medical education and clinical care, representations of the patient help health care teams in planning and coordinating patient care, sometimes over geographic distances. This takes forms ranging from telemedicine consultations to using simulations and information and communication technology representations to plan, and at times, perform clinical procedures such as are done in intensive care units or in surgery. The increasing reliance on computer-mediated interaction in health care generally is considered the means to more efficient, equitable, and cost-effective care with reduced errors. Clinical work, then, may be carried out with simulated images and processes rather than through such physical processes as examining the patient directly. Instead of treating the actual person, one result may be that clinicians are treating computer-mediated representations of that person.

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This session explores virtuality in health care environments, with a particular focus on the virtual patient. Panelists discuss treating representations of patients by addressing how: (1) usability studies reveal the extent to which physicians may pay more attention to representations of the patient condition rather than to the actual patient, (2) images may be considered as more real than the patient, (3) different graphic representations of patient data have different consequences, and (4) virtuality affects quality of care in virtual intensive care units. From different research and theoretical perspectives and studies in these different environments with different technologies, panelists discuss repercussions of virtuality on teamwork and service delivery in health care. Their presentations of developments leading towards virtual patients point towards significant issues of virtuality in other environments.

1 Introduction

Information technologies increasingly are being integrated into medical education and clinical care so that representations of "the patient," such as electronic health records and patient simulations, are becoming more prominent, and, in some cases, replacing the actual patient. These representations help health care teams in planning and coordinating patient care, sometimes over geographic distances. However, rather than treating the person, one result may be that clinicians are treating computer-mediated representations of the person. This trend takes forms ranging from telemedicine consultations to using simulations and information and communication technology (ICT) representations to plan, and at times, perform, clinical procedures. Clinical work, then, may be carried out with simulated images and processes, or in simulated environments, rather than through such physical processes as directly examining the patient.

The increasing reliance on computer-mediated interaction in health care generally is considered the means to more efficient, equitable, and cost-effective care with reduced errors. This techno-utopian perspective is counterbalanced by concerns over moving the locus of care from the actual patient to representations of the patient, and decision-making from the bedside to either the conference room or to health care team interactions mediated by the ICT.

Panelists explore virtuality in health care environments, with a particular focus on the virtual patient. They discuss the shift from treating the patient to treating representations of the patient. In particular, Peter L. Elkin will discuss how usability studies in health care reveal the extent to which physicians may pay more attention to representations than to actual patients, with significant consequences for organizational mission. Bonnie Kaplan will draw on ethnographic field research to present how the meaning of clinical images is negotiated, despite belief that the image represents "what's really there." She found that the image may be treated as more real than the patient. She will raise issues of objectivity and subjectivity in virtuality. Paul N. Gorman's studies of graphic representations of patient data explore the consequences of different ways virtual patients may be presented, to different effect, and, therefore, what different representations mean for team work and organizational mission. Ross Koppel and Frank Sites will integrate these themes of how virtuality affects patient care by discussing how communication and coordination difficulties affect patient safety and quality of care change in a virtual intensive care unit.

From different research and theoretical perspectives and studies in different environments where different technologies were used, panelists discuss repercussions of virtuality on teamwork and service delivery in health care. Their presentations of developments leading towards virtual patients point towards significant issues of virtuality in other environments. Among these issues, the panel addresses general conference themes of:

- What is gained and lost by focusing on representations rather than actual individuals, including how creating the virtual may detract from interaction with the real;
- To what extent the medium matters, and how paper record representations and ICT ones compare in their effects and use;
- How individualized customer service and organizational mission can be enhanced or reduced by virtuality;
- How teamwork may change in virtual environments;
- What current trends towards increasing use of ICT in health care indicate about the nature, direction, and future of the technology, the work, and the organizations where this is occurring; and
- What virtuality in health care suggests about the dual nature of technology, in which human action and the social context in which the action takes place both shape the technology, while the technology simultaneously influences human action and social structures.

2 Panelists' Statements

Elkin: We do usability trials executed at Mayo to simulate how physicians would actually use different ICT applications that involve virtual representations of patients. Trials range from web-based teaching tools that train physicians to take their board examinations to accessing on-line medical records both to enter and obtain patient data. National policy recommends maintaining on-line medical records as an aid to coordinate patient care among various clinicians, while having physicians directly enter patient data is promoted as a way to reduce errors. The trials showed the medical records system caused the desk staff to turn their backs on patients. As a result, the system was revised substantially before implementation, and Mayo saved $1,500,000 by not implementing a system that went against our culture.

Gorman: Clinicians develop models or virtual representations of each patient, but the models of a given patient by different clinicians are different. One example of this is the list of medications each clinician-entity maintains for each patient. My most recent work on medication reconciliation indicates that some of these lists differ, and are more appropriate than others. These differences can make reconciliation difficult and potentially contribute to miscommunication. Understanding these differences can help us understand care processes and communication.

Kaplan: Results from two ethnographic studies of clinical images at medical centers raise issues of objectivity and subjectivity in virtuality, and suggest the importance of face-to-face meetings to negotiate the meaning of shared virtual representations.
In the first study, I did interviews and observations at the alpha site for a new system that incorporated clinical images into on-line patient records. For the second study, I conducted a week-long observation of one clinician to investigate how images were used in clinical work. At the first site, clinicians talked of on-line images as showing "what's really there" and lauded their improved ability to base clinical decisions on the images. At the second, where an on-line imaging system was to be developed, images, too, were objectified, even though I observed the meaning of the images being negotiated through in-person meetings and consultations.

Koppel and Sites: In an on-going study, we find that patient care and staff interactions are different when patients are in traditional intensive care units (vs. when patients are also tended by clinicians in virtual or electronic intensive care units (e-ICU). In e-ICUs, information from cameras and patients' monitors is sent in real time to a remote location (perhaps thousands of miles from patients). e-ICUs are presented as safeguards for patient safety, but they require close cooperation between bedside-clinicians and remote-clinicians. Even with virtual representations of patients and presumably seamless connections between locations, there are powerful differences in the information's reliability, quality, timing, and format. Sub-optimal information flow, data integration, and varying system acceptance by bedside clinicians, contribute to variations in care.

About the Panelists

Peter L. Elkin, MD is a Professor of Medicine at the Mayo Clinic College of Medicine. He is the index recipient of the Homer R. Warner award for outstanding contribution to the field of Medical Informatics. He is a fellow of the American College of Physicians and of the American College of Medical Informatics. He chairs the International Medical Informatics Association Working Group on Human Factors Engineering.

Paul N. Gorman, MD is Associate Professor of Medical Informatics and of Clinical Epidemology, School of Medicine, Oregon Health & Science University, as well as the Assistant Director of Medical Education at Providence Portland Medical Center. A fellow of the American College of Medical Informatics, he chairs the American Medical Informatics Association Education Working Group, and was chair of the Information Technology in Health Care conference in 2004.

Bonnie Kaplan, PhD is a Lecturer in Medical Informatics at the Yale School of Medicine, and Yale College, and is an Adjunct Clinical Professor of Biomedical and Health

Information Sciences at the University of Illinois at Chicago. A Fellow of the American College of Medical Informatics and recipient of the American Medical Informatics Association President's Award, she chairs the International Medical Informatics Association Working Group on Social and Organizational Issues. Bonnie Kaplan co-chaired the IFIP 8.2 conference resulting in the book *Information Systems Research: Relevant Theory and Informed Practice*, 2004.

Ross Koppel, PhD, is the Principle Investigator of the study of The Role of Hospital Workplace Culture and Medication Errors–a project based at The University of Pennsylvania's School of Medicine. He is the President of the Association for Applied and Clinical Sociology and recipient of Applied Sociology's major awards.

Frank Sites, MHA, RN has over 13 years of health care, research, and administrative experience. He has worked in the health information technology industry, helping to customize and implement technologies in parallel with workflow process. Now the Operations Director for the Penn E-lert eICU, the telemedicine system at the University of Pennsylvania Health System, he has been intimately involved in the implementations of a major computerized physician order entry system across the health system and has worked to identify process changes in workflow.

Jan Talmon, PhD has been leading an EU-funded concerted action on System Engineering in Health Informatics with a focus on evaluation, he was co-leader of the EU-funded concerted action on Assessment of information Technologies In Medicine (ATIM), participated in various EU-funded projects in which he contributed to the evaluation work packages. He is chair of the International Medical Informatics Association Working Group on Technology Assessment and Quality Improvement, and co-editor of the *International Journal of Medical Informatics*.

Index of Contributors

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