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Rae Earnshaw

Art, Design and Technology: Collaboration and Implementation

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Foreword

In this book, Rae Earnshaw emphasizes the collaboration between art, design, and technology in a unique way. This association of art and design with technology seems at first glance not very natural. Artists may be perceived as less rational than the rest of people, while scientists are often considered as rather rigid as and less artistic than others. However, artistic and technological creations have essentially something in common; both are human creations. Leonardo da Vinci is renowned primarily as a painter, but he made substantial discoveries in anatomy, civil engineering, geology, optics, and hydrodynamics and designed many machines. Einstein is one of the greatest physicists of all time and was a fine amateur pianist and violinist.

The oldest example of collaboration between art and technology is probably the making of Automata. These complex mechanical devices are known to have already existed in Hellenistic Greece, but were still present in Middle Age and the Renaissance. You may admire some of these marvelous pieces of art and technology in the CIMA Museum in Sainte-Croix in Switzerland.

I also would like to mention the permanent exhibition Future World at the ArtScience museum in Singapore. In one of the attractions, children can color pictures of vehicles, planes, or buildings as they wish. They then scan their picture, and it will appear on a large screen integrated into a city image displayed for everybody. The pictures do not just bounce around the screen randomly, the vehicles move along the road, the planes fly in the sky, and the buildings are placed on an empty space on the ground. It is just an amazing technology for children that stimulates their creativity.

Singing is an art and singers are artists, but most singers (except opera singers) need a key piece of technology: the microphone. And there is a microphone art: Microphones are beautiful pieces of equipment and have been the staple of design in any studio.

The commercial success of Apple is also an interesting example of collaboration between art and technology. Why do laptops have to be always sad and gray, or mobile phones so unattractive? Apple has shown that it is possible to be creative in both technology and design by launching attractive models of reliable computers, mobile phones, and tablets.

I would not like to finish this foreword without emphasizing that I have known Rae Earnshaw since the end of the 1980s. We were both among the founders of the Computer Graphics Society (CGS) with Prof. Nadia Magnenat Thalmann and Prof. Tosiyasu L. Kunii. Rae organized three times the main CGS conference, Computer Graphics International (CGI) in 1989, 1992, and 2002. We had also the great opportunity to work together in EU projects such as VISINET and VPARK. While I was more involved in virtual humans and virtual reality, Rae Earnshaw pioneered the area of digital media and it was already a promotion of the collaboration between technology, art, and design. This book concretizes this early vision.

March 2017

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Preface

The first book[1] in this subject area covered the key aspects of collaboration and communication in Research and Development (R&D), and how technology may be used to support creativity in the R&D process. This included how research and development in art and design may be formulated, and framed, and then evaluated and measured, and the valuable contribution that art and design makes to the scientific and technological enterprise and vice versa. A second book[2] covered the collaboration between the academy and industry to support developments in the creative industries and more general industrial applications.

This book examines the relationship between art, design, and technology—in particular, in the areas of collaboration and implementation. These aspects are also illustrated with a number of illustrative case studies. The latter are used to examine how the processes of collaboration and implementation work out in practice, and the lessons that may be learned from this.

Art and design have a long history of using a variety of tools and materials—whether naturally occurring or man-made—to produce a creative work, or artifact, or achieve a particular design objective. Thus, technology and collaboration have always been implicit in art and design to some degree—whether to learn how to optimally use a tool (e.g., stone, pencil, paint brush, or iPad) or to interact with other artists to gain from their knowledge and experience.

Many artworks also reveal their interaction with the social and cultural environments in which they were first produced. They often had a theme, some form of message, and also used a selection of materials from the contemporary world. The outputs resulting from this creativity also had the potential to subsequently modify the sociocultural environment that first produced them.

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[1] Earnshaw, R.A.: Research and Development in Art, Design and Creativity. Springer (2016) http://dx.doi.org/10.1007/978-3-319-33005-1.

[2] Earnshaw, R.A.: Research and Development in the Academy: Creative Industries and Applications. Springer (2017) DOI 10.1007/978-3-319-54081-8.

It is also clear that the extensive nature of many artworks produced by ancient civilizations means that it is likely that many were collaborative efforts—both to obtain the raw materials and then to transform them into their final art forms. However, it can be challenging to collaborate effectively across different discipline areas due to different cultures and ways of working. These challenges are summarized.

The digital revolution has created a connected world. The consequences for art galleries and museums are immense:

> The future of the museum may be rooted in the buildings they occupy but it will address audiences across the world—a place where people across the world will have a conversation. Those institutions which take up this notion fastest and furthest will be the ones which have the authority in the future
>
> — Sir Nicholas Serota[3]

The digital revolution has provided many user-friendly tools and facilities for the artist (e.g., iPad—David Hockney). Technology has facilitated the production of new kinds of artwork that have not been produced before (e.g., wall displays by David Hockney). Thus, it could be said to have facilitated creativity. Technology also provides low-cost multimedia interfaces and virtual reality. This can provide new dimensions of interactivity with artworks, as well as provide access to remote viewers over networks and the Internet.

Wireless digital technology (e.g., mobile phones) can be used to interact with installation art. The digital revolution has provided low-cost interfaces (e.g., multimedia, VR) to enable the viewer to interact with, and explore, large artworks such as installation art which may not be directly accessible to viewers.

A wide variety of low-cost, or free, application software is available to assist the artist and designer. High-functionality hardware is also available to perform functions in art and design that were not possible before—or at least, not easily, e.g., laser scanning, 3D printing, stereolithography. Software is also available to support art galleries and museums in the management and organization of exhibits.

The case studies in Chaps. 6–8 provide examples of how technology may be integrated with arts applications for a particular purpose, and the lessons that were learned from this. Each case study is authored by a specialist author (or authors), and they are detailed in the Acknowledgements section at the end of this Preface.

The University of Bradford, UK, pioneered the area of digital media in the mid-1990s by tripartite collaborations between technology, art and design, and media and broadcasting. It was done by setting up a new academic department because it did not sit easily within existing academic disciplines and structures. It was very successful in attracting students and also meeting the needs and requirements of industry. It also highlighted the benefits and advantages of interdisciplinary collaborations. Involvement in a number of large interdisciplinary

[3]Serota, N.: The Museum of the 21st Century, London School of Economics (7 July 2009) http://www.youtube.com/watch?v=tVhXp9wU5sw (52 min 43 sec).

European Projects over the years at the Universities of Leeds and Bradford required R&D in a number of application areas, such as multimedia assets for design, collaborative visualization over networks, and virtual entertainment and led to a number of important results. These are detailed in the first book referred to above.

Involvement as a professor in the School of Creative Arts at Glyndwr University, Wales, over recent years has provided opportunity to think about these aspects and publish a number of papers in collaboration with the faculty.

The book is being published in the Springer Briefs series which are summaries of the state of the art in a particular area. It is being published as a print book, a Kindle book, and an e-book. In the latter, each chapter will be downloadable separately. This is why the Further Reading and References appear at the end of each chapter. Thus, a chapter contains the main points in the area and the reasons for their significance. It is not intended to examine each of these points in detail—there is insufficient space to do this. However, the interested reader can follow up in the Further Reading or References for further detail and information.

It is hoped that this book makes a useful contribution to an important area of discussion and debate.

Acknowledgements

Chapters 6–8 are case studies, and thanks are expressed to all the authors who contributed these chapters. Chapter 6 on '*Using Mobile Technology to facilitate Engagement with the Arts for Children with Autism and their Families*' was supplied by Dr. Tracy Piper-Wright, University of Chester, UK. Chapter 7 on '*The Development of New Technology in Creative Music Applications*' was supplied by Dr. Stuart Cunningham, Steve Nicholls, and Steffan Owens, Glyndwr University, UK. Chapter 8 on '*Visual Arts, Mental Health and Technology*' was supplied by Dr. Karen Heald, University of Bangor, UK, and Dr. Susan Liggett, Glyndwr University, UK.

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Bradford, UK
March 2017

Rae Earnshaw

Contents

Chapter 1
History

Abstract Artifacts and objects have a long history. They communicate value and meaning through being observed and studied, particularly in their original context insofar as this can be determined for very ancient artifacts. However, they clearly shaped the social and cultural environments within which they were first created, and those environments may also have played a key role in the artifacts and objects which were produced. The developments of the Renaissance brought a more systematic view of the world where created objects could serve a practical purpose as well as a cultural and aesthetic one. Developments in technology created a bridge between the real-world and artistic endeavor. Art and design have enjoyed a productive and symbiotic relationship with traditional art and design environments and also with technology. It has widened the scope of art and design and enabled it to develop new approaches and new perspectives. This has benefited an understanding of artistic and design processes and the various ways of implementing them. Collaboration between art, science, and technology is reviewed. Many forms of technology have been utilized in art and design, and these are summarized.

Keywords Visual culture · Collaborative design · Computer-aided design · Virtual spaces · Virtual reality interfaces · Large format displays · Digital art

1.1 Early Developments

Art and design have a long history in antiquity. They have shaped the values, social structures, communications, and the culture of communities and civilizations. The direct involvement of artists and designers with their creative works has left a legacy enabling subsequent generations to understand more about their skills, their motivations, and their relationship to the wider world, and to see it from a variety of perspectives. This in turn causes the viewers of their works to reflect upon their meaning for today and the lasting value and implications of what has been created.

Some historical examples of art and design were able to use semiautomated methods for creation, particularly where large areas of a canvas or model needed to

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be filled in. However, it was only with the advent of modern technology that the advantages of harnessing digital techniques were able to be exploited. One of the earliest examples was the Architecture Machine [1] designed and implemented at the Massachusetts Institute of Technology (MIT). The objective was to enable digital technology to assist the user with design tasks, particularly those at large and small scales, where it was known that designers had particular challenges and difficulties. In addition, the computer was able to store data and reproduce designs, thus facilitating the speedup of the iterative process toward a final design which met the objectives of the designer and the requirements of the client.

1.2 Utilization of Technology

More recent examples of artists and designers interacting with technology include the use of the iPad [2] to produce sketches of scenes which were subsequently grouped into a montage to give a large wall display containing multiple images.

Art installations have also harnessed modern technology both to process information and to display it. Such environments have proved useful in engaging users and visitors with real-time images and interactive art.

Collaborative design has enabled the sharing of information across digital networks to produce designed objects in virtual spaces. Augmented and virtual reality techniques can be used to preview designs before they are finalized and implemented.

Ancient and modern art and design environments illustrate the design and implementation processes involved, and the opportunities for collaborating and interacting with other artists and designers.

1.3 The Value of the Arts

At times of economic downturn, or financial stringency, or when grant funding approvals require a demonstration of immediate impact or economic benefit to society, the value of the arts and culture to society comes under scrutiny. Its value to society has therefore to be periodically reassessed [3, 4]. In addition, the case has been made for a reconsideration of what is meant by 'value' where the term has come to be understood as principally synonymous with impact, or economic benefit, or making the case for public funding [5, 6]. It is recognized by national bodies that in times of economic recession or financial austerity then the arts and humanities come under attack [4, 7–9], and their value and merit need to be restated and reasserted.

1.4 Collaboration Between Art, Science, and Technology

There are also increasing opportunities for artists to use their skills and expertise to illuminate the latest discoveries in science and technology [10, 11]. There is increasing interest in extracting meaning from very large data sets, which in turn requires sound methods of analysis and presentation of the results. Science and technology is also able to contribute increasingly to the arts, either as a component of the artistic output, or as a part of the methodology used to produce the output. In addition, the traditional boundaries between the arts and technology are becoming blurred due to the way computing technology is being embedded into the everyday environment in a seamless way and the use of social media which enables a greater degree of involvement and sharing by the community. Social media can open up new dimensions of interaction and participation in both the arts and the sciences.

1.5 The Arts and Technology

Many forms of technology are potentially useful and enabling for the arts. These are summarized in this section. More detail on the functionality of the technology is provided in Chap. 3.

1.5.1 Information Technology

Information technology can be used to support the preparation of documentation for artworks and also for the optimum way of displaying them in an exhibition (whether real, or on the Internet). In addition, multimedia facilities can be utilized for the preparation of online digital brochures [12].

1.5.2 Computer-Aided Design

Standard software packages are available to perform 2D and 3D design on a desktop or laptop (e.g., [13]).

1.5.3 Mobile Phone

Increasing screen size, functionality, and power in the mobile phone are enabling more applications to be run on a mobile phone.

1.5.4 iPad

New technology can provide tools and facilities to augment the traditional art and design processes, as has been illustrated by Hockney's use of the iPad [14]. The technology is utilized in the creation and also in the display, where the content of each screen is combined into an overall montage for a wall display.

1.5.5 Wall Displays

A wall display can use multiple monitors or video projection. They can be used for high-end applications where large amounts of detail need to be examined. However, the reducing costs of monitors have enabled these to be used for more general applications [15].

1.5.6 Virtual Reality Interfaces

Virtual reality interfaces provided a more immersive experience for artists and designers and are used for 3D design, simulations, and walk-throughs. More detail is provided in Chap. 3.

1.5.7 Virtual Exhibitions

In the past, artists have relied upon physical exhibitions to display their works. These can also now be done online and made available to a global audience. In addition, traditional art galleries often use the Internet to also display their works online.

1.5.8 Collaborative Design Over Networks

Computer networks enable collaborators who are physically remote from each other to be brought together into a shared virtual space to collaborate on a design [16, 17]. Such environments can be used for a variety of applications including simulation, planning, rehearsal, and entertainment [18–21].

1.5.9 Analysis by Computer

An example of the analysis of cultural artifacts by computer is the Digital Michelangelo Project [22, 23]. Its objectives were to advance the technology of 3D scanning and to create a long-term digital archive of significant cultural artifacts in Italy. These archives were made generally available over the Internet.

1.5.10 Digital Art

Artistic works may use digital methods to produce digital art [24]. Computer games may be considered as a particular kind of digital art as they use computer technology to produce the game.

1.5.11 Digital Audio and Video

Digital audio and video enable the recording, storing, manipulation, and reproduction of sound and video [25].

1.5.12 Motion Capture

Motion capture is a process which records the movement of objects or people by means of cameras [26].

1.6 Conclusions

Digital technologies are having a far-reaching impact on all areas of society including the arts. In addition, the Internet has provided a new dimension for the arts in terms of communication, content, and collaboration.

This book also includes a number of case studies which illustrate the utilization of technology.

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Chapter 2
Independent Working, Collaboration, and Team Activity

Abstract Although many artists and designers choose to work independently, those who also work with the academy often share ideas about future artworks or designs, and also local and national grant funding opportunities. Collaboration and team working may enable larger and more complex projects to be undertaken. Artists have been able to contribute to new kinds of projects within the artistic world, and also work with scientists to stimulate creativity and produce new knowledge. Such a Renaissance team could include expertise on the use of color, visual paradigms, and metaphors. Interdisciplinary collaborations can have significant potential but can be difficult to implement and manage. However, new knowledge and new disciplines can arise at the boundary between existing disciplines. Thus, the potential for a major breakthrough is significant. The challenges for interdisciplinary collaborations are discussed. The use of digital tools can have a positive impact on the arts and cultural organizations. They can also be used to support and facilitate collaborations—both online and off-line.

Keywords Collaborative art and design · Creative collaboration · Renaissance team · Digital tools · Interdisciplinary collaboration · Interdepartmental laboratories · SciArt

2.1 Introduction

Art and design are participatory tasks on the part of artist and designer. An artist communicates with their artwork during the course of its development, as they iterate to the final work. A designer interacts with their design during the design process. Although many artists and designers choose to work independently, those who also work with the academy often share ideas about future artworks or designs, and also local and national grant funding opportunities. Artists and designers who normally work in the academy, or as part of another organization or company, are already part of a community and probably also a team with cognate interests. Those who choose to work alone, or in isolation, still rely on the outcome of their work,

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and to be able to communicate it effectively to one or more third parties. For an artwork, it is to those who view it. For a designed object or building, it is to those who commissioned it, have to approve it, have an interest in it, or will ultimately live or work in it.

2.2 Collaboration

Artists have used collaboration to complete large-scale works for centuries, even though the public perception is often that artists work alone [1, 2]. Collaboration between artists may be due to a shared interest in the subject matter, the methods of working, or the size and complexity of the artwork produced.

Constituent elements of collaboration include the following:

- Motivation—the objectives and benefits of the project
- Communication—dissemination of information about the project
- Sharing—ideas and an understanding of their ownership
- Support—how the collaborators can help each other
- Problem solving—getting round difficulties or changes in direction in the project
- Diversity—utilizing a variety of skills and expertise when required [3].

Collaborations may differ in their emphasis and in how they work depending on the circumstances, the collaborators, and the project.

2.3 Creative Collaboration

A creative collaboration has the goal of creating an outcome, and the team's objective is to achieve this goal. A team may be needed rather than a single individual because of the volume of work, or because the multifaceted nature of the task requires multiple skills.

Artists have been able to contribute to scientific analysis and enable new results to be produced [4, 5]. Such Renaissance teams can stimulate creativity and produce new knowledge [6] in a way that would be very difficult, if not impossible, for a single artist to do on their own. SciArt is a term used to describe the artistic contributions that can be made to scientific investigations [7].

According to Cox, it is necessary to consider some codes of behavior for successful teams to be able to work successfully:

1. There must be a common, passionate goal for the team members
2. Members must have mutual respect for each other member and his/her discipline
3. Each member must be willing to learn from other members of the team
4. Each member must recognize other's intellectual territory

5. The team should not have too many members
6. The team must continually check to make sure that the research is making progress
7. Members must not become overcommitted to other projects
8. One person must carry the flag for project as a champion and coordinate efforts
9. Each member must be credited and given his/her recognition when the project is presented or publicized
10. Each member must get something out of the project which is personally rewarding and tangible [8].

Connective Collaboration

A connective collaboration taps into the potential contributions and expertise of individuals in the community. Social media may facilitate this kind of collaboration.

Compounding Collaboration

This builds on the previous work of others and takes it further [9].

2.4 Digital Technology

Digital technology can contribute to the arts and cultural organizations. NESTA's Digital R&D Fund for the Arts [10] supports ideas that use digital technology to build new business models and enhance audience reach for organizations with arts projects [11].

A variety of digital tools are available for supporting collaborations [12].

2.5 Interdisciplinary Collaboration

Snow [13] identified cultural differences between science and the humanities which made communication across the divide difficult. It is unclear whether this was due to differences in language and vocabulary between the arts and the sciences, particularly the technical terms often used in the latter area, or whether there were more fundamental differences. Critchley [14] proposed that Snow:

> *diagnosed the loss of a common culture and the emergence of two distinct cultures: those represented by scientists on the one hand and those Snow termed 'literary intellectuals' on the other. If the former are in favour of social reform and progress through science, technology and industry, then intellectuals are what Snow terms 'natural Luddites' in their understanding of and sympathy for advanced industrial society. In Mill's terms, the division is between Benthamites and Coleridgeans* [14].

However, Gould took an opposing point of view and emphasized the commonalities between science and the humanities [15]. In 1963, Snow appeared to take a more optimistic view about the relationship between science and the arts and [16].

Shneiderman [17] advances the case for combining applied and basic research and a new paradigm for interdisciplinary collaboration that puts engineering and design on an equal footing with basic science.

Advancing interdisciplinary research can be a major challenge and some of the current difficulties were outlined in [18].

2.6 MIT Media Laboratory

The MIT Media Laboratory is an interdisciplinary research laboratory at the Massachusetts Institute of Technology devoted to projects at the convergence of technology, multimedia, sciences, art, and design.

A recent advertisement (November 2016) for a faculty position at the MIT Media Laboratory indicates the importance attached to interdisciplinary expertise (and beyond traditional disciplines), delivery, and real-world applicability [19]:

> *The MIT Media Lab is seeking a candidate to fill one tenure-track faculty position. Appointments will be within the Media Arts and Sciences academic program at the junior faculty level. The Media Lab is an antidisciplinary lab with decades of experience in the development of new technologies for social change and longstanding involvement in societal development.*
>
> *Every country is a developing country in its own way. Both rich and poor nations face development issues, from mass incarceration and institutionalized segregation, to inadequate housing and lack of economic opportunities. To help address the deep development problems affecting countries at all levels of income, the ideal faculty candidate should be focused on development by creating and testing enabling technologies, as well as advancing the understanding of the core issues underlying development problems. Candidates should have a strong record of research and practice, a willingness to take risks, a desire to look beyond traditional disciplines, and a dedication to making a difference in the world.*
>
> *You can be a designer, inventor, scientist, or scholar–any combination–as long as you make things that matter. Impact is key. A doctorate or equivalent experience is required.*
>
> *Successful candidates will be expected to: establish and lead their own research group within the Media Lab; pursue creative work and research of the highest international standard; advise master's and doctoral students; participate actively in the Media Lab community; and teach at the graduate level in the Media Arts and Sciences program.*
>
> *To apply, please fill out the application (http://apply.interfolio.com/38628). Applicants will be asked to upload their CV, personal website URL, links for three publications, the names (and contact information) of three references, and a personal statement of no more than two pages that includes the applicant's plans for exploring big ideas and challenging questions, and discusses what the applicant will bring to the Media Lab and how the Lab will enable you to accomplish your goals.*
>
> **Application deadline: December 20, 2016**
>
> *MIT and the Media Lab have a strong commitment to diversity in education, we especially encourage minorities and women to apply. MIT is an Equal Opportunity/Affirmative Action Employer. EOE.*
>
> *Questions? Contact faculty-search@media.mit.edu* [19].

As a world-leading institution, MIT is able to attract major industrial sponsors at international level to fund projects in the MIT Media Laboratory [20]. However, the founding of the Laboratory was not without its challenges and difficulties given that MIT was perceived as a world-class technology institution with highly performing engineering departments. Nicholas Negroponte was able to expand into digital media by building on earlier initiatives in the Architecture Machine Group within the School of Architecture and Planning, with the help and support of a former President of MIT, Jerome B. Wiesner. This was able to overcome any challenges and potential opposition within the institution. However, in universities of lesser standing there has been opposition from traditional engineering departments to new initiatives of this kind as they are perceived as ‘diluting the brand’ of engineering. Strongly performing departments wish to protect their position and reputation against any perceived threat, particularly in competitive environments for funding internally and externally. The MIT Media Laboratory is still within the School of Architecture and Planning, whereas in other institutions they tend to have closer connections historically with departments in the areas of computer science, electronic engineering, or media and arts.

There is increasing evidence that the value and significance of interdisciplinary research and development is being recognized in leading universities. The provost of MIT indicated that MIT’s success in achieving its fifth position in the World University Rankings in 2016 was principally due to its interdisciplinary approach [21], which was fostered through interdepartmental laboratories, shared facilities, and initiatives centered on global problems [22]. Working across disciplinary boundaries in a collaborative way enabled faculty and students to see opportunities that might not otherwise be seen if they were working in a disciplinary silo. In addition, the interdisciplinary approach was also implemented at undergraduate level, where all undergraduates were required to take at least one humanities or social sciences subject per semester, regardless of their specialism.

This may be less common in other institutions where students are more strongly tied to their home academic department throughout their undergraduate studies, often for financial reasons as well as traditional academic practice. In Europe, students tend to graduate in a particular subject, whereas in the USA although they may have a major subject, they can accrue credits by taking other subjects as well that count of equal weight on the final transcript. Some universities in the UK are moving to transcripts in the interests of transparency and openness toward the student, as well as potential benefits to employers (as they can see the student’s progress throughout the course, not just the result of the final examination). However, some institutions only include the final year marks in the transcript, as this is the primary, or sole, measure used to decide the class of degree to be awarded to the student [23, 24].

Universities of lesser standing than MIT may find it difficult to attract external sponsorship for research and development in new and novel areas. Obtaining funding for interdisciplinary research proposals in many institutions can be difficult simply because such proposals may fall outside the traditional expertise of grant awarding bodies.

2.7 Arizona State University

Universities have long-standing traditions with regard to disciplines and structures. When these are well established, they are slow to change because they are thought to represent the collective wisdom of faculty over many years. Universities are also reluctant to change these disciplines and structures for the same reasons. However, if there are major changes in society, or the challenges that society faces, it is possible that these traditions and structures are not able to optimally address these challenges, simply because they have been founded in the past when society was different. Arizona State University has implemented a major restructure designed to address major social and environmental challenges by enabling it to operate beyond traditional discipline boundaries. The objective is to '*advance research and discovery of public value and assume fundamental responsibility for the economic, social, cultural, and overall health of the communities it serves*' [25].

The redesign of the university aims to '*maximize its potential to generate the ideas, products, and processes that impact quality of life, standard of living, and national economic competitiveness*' [26–28].

2.8 The Challenges of Collaboration

Collaborating across different subject areas can present a number of challenges. These can include the following:

- Different vocabularies to describe the disciplines
- Different norms and expectations for each discipline
- Different working practices for each discipline
- Different paradigms for evaluation of outcomes in each area
- Different budgets, resource allocation models, and resource center boundaries.

Innovation and creativity are challenging concepts to apply across disciplinary boundaries—for the reasons set out above. They are even more challenging when applied to new disciplines and new areas of research, from which new outcomes may emerge. At the same time, many fruitful innovations have come about because artists, scientists, and technologists with different perspectives and skills have combined to produce something completely new. For example, it can be argued that the fields of oceanography and cognitive science emerged from multidisciplinary collaborations [29].

Earnshaw [30] stated:

> *Some would argue that as existing disciplines have become well established, then it is more likely that new disciplines will tend to emerge along the boundaries of existing ones, rather than within them, and contain some of the elements from more than one discipline. Thus working at the boundary, or across the boundaries, is likely to be more fruitful in terms of research and developing new knowledge. However, this is not without its risks as noted by*

> *Blackwell et al.* [31] *because of the silo effect of current disciplines, as well as other factors. It is also well-known that interdisciplinary research tends to be less well understood by reviewers from the established disciplines because it is not regarded as sufficiently pure or traditional, or it may cut across the norms and conventions that have been established within a particular discipline.*
>
> *A further challenge has been noted by Snow* [32] *which is the antipathy between the arts and the sciences brought about by a long history of different understandings and modes of discourse about the world, and also the changes brought about by the Scientific Revolution* [33]. *These different modes of discourse, and understanding of what is regarded as relevant or significant, can make it difficult to accomplish interdisciplinary collaborative research. Yet it may be precisely this research that yields the new insights and the new forms of understanding that open up the future.*

Multidisciplinary, interdisciplinary, and transdisciplinary research are identified by Holzbaur et al. [34] as different aspects of collaboration across boundaries. The existing structures of knowledge and information may be inadequate to cope with their future expansion. Knowledge is increasingly interdisciplinary, and the traditional barriers between existing disciplines are being broken down in order to make progress. One way to begin to understand this transition, and start to address this challenge, has been set out by Wilson [35].

Cognitive diversity enables groups to find better solutions and also facilitates finding solutions when the problems are complex. Thus, collaboration across discipline boundaries may yield more ground-breaking results than collaboration within a discipline.

One effect of modern technology such as the Internet and the World Wide Web has been to break down traditional barriers. Formerly, collaborators were colocated within the same physical unit or structure in order to facilitate interworking. Virtual working now allows researchers to collaborate across time and space, sharing ideas and theories, experiments, simulations, and results [36, 37]. In theory at least, research and collaboration know no boundaries.

2.9 Conclusions

Pohang University of Science and Technology (Postech) ranks at position 104 in the World University League Table for 2017, 40th in engineering and technology 2017, and first in the world's top 100 universities under 50 years old by Times Higher Education for three consecutive years from 2012 to 2014. Its commitment is to—"*be a trailblazer exploring uncharted territories in higher education and research and prepare to take its next leap forward as a world-class institution of higher learning*". Postech has set up a new Dept of Creative IT Engineering:

> *The Department of Creative IT Engineering (CITE) is an academic unit of the POTECH i-Lab which was selected as a host institution for the 'IT Consilience Creative Program' by the Ministry of Knowledge Economy (MKE). The Department aims to train creative talents who will be on the nation's future frontiers in IT engineering. The IT Elite Program was launched by MKE to establish a university lab, comparable to the MIT Media Lab, and to*

foster convergence-oriented creative talents who will be the leaders of the global IT industry. The Department represents a new chapter of challenge for POSTECH, and pushes forward a model of education and research with the support of the POSTECH i-Lab [38].

The attributes of the education and research programmes are—"*Creative, Collaborative, Cultivating, and Convergence*".

Mark Gatenby in an article on the Utopia [39] presents the case for creating '*new spaces for universities that can be occupied by post-disciplinary thinkers who want to think about the world in more open-minded ways*':

In his recent book, The Hidden Pleasures of Life: A New Way of Remembering the Past and Imagining the Future, Theodore Zeldin, the conversationalist philosopher, notes how over millennia human civilisations have clashed through two contrasting visions of social life. On the one hand, there is the view of civilisation as a city-fortress, surrounded by walls, protecting itself against barbarians and rejecting the vices of the external world. On the other hand, there is the city-port, always hungry for what it does not possess, searching for a better life by trading with strangers and importing novelties without too many worries about where they might lead. Many university disciplines have become more like the former than the latter. Threats of government policy, markets and commercialisation have led to their becoming increasingly defensive and closed in.

If we go back to More's island imagery, we can think of universities today as drifting archipelagos of academic disciplines. Each island has a cathedral at its centre, extolling the discipline's canons and creeds. The occupation of every islander is to serve the unending process of building and embellishing the cathedral. And the limited size of most islands gives their inhabitants a continual and inescapable reminder of their vulnerability to the dangers posed by foreign lands [35].

He reminds readers of the lectures given by the President of the University of Chicago, Robert Hutchins, in 1953:

In 1953, the president of the University of Chicago, Robert Hutchins, gave a series of lectures on the University of Utopia, asking what universities should ideally become. Hutchins was a traditionalist in the Western canon, believing that universities should build a compulsory core curriculum that all students should master as the foundation, before specialising in a profession or occupation. But Hutchins also believed that the University of Utopia would be a connected and coherent intellectual community, not a dispersed archipelago. "In Utopia," he wrote, "the object is to make it possible, and even necessary, for everybody to communicate with everybody else. Therefore, the University of Utopia is arranged so as to force, in a polite way, the association of representatives of all fields of learning with one another."

I am not Utopian enough to think that contemporary university departments will ever coalesce around a core curriculum shared by all students. But I do believe that "disciplinarity" has reached its limit and should be looked on as a twentieth-century idea. Disciplinary theories and methods have become too insular to address important questions in the contemporary world [39].

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Chapter 3
Utilization of Digital Technologies

The future of the museum may be rooted in the buildings they occupy but it will address audiences across the world—a place where people across the world will have a conversation. Those institutions which take up this notion fastest and furthest will be the ones which have the authority in the future.

Sir Nicholas Serota 2009 [1, 2].

Abstract Digital technologies have revolutionized how creative works may be created, distributed, accessed, and used. It is expected that for the immediate future, Moore's law will ensure that computational power will continue to increase at current rates, bringing more speed, capacity, and connectivity to handle more sophisticated applications and end-user requirements. Post-silicon technologies are reviewed and evaluated. Post-wimp user interfaces can provide flexibility and innovation for a wide variety of applications including those in the areas of art and design. The increasing availability of lower cost virtual reality interfaces is providing new opportunities for artists and designers.

Keywords Digital technologies · Moore's law · Post-silicon technologies · Post-wimp interfaces · Virtual reality

3.1 Moore's Law

Moore's law states that overall processing power for computers doubles every 1.5–2 years, or less [3]. This also applies to telecommunications. Although a general guide rather than a fundamental law, it has proved remarkably consistent since the implementation of the first semiconductor integrated circuit in 1960 (Fig. 3.1).

It is expected that for the immediate future, Moore's law will ensure that computational power will continue to increase at current rates, bringing more speed and capacity to handle more sophisticated applications and end-user requirements. Devices are becoming increasingly intelligent and are able to monitor data and environment. Automobiles can contain up to 100 microprocessors to monitor the various functions of a car. New cars carry 200 lb of electronics with over a mile of

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SpringerBriefs in Computer Science, DOI 10.1007/978-3-319-58121-7_3

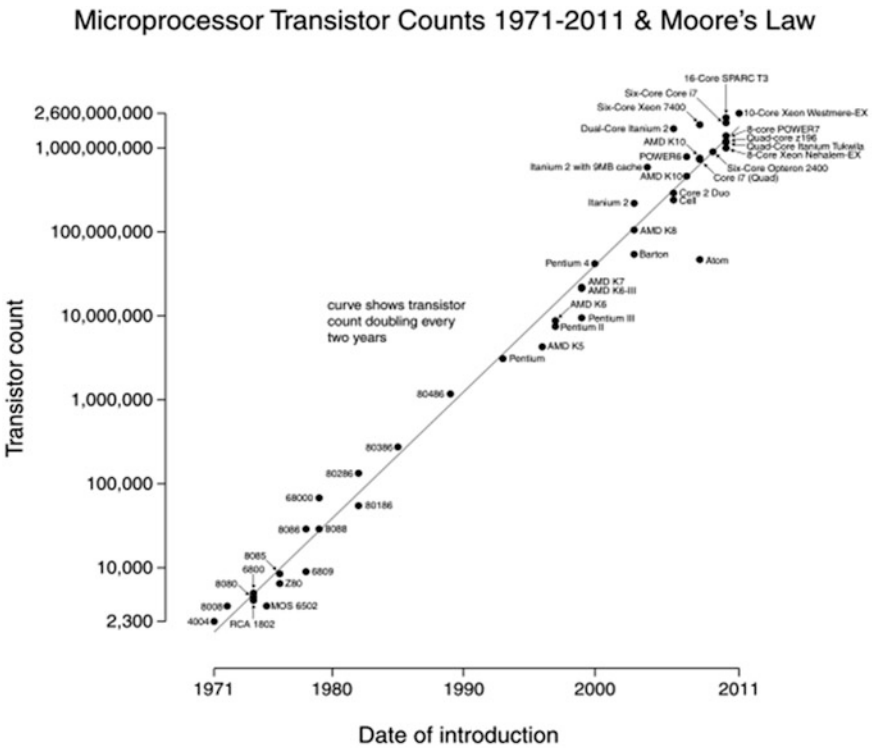

Fig. 3.1 Plot of CPU transistor counts against dates of introduction. Note the logarithmic vertical scale; the line corresponds to exponential growth with transistor count doubling every two years. *Source* http://en.wikipedia.org/wiki/Moore%27s_law

wiring. On a wider front, the Internet of Things is able to connect together the embedded devices that can provide a wide variety of data and sensor information. Gartner [4] estimates that there will be 26 billion devices on the Internet by 2020. A network of autonomous smart devices will enable a whole range of operations and applications to be carried out without direct intervention by the user.

Utilization of digital media systems and the increase in the use of social media appear to follow the law of sharing, an equivalent of Moore's law in the context of social media. The law of sharing states that the average amount of shared information doubles every year [5]. The analogy helps businesses to be aware of the rapidly changing environment in which they are operating, and enables them to define business information handling requirements, and develop and accelerate commercial and social applications, where appropriate.

Denning and Lewis [6] expect that many additional years of exponential growth are likely even if CMOS technologies reach their limit. As alternatives become feasible, it should be possible to switch to new technologies and continue the growth path.

3.2 Computing Technology Post-silicon

Since 2002, the heat generated in the circuits has so far limited clock speeds to 3.5 GHz (such as Intel Pentium 4), because the cost of heat dissipation technology to address this and to allow faster clock speeds is too prohibitive. The only way forward, therefore, with existing technology has been to use two-core chips and support the CPUs running in parallel which in turn required the software to be parallelized. The smallest transistors in production are currently around 7 nm in size [7], although Lawrence Berkeley National Laboratory has successfully built a functional 1-nm-long transistor gate [8]. Transistors smaller than 7 nm have higher development costs and are expected to experience quantum tunneling through their logic gates. It is envisaged that a technology to replace silicon will be needed at some stage if Moore's law is to continue. Possible alternative technologies include optical computing, quantum computing, DNA computing, germanium, carbon nanotubes, and neuromorphic computing, and others [9].

3.2.1 Optical Computing

Optical computing uses photons for computation, with a potentially higher bandwidth than current technology. However, it is currently unclear whether they would be an improvement on silicon when the full range of performance criteria is taken into account such as speed, power consumption, cost, and size. For optical logic to be competitive beyond a few specialized applications, major breakthroughs in nonlinear optical device technology would be required.

3.2.2 Quantum Computing

Quantum computing makes direct use of quantum-mechanical phenomena, such as superposition and entanglement, to perform operations on data. Digital computing requires that the data be encoded into binary digits, each of which is always in one of two definite states (0 or 1). Quantum computation uses quantum bits, which can be in superpositions of states. In contrast to classical computing which is based on classical Boolean logic, quantum computing is based on the Birkhoff-von Neumann quantum logic [10]. It is expected to improve computational power for particular tasks such as prime factoring, database searching, cryptography, and simulation. Various approaches are being developed but it is not yet clear which will have the best chances of success, nor the timescale required to develop a commercial product [11]. There has been recent experimental verification that quantum computation can be performed successfully [12]. The significance of quantum computing may be gauged by the recent interest in the area by Google, IBM, Microsoft and major research laboratories [13].

3.2.3 DNA Computing

Information is carried by DNA at the molecular level to make logic and arithmetic operations. Shapiro and Ran [14] have demonstrated that DNA molecules can be programmed to execute any dynamic process of chemical kinetics. They can also implement an algorithm for achieving consensus between multiple agents. There is also the possibility of using nucleotides, and their pairing properties in DNA double helices, as the alphabet and basic rules of a programming language. Thus, DNA can represent hardware and software and can provide a direct interface for the digital control of nanoscale physical or biological systems. It can also use many different molecules simultaneously and therefore run computing operations in parallel.

3.2.4 Germanium

A new design for germanium nFETs which improve their performance significantly has been reported by Bourzac [15] and generated interest in this technology.

3.2.5 Nanotubes

In theory, carbon nanotubes could be considerably more conductive than copper. They are also semiconducting. Thus, it has the capability for replacing silicon on a nanometer scale [16].

3.2.6 Neuromorphic Computing

Neuromorphic computing seeks to utilize neural systems to process information. Neuromorphic engineering is a new interdisciplinary subject that takes its motivation from the biological and natural sciences to design artificial neural systems, such as vision systems, head-eye systems, auditory processors, and autonomous robots, whose structure and properties replicate those of biological nervous systems.

3.3 Post-wimp User Interfaces

Post-wimp are interfaces which seek to go beyond the paradigm which uses windows, icons, menus, and a pointing device. Wimp interfaces have been traditionally suited to 2D screens and 2D documents, because they operate in an analogous manner to dealing with physical 2D documents and diagrams. However, they are not so well suited to 3D representations or interactive games, as the complexity of the image and text can obscure the interaction. Such interfaces will normally benefit from customization to enable both representation and interaction to proceed in a beneficial and constructive manner. These interfaces are classed as post-wimp. However, it is recognized that they are difficult and challenging to construct as they embody not only technical aspects but also human perception, cognition, and social interaction aspects. In addition, trade-offs may have to be made between rapid learning, fast performance, and low error rates.

The rationale of post-wimp user interfaces is detailed by Gentner and Nielsen [17, 18], and van Dam [19].

3.4 Virtual Reality Interfaces

A joint European Union and National Science Foundation workshop on Human-Centered Computing, Online Communities, and Virtual Environments identified the following issues with regard to future interfaces:

> *7.2.13 Authoring and Development Environments*
>
> *While visual programming tools, user interface toolkits and UI management systems have made the task of constructing WIMP GUIs significantly easier, they are limited to the well-understood, well-constrained set of 2D visual widget conventions. Also, they deal primarily with 'look' rather than sophisticated 'behavior' feel, which largely still has to be programmed explicitly. Building 3D widgets, let alone other UI components for the other senses, has no equivalent development/authoring environment, in part because the design space is so much larger, and in part because so little commonality has been found in post-WIMP UIs. Some (visual) authoring environments do exist for building 3D worlds (c.f. Jaron Lanier, VPL Body Electric), but those don't help with the task of building multimodal UIs, let alone perceptual UIs, where even the component technology is still immature. We need to get beyond the point of handcrafting our post-WIMP UIs because it is a complex multi-disciplinary specialty too few developers will possess* [20].

The workshop identified the following issues with regard to mobility:

> *7.2.17 Mobility: Not Just a Connectivity Issue; Heterogeneity*
>
> *Future users will not be anchored to any particular place nor to any particular machine. They will, however, still be anchored to many of the same tasks - calculating, conceiving ideas, consuming and communicating. Moreover, they are going to want to continue to do all of these while they are moving about.*

Devices carried by the user will enjoy greater or lesser degrees of connectivity depending on where the user moves. Consequently, the utility of a device for a particular task will increase or decrease depending on proximity to other elements of the computing environment. For example, the audio and video components of the UI will probably degrade when their connection switches from a wireless LAN to a longer-range cellular network. Nevertheless, these changes to the utility of the device must make intuitive sense to the user.

The fixed components of the computing environment must be similarly flexible. The mobile user will continue long-running tasks while moving from desktop to PDA to automobile to public kiosk. We desire that a single task seamlessly migrate through all of these environments. The task needs to adapt to a constantly changing set of UI capabilities throughout its duration, and this leads directly to the requirement for plasticity in the UI. A familiar health-related scenario, to some of us, is the pregnancy/labor/delivery task that, when augmented with computation and communication, still involves a home environment, followed by a mad dash via auto and a variety of hospital environments. The amount of decision making, information gathering, sensing and recording, not to mention the inappropriateness of conventional UIs, make this task a prime scenario for an interface that is mobile and flexible, and that makes no demands on the attention of the user.

Mobility also stretches our notions of ownership and membership. The most often used example is printing. Does a user gain access to a printer merely because of physical proximity? Generalize this example to all of the elements of computing, and one can begin to appreciate how 'clunky' the best of our current mobile services (e.g., ATMs and copy centers) really are [20].

3.5 Virtual Environments and Creativity

A virtual environment generates a 3D world and presents this to the user via a display in an enclosed headset, a walk-in space such as that provided by a Cave where the user is surrounded by a virtual representation, or a combination of the real environment and the artificial by means of augmented reality. Figure 3.2 shows a Cave environment.

The name is thought to be a reference to the allegory of the Cave in Plato's *Republic* in which a philosopher contemplates perception, reality, and illusion—though this Cave was a constrained environment compared to the real world. The user's immersion in the Cave as depicted in Fig. 3.2 is thought to provide an additional sense of realism over and above that which would be experienced by observing a 2D image or even a 3D stereoscopic image with depth cues. It has also been suggested that immersion of a human in an environment of this kind provokes a kind of "suspension of disbelief"—so that even though the world displayed is artificial, it is made to feel more real because the observer feels they are a participant within it. Virtual environments have been very successfully used for flight simulators, and also for the presentation and simulation of a wide variety of objects and spaces. Do they offer any advantages in the design process? Research studies in architectural design in immersive virtual environments have demonstrated that

Fig. 3.2 A Cave "CAVE Crayoland" by user: Davepape—own work (self-photograph using timer). Licensed under public domain via commons—https://commons.wikimedia.org/wiki/File:CAVE_Crayoland.jpg#/media/File:CAVE_Crayoland.jpg

designers perceive and understand volumes, spaces, and spatial relationships better than in 2D environments [21]. Virtual environments also assist in the exploration of 3D spaces and can provide realistic "walk-throughs" to give the user a direct experience of what a 3D building or object will look like and feel like after it has been constructed. If some spaces are constricted compared to what it is envisaged they will be used for, it gives the designer the opportunity to modify this before the building is finalized and constructed. Thus, there is significant potential for producing an optimum design. In addition, color schemes and furniture can be trialled in the virtual building in order to determine what is most suitable for the purposes of the building.

3.6 Desk-top Virtual Reality

Desk-top-based VR enables a 3D virtual world to be displayed on a desktop display which is then displayed in a VR headset.

Table 3.1 Examples of virtual reality equipment

	Google glass	HTC vive	Oculus rift
Display	640 × 360	2 × OLED	2 × OLED
Resolution	640 × 360	2160 × 1200	2160 × 1200
Camera	5 M pixels, 720p video		
Refresh rate		90 Hz	90 Hz
Field of view	54.8 deg horiz 42.5 deg vert Expand by Google Lens to— 109.8 deg horiz 57.8 deg vert	110°	110°
Tracking area		15 × 15 ft	5 × 11 ft
Controllers		2 × wireless VR	2 × wireless VR
Connectivity	Wi-fi, Bluetooth	HDMI, USB	HDMI, USB
Cost	£1000	£759	£549 + £189
	https://www.google.co.uk/intl/en/glass/start/	https://www.vive.com/uk/	https://www3.oculus.com/en-us/rift/
	Withdrawn Jan 15, 2015		

3.7 Virtual Reality Equipment

Table 3.1 provides some examples of relatively low-cost virtual reality equipment.

Google Daydream is a headset which is made from lightweight material into which a mobile phone is fitted [22].

3.8 Conclusions

The increasing power and reducing cost of digital technologies is bringing more speed, capacity, and connectivity for applications. They can provide more opportunities for local, national, and international collaborations via networks and the Internet. Post-wimp user interfaces can provide flexibility and innovation for a wide variety of applications including those in the areas of art and design. The increasing availability of lower cost virtual reality interfaces is providing new opportunities for artists and designers. Developments in computer games are driving many of the innovations in this area, which in turn can benefit art and design.

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Chapter 4
Installation ArtWorks

Abstract Installation artworks are normally major works which act in a stand-alone capacity either inside or outside a building. They occupy a dedicated art space and focus an observer's attention on particular aspects related to the work or its relationship to the environment in which it is set or a combination of these two aspects. Examples of installation art are reviewed, including those uncovered by archaeological excavations and also those that are current. The extent to which modern technology may be utilized to enhance the viewer's experience is examined. This includes interactive capability and the use of audio and video. Virtual reality technology offers the viewer a more immersive experience and the opportunity to explore the artwork in more detail if it is physically inaccessible to the viewer. The relationship between art installation and theater are explored, and the extent to which the viewer's self-identity is maintained is discussed.

Keywords Dedicated art space · Story enactment · Time and culture · Real-time technologies · Multimedia

4.1 Introduction and History

Installation art [1, 2] is a major project which is normally implemented as a stand-alone exhibit. It is normally indoors, but it can also be outdoors. They have been constructed in dedicated art spaces such as galleries and museums, and also in private companies and public spaces. It differs from traditional art or sculpture by being one unified whole rather than a collection of different artworks. It may be designed to be viewed from the periphery of the installation, or with pathways through it so that observers can explore it close up. Sometimes such installations are specific to the site in which they are constructed and have some kind of symbiotic relationship to the space of which they are a part. Most are currently static, but some are interactive. Some also use modern technology, such as multimedia, or virtual reality, in order to provide a more immersive and interactive experience for viewers.

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Art installation and theater have some parallels. In both cases, the viewer enters from the external world and observes a presentation and enactment of an implicit story. The art installation is observed by the viewer who is expected to consider and react to what is displayed whilst at the same time maintaining their self-identity as a viewer. A similar situation pertains in a production where an artistic work (e.g., a play) is presented by actors to an audience in a theater. The degree to which the viewer suspends belief of the real world may depend to some degree on the effectiveness of the art installation.

If there is interaction of the viewer with the art installation, then the viewer may be able to generate their own story and perception of the artwork using the installation as a backdrop. Interaction may be supported by allowing the viewer to physically explore the components of the installation, or it may support a virtual reality experience, where the viewer interacts with a virtual reality implementation of the installation.

4.2 Qin Tombs

The Qin Tombs near Xian in China contain terracotta warriors and may be considered as a historical art installation though its purpose was to protect the mausoleum of the emperor. First investigated by archaeologists in 1974, the excavations cover an area of 20,000 m^2 and have uncovered over 8000 statues of terracotta warriors and horses and a hundred wooden battle chariots and weapons [3]. They date from approximately the third century BCE. Figure 4.1 shows pit no 1 in the museum of Xian with the terracotta warriors. Figure 4.2 shows a terracotta soldier and his horse. Figures are in the public domain courtesy of Robin Chen.

There are many similar archaeological excavations being performed at many sites around the world and many of them contain art exhibits or collection of artworks for particular purposes.

4.3 Installation Art and Infrastructure

The boundary between installation art and other displays and infrastructure which may be used in art galleries and museums to support or portray exhibits may be blurred and difficult to define. For example, a natural history museum may utilize artificial environments to create an artist's impression of the natural world they are seeking to portray. Similarly, many shops have display windows which create artificial environments to display their products to best advantage. High-end restaurants create physical environments which seek to add positively to the dining experience within them. Computer games contain virtual environments which seek to add value to the experience of gameplay.

Fig. 4.1 General view of the pit no 1 in the museum of Xi'an (courtesy of Robin Chen). https://en.wikipedia.org/wiki/Mausoleum_of_the_First_Qin_Emperor#/media/File:Xian_museum.jpg

4.4 Art Installations

4.4.1 The Mattress Factory

The Mattress Factory in Pittsburgh, USA, exhibits room-sized installation art [4]. It derives its name from its previous commercial use, and the name is not related to its new purpose or the various installations now within it. It also offers artists space for research and development. It supports various forms of new media [5] and has a YouTube channel [6]. It was one of the first museums in the USA to utilize QR codes, and these are used to provide information to visitors [7].

Its mission statement is stated as follows [8]:

> *The Mattress Factory is a research and development lab for artists. As a museum of contemporary art, it commissions new site-specific works, presents them to the widest possible audience and maintains selected individual installations in a growing - and distinctive - permanent collection. The Mattress Factory's physical and organizational environments have developed out of and responded to a central focus in the creative process.*

Installation artworks from the following artists are on permanent display in the Mattress Factory—James Turrell, Bill Woodrow, Allan Wexler, William Anastasi, Dove Bradshaw, Jene Highstein, Rolf Julius, Yayoi Kusama, Winifred Lutz, Greer Lankton, Vanessa Sica & Chris Kasabach, Monica M., Bock, Mary Carlisle,

Fig. 4.2 A terracotta soldier with his horse (courtesy of Robin Chen). https://en.wikipedia.org/wiki/Terracotta_Army#/media/File:Soldier_Horse.JPG

Cathy Lynn Gasser, Melissa Goldstein, Sandrine Sheon, and Catherine Smith (collaboration) [8, 9].

4.4.2 The Museum of Installation, London

Nico de Oliveira, Nicola Oxley, and Michael Petry opened this museum in 1990. It was dedicated to art installation [10].

4.4.3 The Fairy Doors of Ann Arbor

A more specialized, unconventional, form of installation art is the series of small doors [11, 12] found in Ann Arbor, Michigan, USA. They have generated a cult following and appear to be mainly for children. New doors appear in new venues from time to time [13].

4.4.4 *Yayoi Kusama*

Yayoi Kusama's installation art impacts on the boundaries of space. Videos illustrate this [14].

4.5 Utilization of New Technology

The rise of the digital age has enabled static art installations to utilize video and audio and other digital functions and facilities. For dynamic installations, they can include facilities for interaction by the viewer by means of wireless links (e.g., from a mobile phone). This has enabled art installations to move to a new level of artistic power, complexity, and impact for those artists wishing to utilize the digital facilities now generally available.

Digital technology not only provides new functions, but can also have an effect on traditional understandings of space, time, and culture [15, 16]. Real-time technologies can involve the processing of large amounts of data not previously possible and real-time responses in interaction. Thus, galleries and museums can face new opportunities and possibilities particularly in the areas of communication, dissemination, and interaction.

4.6 Conclusions

The nature of installation art has been reviewed. A number of venues with installation art have been examined. The relationship of the installation art to its setting immediate environment has been reviewed. Digital technology is making an increasing impact on installation art. It offers possibilities for audio and video and also interaction with the artwork, which increases the range of user experiences. Virtual reality technology also offers the viewer a more immersive experience.

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Chapter 5
Implementation: Hardware, Software, and Applications

Abstract A wide variety of hardware, software, and applications is available to support art, design, and collaboration. The issue of Mac versus Windows PC is reviewed for art, graphics, and design applications. Public domain and commercial software are available for 2-D and 3-D painting, design, and animation containing a variety of functions, and these are reviewed. Specialized applications such as 3-D printing and laser scanning are summarized.

Keywords Commercial software · Public domain software · Painting software · 2-D drafting · 3-D design · 3-D animation · Laser scanning · 3-D printing

5.1 Introduction

The majority of hardware and interface technologies need software to drive them. This means that it is primarily the software which interfaces directly with the user. It is important therefore that the software offers a user interface which is clear, easy to use, and unambiguous in order to enable the user to activate the functions in the hardware that they require with the minimum of effort. This enables the user to concentrate on the task they wish to accomplish and ensure that the hardware/software combination acts as servant to their creative objectives. This is ideal, of course, and many hardware/software interfaces fall short of this ideal in various ways. It is important therefore that the user exercises caution and rigor when selecting software for their application. Post-wimp interfaces including virtual reality are discussed in Chap. 3 on Technology.

5.2 Mac Versus PC

Historically, graphics designers favored the mackintosh because of its more powerful processors and its graphics community [1]. However, the internal components are now very similar for both Mac and PC. In addition, the application interface to

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the user for most programs is now the same, so in theory it makes little difference whether the underlying platform is Windows PC or Mac [2, 3]. The latter is normally more expensive than the PC. If more general computing facilities are required in addition to those for art and design (e.g., 3-D modeling), it may be an advantage to use a Windows PC because of the wider variety of more general software that is available.

Reasons to Favor a Mac.

There are some technical reasons why some people should choose a Mac for their design workflow. Here are a few.

- Using Thunderbolt 2 for large file transfers or connecting to 4 K monitors, especially when using laptops
- Integrating a workflow that uses other Apple devices such as the iPad and iPhone.
- You're a Motion Graphic Designer that uses Apple Motion and Final Cut Pro in addition to your Adobe applications.
- Operating System preference for usability and minor features.

Reasons to Favor a Windows PC.

Likewise, here are some important reasons you might opt for a PC.

- Windows computers cost dramatically less for the same performance specifications, particularly in laptops.
- Access to Windows-only productivity and business software.
- System compatibility with your business clients, especially if they are outside the creative services industry (90% Windows users).
- The ability to upgrade and customize hardware to specific needs.
- You're doing high-end animation or video production in addition to design and need to leverage multiple hard drives and graphics cards in your workflow.
- Operating System preference for usability and minor features [4].

5.3 Commercial Software Versus Public Domain Software

Commercial software has vendor support and an upgrade path to new versions. However, it has a cost. This may depend upon the version selected—lowest cost versions may contain the smallest number of functions, while the highest cost version contains the most advanced functions.

Public domain software is free and comes without support (though there may be a community of users who can answer questions). Some vendors may make earlier version of their software available for free download.

5.4 Painting Software

Software is normally available on both Mac and PC. Some vendors will make earlier versions of their software available as a free download. Table 5.1 summarizes a number of applications programs for painting. Prices given are approximate and are likely to change over time as updated software versions become available. Vendors may have a number of different versions of their software available ranging from low-end (at lower cost) to advanced functionality (at higher cost). Users generally select the version which contains the functions they need and best suits their application and its requirements.

5.5 Software for Artists, Designers, and Animators

A number of these applications are designed for the high-end film, animation, and video game sector and therefore have a cost which reflects the power and capability of the software. Prices given are approximate and are likely to change over time as updated software versions become available. Vendors may have a number of different versions of their software available ranging from low-end (at lower cost) to advanced functionality (at higher cost). Users generally select the version which contains the functions they need and best suits their application and its requirements.

Some vendors will make earlier versions of their software available as a free download.

Table 5.2 summarizes a number of applications programs for artists, designers, and animators.

Table 5.1 Painting software

Software	Functions	Application to art and design	Cost/access
Adobe photoshop	Image editing and manipulation	Digital painting and drawing to mimic those done by hand	Lowest cost access is via Creative Cloud at approx. $10 per month
Corel painter	Painting	Natural media brushstrokes	Approx £200
Corel particle shop	Particles	Plug-in for Photoshop to give fluid brushes which depend on pressure and movement	£24
Art rage	Paints and mixing	Chalk, oil paints, watercolors, inking pens	$79
Rebelle	Watercolor	Pastel, pencil, ink pen, marker, and airbrush	$60
Autodesk sketchbook pro	Sketching	Sketching	$25 p.a.

Courtesy of http://www.digitalartsonline.co.uk/features/creative-software/best-painting-software-for-artists-painting-apps-for-mac-pc-as-used-by-professionals/

Table 5.2 Software for artists, designers, and animators

Software	Functions	Application to art and design	Cost/access
Poser pro	3-D character art and animation	3-D animation	\$300
Go animate	Online animated videos	Online animated videos	\$300–1000 p.a.
Mudbox	3-D animation	Sculpting and texture painting tools	\$495
Blender	3-D animation	3-D animation	Free
Flipbook	2-D animation	2-D animation	
Easy paint tool	Painting	Paint brushes	
FL studio	Software music production environment	Compose, arrange, record, edit, mix, and master professional quality music	\$89–830
ZBrush	3-D	Sculpting, texturing, rendering	\$795
Cinema 4-D	3-D	Modeling, animation shading	From £385
Maya	3-D animation	3-D animation and visual effects	From \$36 per month
Harmony	2-D animation	Animation software and storyboard software for animation *studios* and media publishers	\$15–73 per month
Adobe illustrator CC	Industry-standard vector graphics app	Logos, icons, sketches, typography, and complex illustrations for print, web, interactive, video, and mobile	\$30 per month
Adobe Premiere Pro CC	Video editing	Film, TV, and web	£9–69 per month
Unity pro	Game development	Games and VR/AR	\$75–125 per month
Mari	3-D modeling and texturing	3-D texture painting	Approx £1200
Autodesk 3DS max	3-D modeling, animation, and rendering	3-D modeling, animation, and rendering	\$185 per month

Courtesy of http://www.animationcareerreview.com/articles/top-20-most-essential-software-artists-and-designers

5.6 Free Software for Computer-Aided Design

Computer-aided design (CAD) uses an application program to perform the design and documentation process. Interaction enables design ideas to be explored before they are finalized. A 3-D design can be displayed as a plan drawing (i.e., suitable for architects and builders to use) or a 3-D rendered version to enable the designer to see how the 3-D structure fits into the real-world environment. Table 5.3 shows some typical free software for CAD.

Table 5.3 Free software for computer-aided design

Software	Functions	Application to CAD	Cost/access
SketchUp make	Creates surfaces from lines and extrudes 3-D solids from surfaces	Library of pre-designed scenes and objects	Free
Sweet home 3-D	3-D design	Library of furnishings and objects	Free
Blender	3-D modeling	Import/export more than 20 file formats, including DXF/DWG	Free
ProgeCAD smart	Similar to AutoCAD	Libraries of over 11,000 blocks and symbols	Free
Sculptris	3-D	Works with .OBJ files, creating shapes and then applying textures	Free
DraftSight basic	3-D	Create, edit, and view DWG files	Free

http://www.techsupportalert.com/best-free-cad-computer-aided-design-programs.htm, http://blog.dreamcss.com/design-tool/free-computer-aided-design-software/, http://www.hongkiat.com/blog/free-cad-software/

5.7 Software for Computer-Aided Design Requiring a License

Prices given are approximate and are likely to change over time as updated software versions become available. Vendors may have a number of different versions of their software available ranging from low-end (at lower cost) to advanced functionality (at higher cost). Users generally select the version which contains the functions they need and best suits their application and its requirements.

Table 5.4 presents a selection of commercial CAD software.

5.8 Software for Graphic Design

The best free graphic design software [5] includes as follows:

- Vector art
- Image editing
- 3-D software
- Data visualization
- Other useful tools.

Table 5.4 Software for CAD requiring a license

Software	Functions	Application to CAD	Cost/access
AutoCAD	Most popular CAD software	Drawing exchange file form, DXF, is an industrial standard	£204 per month, and upward for premium product
Turbo CAD deluxe	2-D/3-D modeling	Draw, modify, dimension, and annotate. Materials, lighting, and photo-realistic rendering	£105
Design CAD 3-D max	2-D/3-D modeling	High-quality designs, simple renders, and animations	£80
SketchUp pro	3-D modeling	Export pages as PDFs, images, and CAD files	£562
TurboCAD LTE pro	2-D/3-D	Full featured 2.5D CAD that works like AutoCAD LT	£242
CADopia	3-D	For engineers, architects, drafters, designers	£359
Form Z	3-D	Advanced 3-D solid and surface modeling	£804
ZWCAD+	3-D	DWG native format, feature rich commands	£646
BricsCAD	2-D/3-D	Drawing and modeling	£392

Courtesy of http://www.toptenreviews.com/software/multimedia/best-cad-software/
Best CAD software for 2017—http://www.toptenreviews.com/software/multimedia/best-cad-software/

5.9 3-D Printing

3-D printing is an additive process whereby the layers of a 3-D object are built up one after the other. Input is taken from a digital file containing a 3-D representation of the object to be printed [6]. Such objects can be designed on a computer screen and visualized before they are sent to a printer. Schools of Art and Design often have a 3-D printer accessible over the network. If not, central IT services or the Department of Mechanical Engineering in an institution or organization may have access to such a printer.

5.10 Laser Scanning

Laser scanning involves the control of a laser beam to measure distance and capture the shape of a 3-D object, such as a statue, building, or landscape. This process is controlled by software running on a computer, and the scanned object is stored in digital form. This may then be analyzed or modified using CAD software, or more specialized applications.

The Digital Michelangelo Project [7] at Stanford University performed a detailed scanning and analysis of statues and mosaics and compiled an archive of 3-D models which is made freely available over the Internet [8]. This project illustrated how technology could be utilized in an artistic application.

It is also possible to generate a 3-D model from photographs and images using specialized software [9].

5.11 Collection Management Software and Art Gallery Software

A variety of software is available for management of collections and also for organizing art gallery exhibitions [10].

5.12 Case Studies

This volume includes a number of case studies to illustrate the processes involved in utilizing technology for creative and artistic applications, often in the context of collaboration.

5.12.1 Using Mobile Technology to Facilitate Engagement with the Arts for Children with Autism and Their Families

Dr. Tracy Piper Wright details a project to use mobile technology to increase engagement with the arts for children with autism. The aim of the project was to provide supported and positive experiences to children with autism and also to provide motivation to explore further arts and cultural opportunities. The project was part of the UK Digital R&D Fund for the Arts, whose objective is to increase engagement with the arts through technology.

Four principal issues arose during the work as follows:

- How to produce a design for this application area
- How best to involve the target users in the design process
- How to engage participants from areas that are hard to reach
- How to best manage the discussions between the various fields of expertise in the multi-disciplinary collaboration.

5.12.2 The Development of New Technology in Creative Music Applications

The next case study, by Dr. Stuart Cunningham, Steve Nicholls, and Steffan Owens, explores how technology has been instrumental in the development of music, the areas of music generation, music representation, and music recording. The case study focusses on the relationship between musical creativity and technological development.

The interaction of music and technology is investigated in two scenarios:

- the creative processes surrounding music production
- the education of musicians, particularly in the teaching of timekeeping.

It is demonstrated that there has been resistance to fully take on board the possibilities offered by new technologies, in contrast to other areas of the music industry (e.g., digital recordings). Suggestions are made for how this situation might be changed in order to be able to more fully exploit the potential of new technology in this area.

5.12.3 Visual Arts, Mental Health, and Technology

The final case study by Dr. Karen Heald and Dr. Susan Liggett investigates the use of the visual arts and new technologies in the field of health and well-being by exploring a number of nationally funded projects in the UK in this area.

Much of the human's emotional experience is pre-verbal or non-verbal and occupies an experiential space that is dream-like and difficult to articulate. This case study investigates the work of several contemporary international artists. Some of the artists use multimedia, and some use technology in distant locations to assist with vulnerable adults and young people.

The use of video and new technologies such as virtual reality has made a significant contribution to the field of arts in health.

The lessons learned from the problems and difficulties encountered by artists collaborating with the medical professions are summarized,

5.13 Conclusions

The increasing sophistication and usability of new technology is making an increasing impact on art, design, and collaboration. It can be seen as a tool which facilitates and augments creativity rather than impedes it. A wide variety of software is now available for design, animation, and painting. The basic functions an artist or designer may require are often in the low-cost (or free) version, providing opportunities for artists and designers to explore these new capabilities at minimum cost.

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Chapter 6
Using Mobile Technology to Facilitate Engagement with the Arts for Children with Autism and Their Families

Tracy Piper-Wright

Abstract This case study discusses the research project *Show and Tell* and provides an example of how collaboration across different creative disciplines, and within a field nominally unrelated to art and design, can yield successful results by applying creative perspectives to an existing problem. *Show and Tell* was a collaborative research project which used mobile technology to increase engagement with the arts for children with autism and their families. The research team comprised a community circus (Circus Starr), an app developer (Therapy Box) and an academic researcher (Dr. Tracy Piper-Wright). The aim of the project was to enable a child with autism to enjoy a supported, positive experience at the circus, which in turn would give him or her more confidence and inclination to explore other arts and cultural opportunities. The project was conceived as part of the UK Digital R&D Fund for the arts which sought innovative ways to increase engagement with the arts through technology. The project had several objectives: firstly, to create a visual story which would provide sufficient familiarization with the circus environment to encourage a visit; secondly, to design a mobile app that would be suitable for the delivery of that story to an autistic child user, and thirdly, to test the efficacy of the app and the visual story in real time with the audience for Circus Starr's Autumn 2014 tour. The project took place in a research and development context in which experimental approaches to the problem of disabled audience development were explored. For this reason, the project exposed some key issues for researchers, app developers, and arts organizations who might be exploring similar territory. Four main issues arose during the project: how to design effectively for a specialist user group; how best to involve those target users in the design process; how to engage research participants from 'hard to reach' demographics, and how to manage the conversation between different fields of expertise in a multi-disciplinary collaboration.

Keywords Mobile technology · Creative collaboration · Visual story · Disabled audiences · Autism-friendly design · Adaptive strategies · Technology interfaces

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6.1 Introduction: The Research Context

Circus Starr is a charitable organization which brings the contemporary acrobatic circus to audiences across the UK. Their main target audience is families who are disadvantaged financially, socially, or through disability, and tickets for shows are distributed to organizations who support these groups. Circus Starr received very positive feedback from parents and organizations who reported unusually high levels of engagement and enjoyment with the circus by children with autism. It appeared that the accessible nature of the Big Top alongside the friendly, interactive, and 'relaxed' character of the show created an environment in which children with autism felt comfortable. However, whilst the show itself was 'autism-friendly,' there was a barrier to participation for those children who were still too anxious to make it inside the Big Top. The *Show and Tell* project was conceived to provide a preparation for the circus and to give advance warning of particular sensory features of the environment which might be encountered. Fear of the unknown is the leading cause of anxiety for autistic children so this form of preparation enables the child to previsualize the event and to develop coping strategies for situations which may arise.

The project also contributed to the debate about access to the arts for disabled audiences. Disabled audiences are frequently excluded from many cultural opportunities due to their specific needs, and in light of reports [1] which suggested that audience numbers for arts events are decreasing, it is pertinent to consider accessibility and audience reach for the arts in the twenty-first century. According to the National Autistic Society, there are 700,000 people with autism in the UK and 2.8 million (wider families) directly affected [2]. While there are a number of adapted performances in theaters and cinemas, the number of art events catering specifically to an autistic audience is low.

6.2 A New Approach: A Visual Story Delivered Through Technology

Because of the preference of children and adults with autism for schedule, repetition, and routine, the prospect of a new event or activity can cause anxiety. There are many adaptive strategies in use amongst families and professionals to help with this and the visual story is one of these. A visual story is designed to help a child access an activity or event and has been used in the UK in relation to the arts since the Relaxed Performance Project [3]. A visual story not only prepares for the event, but can also become an aid in remembering that experience and can encourage a second visit with real memories attached. Parents are highly skilled at providing material for a foretaste of a situation to be encountered, but this can be time consuming because the visual story has to encapsulate all aspects of the event in order to be fully effective. Autism support organizations and parents do not necessarily have access to images, sounds, or detailed environmental information that would build a comprehensive previsualization of a situation to be found in a theater or performance space.

A readymade visual story will therefore always be preferable to the child and family. Presenting a story through computing technology further increases the accuracy of the story because live sounds, photographs, and video can be incorporated. Providing a visual story on a mobile device was therefore of primary importance to the project as it expanded the possibilities for an already tried and trusted form of support for autistic children.

The use of technology amongst children and adults with autism is widespread. Technological interfaces are visual, consistent, and predictable and therefore circumvent the complexities of social interaction and communication that those on the autistic spectrum find difficult. Technology interfaces are stable and facilitate repetition which makes computers and tablets ideal formats for the delivery of a visual story [4].

The *Show and Tell* app included two aspects of the visual story—preparation ('Plan My Visit'), and remembering ('After My Visit'). The visual stories used a mixture of text and image with links to audio and video content. The app also contained a repository of images, videos, and audio tracks which evoke the sights and sounds of Circus Starr. Figure 6.1 shows the Show and Tell app home page.

Early slides in the 'Plan My Visit' story prompt the user for content which personalizes the story for them and adds realistic detail such as the date of the circus

Fig. 6.1 Show and Tell app homepage

trip. Further slides familiarize the child with aspects of the circus which might require preparation, such as noise, queuing to get in and waiting times, using images, audio spoken by the ringmaster, and simple text captions. Latter slides preview the circus acts and link to video clips of the acts.

'After My Visit' consists of five slides which prompt the child to recount their visit and to record which acts they enjoyed by inserting either their own picture or a picture from the app's image bank.

'Welcome to The Circus' is a repository of images, video clips, and audio files which can be accessed independently of the visual stories. This feature enables users to enjoy highlights of the circus performances and to view this material separately if additional familiarization is required.

Several research projects have explored how autistic children make use of technologies designed for them (Keay-Bright 2007; Shaughnessy 2013; Walker et al. 2012; Fletcher-Watson 2013, see further reading). These projects informed the approach taken in the development of *Show and Tell* and validated the use of app technology with autistic children for creative and social benefit. However, investigating visual story and technology use by autistic audiences in relation to the arts and arts engagement was entirely new.

Much existing research into autism and technology is focused on social skills development or tasks which are designed to improve or modify some behavior [5]. Much of this research is carried out on a small scale, using two to three participants, often in a clinical or education context. While *Show and Tell* could be seen as modifying behavior (in this case anxiety behaviors), it was primarily envisaged as a way to get children to engage with an exciting and unpredictable art form.

Furthermore, the project focused on facilitating a leisure time activity that others might take for granted. For children whose lives are heavily scheduled and monitored, entertainment, play, and relaxation are often not factored in. However, they are as important to a child with autism as any other [6]. By developing a project within the context of entertainment, the needs of children with autism were addressed beyond the conventional clinical or education settings. Experiencing the arts in childhood has the potential to create lifelong patrons and practitioners. The project recognized that autistic children come with families and that enabling them help all the family enjoy an activity together [7].

6.3 Challenges Encountered During the Project

6.3.1 Designing for Autism: Engaging Target Users in the Design Process

The app was designed in collaboration with a National Autistic Society consultant who was able to advise on accepted protocols of autism-friendly design [8]. These adaptations included using clear and literal language, simplifying images and avoiding animation, sound effects, and other potential sources of sensory disturbance in the app.

With this knowledge, the team produced a first build which had simple swipe navigation, images and text placed centrally and minimal background graphics. This version of the app was tested with a small focus group in a relaxed after-school setting where several children were able to use the app with their parents.

The focus group was a solution to a problem that was faced quite early on in the research process: How to include autistic children in the design process effectively while acknowledging that engaging with 'testing' or 'research' could itself be a barrier for someone who found unknown and unexpected environments and activities stressful?

The focus group, therefore, had to tread a line between being sufficiently relaxed to engage the children effectively with us and the app and consistent enough to provide useful feedback which could be used to develop the design.

The focus group produced some challenging results. While the children enjoyed the ability to edit and personalize the visual story, they were critical of a perceived lack of 'fun' in the app: what they saw as a lack of 'circus-feel' in terms of animation, sound, and interactivity. This flew in the face of what we had been told about designing for autism, but what it did highlight was the need for differentiation in design. The focus group included proportionately more children who could be characterized as 'high-functioning' and therefore better able to cope with the stimulation of contemporary technology and more used to it due to their use of apps aimed at a general user.

Modifications were made to the app subsequent to this feedback and a greater level of clarification in menus, and more interactive elements were included as well as accessible sound and video files of the circus. The ability to access these aspects of the app at will and to turn off animation and sound features made the app more generally accessible to a wider user group while going some way to include the features which the app appeared to lack. However, ideally, the app would have been tested with several focus groups of children of differing ages, abilities, and diagnoses in order to create a more fully rounded set of feedback from target users.

Feedback received from the final rollout of the app concluded that the relative simplicity of the app content and features continued to be a drawback to older and abler children. Feedback suggested that a more diverse range of activities or actions for the user would enhance the desirability of the app and promote repeated use and would also better reflect the excitement and dynamism of the circus.

It is highly likely that the increasing use of apps by autistic children which are not designed for them has created a higher tolerance for features which designing for autism would normally resist. It is likely that accepted wisdom on animation and interactivity needs to be rethought in the light of an 'iPad generation' of autistic children who have grown up with rich interfaces and are able to navigate a more complex interactive online world. In the context of leisure and entertainment, the *Show and Tell* app perhaps lacked the excitement that users felt should associate with that context, and it was interesting that feedback from research participants commended the app as providing a template that could be used to prepare for a range of other situations—such as school transition, doctor visits, or holidays.

Designing for 'one size fits all' is problematic, and a solution would be to create an adaptable app which would have features differentiated from the outset according to age and ability. Future projects would benefit from thinking about the autistic user in a more nuanced way and to include differentiated levels of complexity and content in a design so it meets the needs of different users. Consideration would need to be given to how to engage users who find working in new contexts stressful in order to include them in the design process, but the first step would be to recognize that autism is a highly individualized diagnosis and as such terms like 'autism-friendly' can imply a homogeneity that does not exist in reality.

6.3.2 Bringing Research into the Real World: Encouraging Research Participation

Recruiting parents and children to trial the *Show and Tell* app was a challenge. The research team were aware of the 'hard to reach' nature of the audience being targeted, and accommodated this in their recruitment plan and tools. However, the main barriers to participation were access to appropriate technology, particularly in low-income areas, and reluctance to commit to new activities which in themselves could be a potential source of stress to the autistic child.

While research and anecdotal evidence suggested that iTechnologies were popular amongst families with autistic children, it became evident that the locations in which Circus Starr was performing had fewer participants who had access to this technology. Several families were disappointed at not being able to participate in the research due to having Android devices. Rollout to Android platforms would have required a far longer development time than the 18 months of our R&D project allowed, but it was an appropriate reminder that the relative inexpensiveness of Android tablets and phones was of key importance to families with autistic children with limited financial means.

The complexity of the lives of parents with autistic children was brought home to the research team during the follow-up interview stage. Parents discussed the extensive forward planning that needed to occur on a daily basis, and how unpredictable situations and events were best avoided. While there was a relatively good return on questionnaires and interviews, the project team worked hard to encourage the completion of, or participation in, these activities throughout the data collection period. In hindsight, it was apparent that more opportunities for face-to-face interaction with parents and children, such as dropping in on preexisting community support group sessions, would make the activity of completing questionnaires or carrying out interviews more easily achievable and thereby increase the quantity and richness of data.

While steps were taken to accommodate the research to the needs of the participants, the research team learnt that in future situations it would be important to go much further in order to facilitate engagement in the research, and that increasing opportunities for the researchers to enter the participants' daily life (rather than the other way round) would be a more successful strategy to engage 'hard to reach' audiences.

6.3.3 Multi-disciplinary Collaborations: Language Barriers and the Importance of Dialogue

The process of designing and testing the app was very rapid due to the nature of the R&D project which demanded a product to put before audiences to test as part of this research. The multi-disciplinary team drawn from circus arts, autism research, app development, and academic research meant that drawing together the conversation was sometimes complex.

While the arts formed the basis of the connection between all parties, it was clear that structural aspects of the project were sometimes in tension. The developer had to produce a template at the early stages of the project in order to meet build deadlines; however, this meant that the design was 'locked in' at an early stage before it had been user-tested. While alterations could be made, these occurred within the existing template rather than working through a process of iteration in which aspects of the app could be reimagined as the project progressed. Lacking in-depth knowledge of the app development process other members of the team were not able to factor this into their research plan and hence opportunities that might have been explored were missed.

Sometimes barriers to effective collaboration occurred due to differences in the nature of the discipline in terms of its methodologies and timescales. While the research team would have ideally pursued a number of ways to generate input from end-users, this was complicated by the lack of access to specialist groups over a long enough period. The project had to fit in with an existing tour schedule which meant there were no other opportunities to test the app in a circus environment until the final launch. With the collection of data occurring at the end of the project rather than during, the research was left to report on the user experience but not to use these findings iteratively to create improvements during the project.

Due to the geographic distance between collaborators, conversations often took place via email or Skype, and this sometimes magnifies differences in perspective and priority. The design, testing, and development stages of the *Show and Tell* project were relatively condensed, and this created pockets of intense activity on the project at key times, one of which was the final development stage before the app went live in the App Store.

During this time, it became apparent that evaluating the responses to the app from the focus group needed to be given careful consideration so that the team could reflect effectively on what was being learnt and how this was best translated into design decisions. For example, a hasty decision almost led to the removal of a key element of the app; a situation which was rescued by the quick thinking of another member of the team, but which could have had a negative impact on the final product.

While remote communication methods such as Skype, email, and telephone were extremely useful during the project, it was apparent that the times when the project team could meet face-to-face enabled better discussion and decision-making to take place. Opportunities for this were rare, but during the final design development, an all-day meeting resulted in some significant, transformative changes to the app interface and content.

The most significant and lasting developments were made during face-to-face meetings such as these which included time for 'noninstrumental' discussion and conversation between the project team. During these conversations, differences in perspective and goal were exposed, and solutions or compromises found more effectively. Face-to-face meetings provided time for productive conversations between partners, in which ideas were tested, analyzed, and refined in a short space of time, with all partners contributing in real time to the design process.

6.4 Project Results and Impact

The response to the *Show and Tell* App from research participants was overwhelmingly positive. The research found that an engaging preparatory visual story, delivered via an interactive technological interface, had a measurable impact in encouraging an autistic child to attend an arts event which they may have previously avoided. The visual story provided a good level of familiarization with the event, enabling users to devise coping strategies and then look forward to their trip to the circus. This reduction of the 'unknown' had a significant impact on autistic children's engagement with and enjoyment of the circus.

According to research participants, the most valuable features of the app were the accuracy of the preparatory visual story, which was comprehensive and detailed enough to cover the majority of sensory aspect of the circus environment; the 'After My Visit' feature which was useful in promoting recall and speech for autistic children and the potential transferability of the app template to other art and everyday situations.

Families and autism professionals reacted positively to a project which was specifically targeted to autistic children [9]. This response was particularly welcome due to the lack of expert autism knowledge amongst the project team at the outset. Sensitivity to the needs of users and a willingness to explore methods which were nontraditional enabled the project to devise an innovative solution which had the potential to be adapted for other situations and other users. In this way, the approach taken did not start by seeing autism as a barrier, but instead as an opportunity to design for that specific audience from the ground up. This proposes a different way of designing for disability: not as a secondary process of modifying existing designs, but as a primary process which prioritizes accessibility and from which adaptations for general users can be made.

6.5 Lessons Learned

- Include as many opportunities as possible to gain feedback on the technology or product being developed from its eventual users. Incorporating the user into the design process can provide valuable insight at an early stage which is just not available to the project team. This might mean risking open-ended design decisions at the start until a clearer picture of the intended outcomes and user needs is gained.
- Be mindful of the world outside the project for the participants, particularly if they are from 'hard to reach' demographics. While the new product or idea may be beneficial, and people keen to help, their lives are full of other competing demands in which your research is simply one other job to complete. The research needs to integrate with the participant's life in order to encourage their engagement, and this requirement is likely to be increased depending on the extent and severity of their personal barriers.
- Effective communication is vital to successful multi-disciplinary collaborations. Factor in time to discuss the project 'in the round' without too many assumptions and deadlines at the start. Keeping an open, questioning dialogue going between project partners and appreciate that discipline specialities will lead to epistemological standpoints that may be at odds. Identifying where potential conflicts may lie at the outset will help the team navigate these and create better, collaboratively envisaged solutions.
- Arts researchers can make valuable contributions to research in an unrelated discipline. The insights brought to the subject from an alternative perspective can often lead to a new interpretation of an existing situation and the development of innovative responses.

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Chapter 7
The Development of New Technology in Creative Music Applications

Stuart Cunningham, Steve Nicholls and Steffan Owens

Abstract Music has been a fundamental aspect of human existence for thousands of years. It fulfills many roles for humanity that range from the intimidating precepts of the bloodiest battles to the emotional release of the biggest celebrations. It is a key creative output channel for humans, which is on a par with the visual arts. Technology has been an important aspect in the development of music, from facilitating new instruments and methods of creating sound, to providing a vehicle by which music can be notated and its sounds recorded. The focus of this chapter is upon the relationship between musical creativity and technological development in recent history and an exploration of the influence that technology is likely to have in the future. As particular case studies, we explore how music and technology interact in two case study scenarios: (1) the creative processes surrounding music production and (2) the education of musicians, particularly in the teaching of timekeeping. It is shown that these aspects of music have remained dependent upon human influence and have been reluctant to fully embrace the possibilities offered by new technologies, unlike other areas of the music industry. Our work discusses ideas and possibilities, encapsulated within the current work of the authors, which seeks to change this situation and embrace the new musical opportunities that technology affords.

Keywords Music creation · Music production · Musical creativity · Musical diversity · Virtual studio technology · Digital audio · Musical timekeeping · Computer-based music instruction · Collaborative partnerships

7.1 Introduction

The field of music has been immensely important throughout human history and has found utility in many scenarios throughout history and for many purposes. Whether used as a tool for motivation, entertainment, relaxation, celebration, and so on, music has been ever present. As humankind has evolved and developed, so too has music, although its beginnings were quite distinct with separate cultures around

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the world having their own tuning systems, instrumentation, traditions, and customs [1]. However, during the nineteenth and twentieth centuries, the proliferation of new communication technologies, such as the Internet and digital information representation, aided by a general trend toward globalization, have shaped recent developments in the field. Many of the traditions have been preserved and developed in their own right, but the use of technology and communication has opened up opportunities for new forms of engagement with music, particularly in the creative process and in teaching and learning.

As particular examples of fields where music technology has, and continues to have, an impact, we examine two particular areas of music that are congruent with our current research activities: the process of music creation and production; and the teaching of music, specifically musical timekeeping. These two areas of research arguably epitomize two of the most vital and longest established fields within music that of creation and education. Without either, music would be extinct and arguably the need to continually evolve these practices, in-line with current technological trends (as well as other influences such as the social, economic, and political) has been a factor that has ensured music survives through time.

7.2 Technology and Music

7.2.1 A Brief History of Music and Technology

Throughout the history of music, its ability to be notated fulfilled a crucial function in allowing music to be remembered and transported from place to place. Hence, we observe two key requirements: archival of music and its distribution. Although notation provided composers with mechanisms to incorporate performance instructions beyond the note durations and pitches, it relied upon a musician to turn the score back into audible sound. As such, notation plays a key role in all forms of music and its related activities, but on its own is a limiting factor, meaning that writing, especially when done collaboratively, and performance, often a multi-musician effort, were only possible with the requisite resources and associated education. Nevertheless, as with all forms of art, people found ways to express themselves, and entertain others, in the creation and performance of music, despite these limitations. For example, thousands of years ago, signing was used extensively, often passed down between generations of family members and laterally accompanied by rudimentary instruments.

The last quarter of the nineteenth century brought with it a range of technological innovations and inventions that laid the foundations for modern recording technology that would, for the first time, allow music performance to be captured, transported, and replayed. This revolution was led by innovators of the day such as Thomas Edison, Alexander Graham Bell, and Emile Berliner. By the end of the 1920s, the proliferation of gramophones, and popularity of analogue radio broadcast, signifies that music production has become a major industry as up to 100 million records are sold per year [2]. Before point, the only way to consume a piece of music was to do so audibly, at a recital, or by studying the score.

This new ability to capture and preserve musical performances and recitals heralded a transition for musicians, and the music consumer, during the early twentieth century in that music could now be relistened to and shared. From the musician and recording studio perspective, the advent of multi-track recording and overdubbing, devised by seminal guitarist Les Paul, brought another significant change. Until this point in the 1940s, music recordings had to be carefully planned and orchestrated. Obtaining balance between instruments and voices was largely a matter of controlling sound levels during the recording process, either by trial-and-error microphone placement, or by manipulating microphone levels whilst recording. The process was also unforgiving; any mistake or undesirable noise in the recording would necessitate a complete re-recording and was thus resource hungry, especially in terms of time and money. Les Paul's multi-track recording process changed this, by giving musicians and engineers the ability to record multiple sound sources simultaneously or by layering them one after another. This opened up huge creative potential, where multiple parts could be performed and recorded on a piece of music by a small number of musicians, in a small space, immediately changing the dynamic of what could be achieved in a music recording and removing many of the barriers previously limiting the creativity of musicians and producers. Les Paul, notably, also recorded a number of his initial commercial recordings in his home studio, perhaps unknowingly, simultaneously giving birth to another trend that has sustained and fueled the musical diversity and capacity of the present day [3].

During the 1970s and 1980s, the music industry experiences a series of major technological shifts, largely due to the incorporation of analogue and digital electronics into the music creation, recording, and production processes. The mainstreaming of synthesizers in the 1970s and ability for a solo artist to produce an album largely independently is epitomized by artist's such as Stevie Wonder who played the majority of the instruments on his *Music of my Mind* (1972) album [4], accompanied by the TONTO (The Original New Timbral Orchestra) synthesizer system [5]. In the 1980s, the transition from analogue to digital technologies introduced the compact disc (CD) to the music consumer market and musical instrument digital interface (MIDI), along with the emergence of digital audio recording, to the musician and recording studio. The development of these, in the 1990s means that it becomes possible for a musician to have a virtual orchestra or band, along with a recording studio, in their home, without any of the physical equipment or spaces that would have previously been prerequisites. All of this is achieved via the personal computer, functioning as a music production system 'in the box.' One notable early example of this is White Town's worldwide hit *Your Woman*, released in 1997 [6] and recorded by one person using a small selection of instruments and an Atari computer [7].

This digital revolution further transformed the opportunities available to the musician. In a relatively short space of time, the synthesizer and MIDI technologies that had previously afforded new timbral and performance opportunities had been integrated into personal computers, providing anyone with a basic musical knowledge or ability to program their own instruments and to record them, noise free, onto a hard disk. The introduction of computers and digital information to the music world led to the potential for new ways that music could be studied, written, produced, consumed, distributed, and written. The combination of the networking technologies, that underpin the Internet, gave rise to the ability for artists to collaborate in real time (or initially, nearly real time) in the writing and recording of music, allowing them to be in different parts of the world, whilst affording the possibility for them to collaborate. Laterally, the ability to record and produce collaboratively is also serviced by the availability of the cloud, permitting projects to be shared and added to by multiple contributors asynchronously.

Such music can now be distributed online via online music stores such as Apple's iTunes, Google Play, and Spotify. The broad public adoption of the Internet over the 1990s and 2000s, coupled with relatively high ratio audio compression technologies, most notoriously the combination of MP3 and Napster, meant that being able to share and distribute music could be easily achieved. This caused an eruption of copyright and intellectual property law suits against the Napster file-sharing platform, as artists and record companies saw themselves losing out on the income from music purchases. The ability to create and release music was now no longer the privilege of the few, but that of the many. Thus, the digital music revolution has been nothing short of a mass democratization, characterized by Breen [8] in an appropriate technologically influence sound bite as being a "*direct access relationship*" between the musician and the audience. However, the ability to create and distribute work does not, of course, guarantee that commercial success will follow. In this respect, the record companies and music promoters maintain precedence largely through the attributes of legacy, brand, resources, and established networks. Nevertheless, as the reader will no doubt be aware, the way in which music is consumed has changed dramatically, even in the last 10 years, and the ways in which music is produced and taught has followed suit.

7.2.2 Technology and Musical Creativity

Technological change has undoubtedly influenced the way in which music is written and created. These developments have brought changes in the way that sounds can be produced and music expressed, such as through the introduction of synthesizers and MIDI control devices in the 1980s, new microphones, and laterally through the development of virtual studio technology (VST) software and digital audio workstations. Thus, the musician, as an artist analogous to a painter, is constantly being provided with new colors and textures in their palette, whilst the dimensions and characteristics of their canvas can be changed and reshaped at will. The role of the engineer and producer in these times of change has arguably become more important than ever and one where engineers and producers have been able to develop their techniques in recording and manipulating sounds to develop their own trademarks and styles [9]. Interestingly, despite these individuals and groups becoming defined as creative practitioners in their own right, the lines, previously well-defined, between artist, engineer, and producer have become blurred to the point that they are often homogenous today.

7.2.3 Technology and Music Education

Perhaps unsurprisingly, those on the music engineering and technology end of the spectrum were quite rapid to adapt their curriculum in response to the possibilities offered by the digital revolution [10]. However, the study of music and performance was not far behind and computer-based music instruction (CBMI) emerged on various platforms since as early as the 1960s and 1970s [11]; a trend that has continued to the present day. The music educator is required to engage in suitable professional development to improve their digital literacy and abilities in using technology to assist in teaching [12].

Such software tuition systems cover a range of musical aspects, such as the understanding of underpinning music theory to the performance and practice of particular musical instruments, such as the keyboard, guitar, or drums. The use of technological instruction continues in the present day but, as with the consumption of music by the audience, the features of the Internet have now augmented instruction, allowing music students to engage with tuition that may take place via audio–visual communication platforms in synchronous or asynchronous lessons and tutorials [13]. This provides opportunities for tuition from a much wider range of teachers and experts, specialist in particular techniques or styles of music, and for teachers to engage with an audience of students worldwide. However, particularly when it comes to the study of the performance of a musical instrument where technique and physicality can often be important, the digital method of remote instruction can potentially present barriers and obstacles for both student and teacher. For example, instruction of the correct bowing technique on a violin might be especially difficult without the ability for teacher and student to see each other in three dimensions and for the teacher to manipulate the bowing arm of the student, so as to achieve the correct motion. However, this is a good example of a particular problem that has been considered, and solutions proposed, by researchers active in this area [14] demonstrating the willingness of the music education community to engage with, and use, new technologies to their advantage. As such, whilst any new technology encounters resistance, the field of music education is one that is keen to experiment with new innovations.

7.3 Musical Creativity and Collaboration

The paradigm shift from the use of expensive commercial recording studios to recording music ‘in the box’ presents a demonstrable change in the way in which people interact with music production systems. The need for large-scale studios, with large mixing consoles and racks of outboard effects and processing, has been eliminated in the main [15]. This is a pattern that could also be related to a wider trend in the music industry where, due to the development of the Internet, high-quality recorded music has become easy to copy and share. Combined with developments in music streaming and distribution services, this means that a wider range of music is available to consumers [16].

The role of musicians has also changed due to the development of the Internet. Whereas the role was once to engage and build audiences through broadcast and printed media, the format and content of which was largely out of their control, many musicians are now combining the role of artist and performer with roles that make use of social media strategies for the purposes of drawing attention to themselves [17]. Examples of this might be to offer lifestyle experiences such as online chats and music tuition. Other examples might be based on regular performances or video blogs. This type of social media engagement is heavily reliant upon regular content delivery with, for example, some YouTube channel operators posting new material numerous times daily.

The increasing demands of consumers mean that in order for a musical artist to remain relevant and commercially viable, they may need to produce material and content at an increased rate. To meet these needs, music producers may wish to embrace new ways to increase productivity, creativity, and possibly quality, at a reduced cost.

Historically, in order to improve productivity, the forming of song-writing partnerships has been shown to be common practice in popular music [18]. For example, songwriters Carole King and Gerry Goffin were hired as ‘staff writers’ at The Brill Building in the 1960s. The Brill Building housed numerous music companies that would buy songs from competing song-writing teams producing many hit songs [19].

However, finding a suitable collaborator can be problematic. Currently, there are no computer systems that will collaborate with a user, essentially emulating a collaborator. Previous research has examined artificial intelligence (AI)-based composition, focusing on music generation, via a variety of algorithms [20]. Many compositional systems have been developed, with much research focusing on areas such as different ways to generate starting points or the behavior of different types of algorithm. The common characteristic in all of these systems was that there was a distinct point at which user interaction ceased, and then all work was carried out by the AI system. This would not, necessarily, be the case in a collaborative system.

One of our research activities is to develop an AI collaborator to assist individuals in the process of writing music. The intention of this system is that it would be able to emulate a human writing partner and to interact in an intuitive and effective manner. The development of a collaborative AI system would involve determining key parameters and defining a set of rules in the collaborative song-writing process. It may be possible that the AI could then collaborate with a single user to create a number of musical pieces. As part of this system, there is a clear requirement for the AI system to be able to learn about its user so that it can most efficiently integrate into their workflow, providing assistance at the right times, and taking a less dominant role when the human user is in a deep period of creativity.

The nature of creative work and collaborative partnerships could mean that a range of human traits and characteristics would need to be modeled by the system. The psychology of artists working in partnership would need to be understood. Issues such as creative tension, conflict and resolution, competition, motivation and strategies for breaking creative blocks would need to be considered. Data gathering from musicians, songwriters, and producers could provide this type of expert input to the system. To address these diverse types of information and processes, we intend that our work in this field will utilize a range of research methods, such as interviews, questionnaires, and observational studies to produce the models and information that will subsequently be used to build the AI collaboration system before putting it into scenarios where it can be evaluate against a human collaborator, using both objective and subjective evaluation methods.

With the computational power that an AI collaborator would possess, increased availability of experiential data and access to creative strategies will be possible. This might increase the rate at which a music producer could compose, and possibly record, music.

7.4 Music Education: Timekeeping

Contemporary instrumental music tuition usually consists of a combination of aural practices and more formal musical notation, but there has been little development in formalizing the teaching practices of timekeeping for entry-level musicians. As time and financial constraints are increased on peripatetic and classroom tutors, individual and group timekeeping is, understandably, not always a priority in short instrumental tuition sessions. Timekeeping is perhaps not the most glamorous component of playing any instrument, but it is an important part of ensemble playing. From a teacher's perspective, any tool that can enhance a musical trait of a student, whilst freeing time for other elements of tuition, would be a welcome addition to the tutor's resources.

It is important to establish a definition of timekeeping in this instance. It is certainly true that musical performance does not always stick to regimented meter and note duration. Expression is a fundamental part of interpretation and performance of a musical piece, but to bend the rules of timekeeping, a performer must be familiar with those rules. Studies suggest that musicians will naturally vary in tempo when listening to or performing passages of music, slowing at the beginning and end of musical phrases [19]; perhaps using this flexibility to imbue a sense of musical punctuation to the piece. Nevertheless, to form a fixed idea of timekeeping, a more mathematical approach is required. A set tempo has fixed markers for each beat and these beats can be used as fence-posts to determine the intervals between each expected note. Exploiting the expected interval as a comparison value to the actual value of a played note can provide distinct figure or measurement of the accuracy of a performer's timekeeping.

Research into the relationship between timekeeping and sensory motor function suggests that the effect of practice alone will improve timekeeping accuracy, and that the rate of this improvement remains similar between musicians and nonmusicians [21]. Is it possible to improve this rate of progress? The traditional practice of playing simple rhythms to a mechanical metronome can be used as one method of training a musician to improve their timekeeping accuracy. This method, however, is subjective to an extent. It is also limited by the capabilities of the equipment itself. The development of digital metronomes has now gone beyond the model of simply providing these fence-posts of interval markers. Musicians now have access to cross-rhythmic metronomes that provide much more audio information, through the use of syncopated rhythms and a wider range of frequency content, i.e., a variation from the stock cowbell audio cue found in many early digital metronomes and DAW software. This increase in audio information may be the key to improving timekeeping accuracy, although some research suggests that audio content can also be a distraction to musicians [22].

If a metronome can influence the timekeeping of musicians, it stands to reason that other musicians can affect this timekeeping. The process of entrainment in musicians is at the heart of musical performance. The natural tendency of humans to synchronize with external rhythmic stimuli inevitably leads to synchronization of musical timekeeping in a group performance [23]. The ability of an ensemble to maintain the intended tempo of a given piece will be influenced by the individual ability of each musician to keep time. Therefore, any improvements that can be made to this ability will benefit the group as a whole.

Our research into musical timekeeping aims to develop tools and techniques, likely, but not necessarily, implemented in some form of e-learning system that produces a significant improvement in the ability of musicians to improve their timekeeping. In the early stages of this work, we will conduct a range of controlled experiments using metronomes of differing timbre, speed, and in individual and group environments, to investigate how these, relatively straightforward, adjustments may impact upon timekeeping. Following this, investigation will take place into different exercises and modes of practice and how these may produce increased timekeeping accuracy. Our work in this field utilizes a strong quantitative, objective series of time measurements to determine the accuracy of participants in experiments, although it may be that later work uses experts in the field to provide a more subjective assessment of participants' timekeeping ability, to see how these correlate with the objective measurements.

It is now common practice for producers and studio musicians to use cross-rhythmic metronomes to enhance timekeeping performance. The increase in rhythmic information provides the musician with more points of potential synchronization, through the use of beat subdivision. As timekeeping can be seen as the ability to predict the intervals between audio cues or markers, it is probable that this ability to predict becomes more consistent as more information is added, particularly at slower tempos [24, 25]. As the definition of timekeeping remains consistent, regardless of instrument type or family, the goal remains the same: to sound or produce a note at the precise moment it is expected. Differing instruments require differing physical and cognitive processes; the use of this technique could inform an adaptive teaching methodology for timekeeping in musicians. It may be possible to tailor metronomic information (ensuring that audio information does not reach the point of distraction) to improve a musician's timekeeping ability, both in the short and long term.

7.5 Conclusions

This work provided an insight into the way that changes in technology have interacted with the creative processes of music production and education. It is established that technology has played a crucial role in the development of music, especially when it comes to the way that it can connect to its audience, and the diverse range of ways that it can interact with learners of differing style and level. However, the introduction of these technologies has, arguably, introduced a divide; the ability to work alone and in isolation affords many resource benefits, but endangers the ability to work collaboratively and learn from more experienced musicians.

Music has certainly not been afraid to embrace technological change and use it to full advantage, especially when it comes to being able to produce more diverse and larger-scale creative works. As such, technology in music has been an enabling platform, as well as affording innovation. In our ongoing work, we look forward to not only attempt to produce a computer program that can write an interesting piece of music, but also to develop an AI collaborator that empowers and supports a human writer in their creative processes, much as a human writing partner would do.

Similarly, when it comes to training the next generation of musicians, we have shown that the use of multimedia, interactive platforms, and fast communication mechanisms has made education a more diverse and accessible opportunity. Although formal music education is still very much undertaken on a person-to-person basis, technology is used as a successful supplement and mechanism for self-tuition and practice. It is this latter area that our work in musical timekeeping is investigating. We soon hope to have developed a series of recommendations, which will subsequently be integrated into a training package that will make best and most effective use of practice time in improving musical timekeeping in musicians.

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Chapter 8
Visual Arts, Mental Health, and Technology

Karen Heald and Susan Liggett

Abstract There are a growing number of research projects in the UK in the field of health and well-being that involve artists utilizing new technologies. This chapter explores current examples of nationally funded projects, exhibitions, and artworks that directly relate to public perceptions of mental health. Lessons learnt from the problems and difficulties encountered by artists collaborating with medical professions are a focus, as is the importance of the medium of video and the use of new technologies such as virtual reality in facilitating the implementation of innovative ideas that have made a significant contribution to the field of arts in health. Anguish and distress are fundamental characteristics of the Western artistic tradition, particularly since the Enlightenment. The visual arts offer opportunities to explore inner personal experiences. Psychiatry has historically used reductionist methods to measure some of these experiences such as mental disorder. Although there has been progress, there has also been an increasing dissatisfaction with the way that reductionist science can drain meaning and lived experience out of its understanding of mental illness. Artists acknowledge that much of our emotional experience is preverbal or nonverbal and occupies an experiential space that is dream-like and difficult to express through words. This chapter investigates the work of several contemporary international artists—individually, and collectively in exhibitions. These include artists using multimedia and those exploring the use of technology in remote locations with vulnerable adults and young people. Several films, videos, animations, documentaries, and online projects involving various public sector organizations and groups of people are also discussed. The lessons learned from collaborative and cross-disciplinary projects are summarized. A research project on art and science continues earlier work where the authors were part of an interdisciplinary research team which completed a pilot study with people attending a mental health outpatient clinic called *In-between-ness* (www.in-between-ness.co.uk). The original objective was to develop and test methods which could be used to explore the experience of people with a diagnosis of depression as their perception of themselves and the world around them changed through the course of antidepressant treatment. During the pilot, the method was refined and improved, largely as a response to the research participants, who had a strong and distinctive voice. Guided by experts, dialogues and engagement within the

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collaboration created added value. The chapter concludes by discussing how an expanded team is now ready to conduct a large-scale study using the method they have developed.

Keywords Interdisciplinarity · Practice-based research · Practice-led research · Research impact · Innovation in art and design · Collaboration in the visual arts · Art/science · Artists moving image · Virtual reality (VR) and the arts · Arts in health · Visual arts and healthcare · Post-traumatic stress disorder (PTSD) · *In-between-ness: windows within*

8.1 Introduction

Fine art is no stranger to the world of mental health. History shows some respected artists' battles with depression in the works of Van Gogh's *Wheatfield with Crows* (1890), Rothko's *Untitled Black and Grey* (1970) or Louise Bourgeois' *Maman* (1990). The visual arts are also linked to mental health from a therapeutic perspective of drawing out one's creative resources to tackle personal issues [1]. This chapter takes neither of these routes to the theme, but looks at how technology and collaboration have facilitated artists to augment new ways of working toward an understanding of mental health through the practice of making artworks.

Artists acknowledge that much of our emotional experience is preverbal or nonverbal and occupies an experiential space that is dream-like and difficult to express through words [2]. Artists explore ways to communicate beyond our logocentric-driven world, often using new technologies, where the self can determine new understandings of reality impacting on mental health. The current funding of projects to explore health-related research through Nesta, Arts Humanities Research Council (AHRC), and the Wellcome Trust are surveyed here to understand the growing interest in 'socially engaged practice,' 'social turn,' and 'new genre public art.' The projects and artworks discussed do not set out to have therapeutic benefit, but the resulting work may act as a catalyst to positively change the perception of the world we live in.

This chapter will also specifically investigate the lessons learned from an ambitious collaborative and cross-disciplinary project that involved the Foundation for Art and Creative Technologies (FACT) working with military veterans (based at BNENC Community Centre in North Everton) and NHS Merseyside (2009) (www.fact.co.uk).

Lastly, the authors will discuss *In-between: Windows Within* a potential AHRC arts and science research project in which they are involved. This research continues the work from 2014 when they were part of the interdisciplinary research team in rural North Wales who completed a pilot study with people attending a mental health outpatient clinic called *In-between-ness:* using art to capture changes to the self during antidepressant treatment. (www.in-between-ness.co.uk). This chapter will conclude by discussing how an expanded team is now ready to conduct a large-scale study using the method they have developed.

8.2 New Technologies and Funding for the Arts (NESTA, Wellcome, AHRC)

Many contemporary artists have confronted the recent technological revolution 'head on' in their work such as Rachel Maclean the recent nominee to represent Scotland at the Venice Biennial in 2017 and the collaborative artists Lizzie Fitch & Ryan Trecartins. Their eclectic mix of video, sculpture, reality TV, and installations explore human interactions with technology and how these have changed the way we engage with the world and with one another. Trecartins says: '*I love the idea of technology and culture moving faster than the understanding of those mediums by people*' [3]. New technologies have also led to an increase in interdisciplinary collaboration as a common modus operandi for artists. This along with research methodologies challenged through 'practice-based' research [4] means that a growing number of artists are teaming up with scientists or engineers to diversify and scale their projects [5].

Funding bodies in the last five years have awarded grants to numerous artists whose work includes a focus on collaborative practice and who utilize new technologies in their work. Nesta's Digital R&D for the Arts Fund, in partnership with Arts Council Wales and the AHRC has a focus on collaboration between arts or cultural organizations and technology partners to either explore business models or expand audience reach [6]. For example, the Arts Alive Cymru project *Exploring Technology in Remote locations* works with professional artists using mobile phone technology to enable the presentation of artworks in rural communities. The aim is to enhance the lives of young people and vulnerable adults in remote locations with little or no connectivity [7]. The Wellcome Trust has Large and Small Arts Awards to fund artistic projects that enable artists and audiences to explore health research. Many of these awards have included artists working with new technologies to address societal problems including health and well-being with many grants in the field of mental health.

Examples of Wellcome Trust Large Arts Award projects that directly reflect the public's perceptions of mental health in the last five years that also involve visual artists using new technologies include: In 2013, Shona Illingworth's *Time Present,* which researches amnesia and the 'erasure of individual and cultural memory' [8]; in 2015, Lindsey Seers moving image installation exploring virtual reality and schizophrenia [9]; and in 2012, Mark Neville's *Bringing the War Home* that investigated the social impact disorders such as post-traumatic stress disorder (PTSD) amongst British troops returning from war zones [9].

Such projects reflect the growing interest's artists have in their work making a direct contribution to society. This is further evidence for the idea of a 'social turn,' a phrase first used in 2006 by art historian Claire Bishop to describe artworks that aim to impact on social change [10]. The artist filmmaker, writer, and founder of *Situationism,* Guy Debord (1931–1994), whose work is a critique of capitalist society and the hegemony of governments in the post-war era, was perhaps the founding father of this sort of practice [11]. His key influence was to eliminate the spectator's position through collaboration with audiences and crossing discipline boundaries to activate social change. Jeremy Deller's *We're Here Because We're Here #Wearehere*: the Somme tribute is a good example of this sort of practice. This piece of work was commissioned to commemorate the anniversary of 100 years since the first day of the battle of the Somme on July 1, 1916. On July 1, 2016, more than 1500 men in First World War uniforms descended on public places around the UK. The legacy of this memorial is through the photographs taken by the general public and shared through social network sites [12].

Another recent term used to describe similar practices is 'socially engaged practice' situated in the wider arena of public art as defined by Kwon [13] that describes contemporary art that is collaborative and involves people as the medium or material of the work which is often the result of outreach activities. Art-in-the-public-interest focuses on social issues, political activism, and community collaborations; the work of Ai Weiwei and his critique of the Chinese government being another tangible example in addition to Deller's work. Similarly, the term new genre public art coined by Lacy [14] is also a form of socially engaged practice, for example, Rural Works [15]. Terminology and categorization can obscure meaning. Visual art is a very broad term and arguments over what it is and what it does give it its character and value. Its virtue is in discourse that raises awareness through observations, tackling issues, dealing with expectations, and assumptions through its many different forms. What many artists have in common is working toward the common goal of exploring the world through investigating problems but not necessary resolving them. Artists often end up with more questions than answers. However, framing such questions can lead to greater insights and understanding of the world and its representations.

Perhaps in recognition of this shift in artists practice to a socially engaged interest is the AHRC's 'Connecting Communities' program which states:

> *The programme seeks not only to connect research on communities, but to connect communities with research, bringing together community-engaged research across a number of core themes, including community health and wellbeing, community creativity, prosperity and regeneration, community values and participation, sustainable community environments, places and spaces, and community cultures, diversity, cohesion, exclusion, and conflict.* [16]

In 2015, Axisweb commissioned research to understand artists in the UK who work beyond the gallery in the UK to help validate artwork which is socially engaged and often exhibited outside the gallery. This research found that many artists are not motivated by the mainstream gallery system choosing nongallery contexts for their work in order to ask '*critical questions about social worlds, rather than to make saleable art objects*' [17].

8.3 Mental Health and the Arts (Wellcome Collection/Oriel Davies Exhibitions)

8.3.1 Mental Health Treatment

The Royal Bethlem Hospital or Bedlam as it was popularly known was constructed in 1247 and reflects wide-ranging developments in mental health treatment; it provides mental health care to this day. The Wellcome Collection curated *Bedlam: the asylum and beyond* as a case study to explore '*changing attitudes toward mental health care and services*' and '*explore how medicine, art, and culture define mental illness, and the big questions it raises about the individual and society*' [18]. This section investigates the work of four contemporary international artists in the exhibition that was shown at the Wellcome Collection, London, from September 2016 to January 2017. The selected multimedia artists are Javier Téllez, Shana Moulton, Mr. X, and Madlove: A Designer Asylum. In addition, Seán Vicary's solo exhibition *Studies in Solastalgia* presented at Oriel Davies Gallery, Newtown, from September to October 2016 is also studied.

The following sections summarize the activities of the four artists who are working both outside and within the gallery system.

8.3.2 Bedlam: The Asylum and Beyond

Weaving through the multiple exhibitions plinths containing a plethora of medical instruments and graphic descriptions of patient's historical experiences at Bedlam, the audience's first encounter of Javier Téllez's surreal film *Calligari and The Sleepwalker* (2008) is through a thick blackout curtain. Entering the minimal darkened space of the artist moving image, viewers experience a creative response influenced from the cult horror film *The Cabinet of Dr. Caligari* (1920). Téllez's witty black and white, silent, hypnotic collaborative film is written and acted by patients at a psychiatric clinic in Berlin. This large-scaled single channel projection that incorporates obscure architectural camera angles, curious costumes, and comical make-up includes people holding framed blackboards containing dialogues in German, with subtitles in English. Mirrors and found objects are utilized when acting out alien characters in fantastical settings to create multiple scenarios that disrupt the role of patient/psychiatrist. This interrupts didactic methods with the intention of engaging the viewers in profound experiences that excellently connect with the exhibition theme. Through films relationship to German expressionism, performance and theater and earlier examples of the Dada and Surrealists plays, Téllez adeptly uses film as a tool for exploring mental health issues through artist moving image.

On exiting Téllez's constructed film space and following the curve of the exhibition wall, past historical documentaries on mental health, visitors to the exhibition are greeted by Shana Moulton's suspended soft sculptures. Created from felt, the sculptures portrayed human-like traits imaginatively created from a pharmaceutical logo for restless leg syndrome, a drug side effect, affecting numerous mental health patients. Moulton's short ten-minute film displayed on a LCD monitor further depicts the condition with a visual narrative running throughout the video. Here, the audience experiences such imagery as arms appearing and disappearing with objects through holes in a unit behind the artist's head to depictions of the artists' legs adopting an octopus style animation on a bed whilst connected to her body when watching a television advert of the said drug in a 'personalized bedroom.' Although a considerably more literal approach the film was notable from the perspective of our relationship to the media, the persuasion of advertising and afternoon TV within a mental health context.

The quirky artworks of Mr. X were documented in a video piece found on a monitor in the far corner of the gallery. An artist and patient of the Royal Bethlem Hospital in its current location [19], Mr. X makes fabulous vehicles out of cardboard which he drives around the hospital and beyond. Film recordings show him driving his vans and trucks along corridors, entrances, and into the hospital's glass fronted elevator as well as the surrounding area of Bromley including its streets and petrol stations. Similar, to Yayoi Kusama, an artist and patient in a psychiatric unit in Japan, who goes out to work in her studio two hours each day [20] Mr. X is not confined or a prisoner in the hospital.

Madlove: A Designer Asylum sits in a corner of the gallery surrounded by an undulating wall adjacent to Mr. X's video. Unlike critics of the exhibition such as Culture 24 which cite displays of footage, prints, photographs, and written accounts that 'place the visitor on the outside looking in, making it difficult to engage with what patients actually experience' [21]. Madlove: A Designer Asylum puts patients at the heart of their design within a gallery context. Culture 24 confirms this in their description:

> *... most importantly of all, exhibitions like this need to leave visitors with some space to reflect and something positive to take away. In 'Bedlam', this comes in the form of the 'Designer Asylum' – a vibrant, utopian, modern day asylum created from the ideas of over 400 people with experience of the mental health system.*

Bedlam: the asylum and beyond received positive and negative critiques [22] regardless whether the reviews were good or bad it is important that this work was exhibited.

8.3.3 Studies in Solastalgia

Seán Vicary's exhibition *Studies in Solastalgia* at Oriel Davies Gallery in Newtown, Wales (2016) was a showcase of different aspects of recent and previously unseen strands to this leading Wales-based artist's work. Vicary, a former painter seduced by multimedia currently works with theories of the uncanny, rewilding and Genius Loci. His practice intertwines scientific, historic, and geographic activity with personal, autobiographical poetic ideas. Through multilayered, high-crafted animations, and delicate sculptural works imbued with dark ecology, he invites the viewer to explore intensely resonate semifictional landscapes concerned with observation, collection, and devastation. The exhibition title is drawn from the word Solastalgia which Australian philosopher Glenn Albrecht describes as a form of homesickness that one get when one is still at 'home.' Vicary adds to this saying that it is also a feeling that is often 'exacerbated by a sense of powerlessness or lack of control over the unfolding change process' [22].

The selection of two pertinent, short animated films from the collection, *Body of Songs: The Nose* (2015) and *Ascension Ceiling* (2014) are included here.

The *Body of Songs* project, supported by Arts Council England and the Wellcome Trust, brought together major musicians and scientists to create songs inspired by the body's organs. As part of the program, a select number of artist–animators were invited to collaborate with musicians and scientists undertaking their own journey of discovery. Transported by Sam Lee and Llywelyn ap Myrddin's *Nose Song* that Vicary described as a sonic version of the all-consuming experience of smell, he began his film by fusing the song with scientific investigations of olfaction by genetics and smell specialist Dr. Darren Logan from the Wellcome Trust Sanger Institute. Vicary's creative animation film aimed for a visual equivalent of the *Nose Song*. Incorporating poetic landscape suggestive of a fictive/autobiographical subtext drawn from his Mother's early childhood in India and personal experience of coping with his Mother's dementia and subsequent death, Vicary certainly achieved it [23].

Ascension Ceiling, Vicary's earlier animated video projection was inspired by the Baroque painting that explored the godlike perspective of drone operators. It responded to the continued use of local airspace in the testing of military drones based at West Wales Unmanned Aerial Vehicle (UAV) Centre in Aberporth but has a much wider more global perspective too. Utilizing audio testimony from military UAV operators, it questioned observation and complicity by creating a reimagining of the world in its constructed animation.

8.4 Technology, Visual Arts, and Well-being Programs (FACT, Lucy Beech, VIP)

8.4.1 The Foundation for Art and Creative Technology

Since 2012 the Foundation for Art and Creative Technology (FACT) has been developing the Veteran's in Practice (VIP) digital arts project with military veterans, artists, and technologists from Liverpool and further afield to produce creative projects including animations, documentaries, and online projects. VIP is just one strand of the services that the Liverpool Veterans well-being program provide (other support includes a one-stop shop for housing, finances, and health).

These works will be critiqued alongside the work of Lucy Beech's whose new film *Pharmakon* was commissioned for the Liverpool Biennial, 2016, and the Liverpool Veterans well-being program, specifically, the VIP project FACT will be explored. Beech's *Pharmakon* was an interpersonal drama that explored how disease operates in an era of mass communication and was screened at FACT. In 2015, VIP won The Royal Society for Public Health, Arts in Health Special Commendation for the excellence of its contribution to arts and health.

8.4.2 VIP

Polish artist Krzysztof Wodiczko is renowned internationally for his large-scale slides and video projections on architectural facades and monuments. In addition and central to his work are complex designs for personal communication instruments and survival vehicles that explore recurrent themes of social and political marginalization. Wodiczko is currently Professor in Residence of Art and the Public Domain, at Harvard Graduate School of Design (GSD), and prior to this, he was Director of the Interrogative Design Group at the Massachusetts Institute of Technology (MIT) where from 1991 he was a Professor in the Visual Arts Program. His practice, known as 'Interrogative Design,' combines art and technology as a critical design practice in order to highlight marginal social communities and add legitimacy to cultural issues that are often given little design attention [24]. His experience as a visiting professor in the Psychology Department at the Warsaw School of Social Psychology enables him to understand behavior in communities and to help 'develop their shattered abilities to communicate' and share their experiences with others [25].

Wodiczko was initially commissioned by FACT to collaborate on the VIP project in the same year his video installation *Guests* (2009) was exhibited as part of the Polish Pavilion of the 53rd Venice Biennial. *Guests* exhibited in albeit a smaller scale at FACT, but with as much connotation, formed part of a retrospective of four decades of Wodiczko's work in 2016. The installation created the illusion of windows, with scenes unfolding seemingly outside of the gallery. 'Legal' and 'illegal' immigrants residing in Italy and Poland were depicted washing windows, sweeping leaves, and being overheard discussing issues of naturalization. This visualization is of huge significance given the current global situation.

In 2009 and 2015, Wodiczko created two extraordinary artworks in collaboration with the war veterans and Veterans in Practice program at FACT. The initial commission continued Wodiczko's interest in returning soldiers from recent war zones and resulted in *War Veteran Vehicle* (2009). Here, Wodiczko transformed a decommissioned military jeep into a 'mobile video projection vehicle' screening text onto buildings and monuments around Liverpool offering moving testimonials from veterans and their families. The intention was to promote the better understanding of the 'impact of social reintegration of soldiers' on returning to peaceful societies [26]. For Wodiczko's second commission in 2015, he developed *War Veteran Helmet* in collaboration with FACT's VIP program. Collectively, they discussed the idea of a virtual reality (VR) wearable device for ex-soldiers and developed a prototype helmet that was initially tested in Poland with war veterans.

> *The War Veteran Helmet proposes a techno-cultural prosthesis that can be worn by veterans to better communicate their experience of trauma. It supports them to be present in crowded environments whilst helping the public emphasise with the challenges they face as civilians returning to civilian life.* [26]

Through a series of experimental prototyping workshops at FACT with artists and technologists, the VIP group is continuing to develop the *War Veteran Helmet.* This time the focus has transferred from individual protection with designs and content for the helmet being created and tested with people in public places such as shopping centers in Liverpool. The aim being to educate the public to 'encourage greater understandings of the realities of contemporary conflict' [26] such as those experienced in Iraq, Iran, and currently in Syria.

8.4.3 Pharmakon

Lucy Beech's film *Pharmakon* was screened in the upper gallery at FACT which coincided and complimented Wodiczko's retrospective on the ground floor exhibition space. Beech's lives in London, UK, and her video and performance works explore ideas around 'emotional capitalism, interrogating forms of emotional labor that place a premium on interpersonal interaction whilst blurring the boundaries between work and play' [27]. Her arts practice is often focused on female group dynamics and uses choreography to disrupt narrative structure in order to explore public intimacy and competitive vulnerability. Beech researched for *Pharmakon* by actively engaging with therapy groups, advocacy Web sites, patient forums, alongside interviewing clinicians working within the field of delusional infestation. By focussing on female group dynamics, Beech examines how 'support networks can care for the individual whilst conversely intensifying symptoms' thereby critiquing how 'connectivity in this context can be both illness and remedy and how diagnosis is dependent on our ability to impose particular narratives on the body' [27].

Alongside the film like Wodiczko, Beech incorporated text, using diagnosis as a collaborative exchange between clinician and patient by inviting writers Alice Hattrick and Naomi Pearce to correspond via email about the film as a way to mirror the dynamic. To structure this, Beech gave the writers a two-week timeframe in which to write and edit the correspondence. This references their earlier collaboration *Under the Influence* in association with Womens Art Library, London (2015) [27].

Beeches *Pharmakon*'s engages with marginal communities that seek support via online networks. The focus of which is the fictitious 'Healing Grapevine' which provides care and conversely intensifies its users symptoms. Beech notes:

> *Here connectivity is perhaps poison and cure. These support groups are stereotyped as women who collaborate in their sickness through a shared discourse.* [28]

The film's interpersonal drama was shot in Liverpool in spaces such as the Palm House and a night club in the city center. It wove an imaginary science fiction experience with gritty realism in a cross-disciplinary artistic documentary to explore how health anxiety and self-diagnosis operates currently in an era of mass communication. The use of cinematography through soft tonal colors and depth of field when capturing the narrative of the fictitious therapist and the side profile and panning shots exposing the close up of the main protagonist the female bouncer to emphasis her anxieties were wonderfully implemented. Dialogues such as 'behavior breeds behavior' and visual imagery of the mirroring of several cleaning women's hands on reflective tables were adeptly captured in phrases such as 'not sensing surface but sensing itself.' The connection between diseases such as delusional infestation (DI) and obsessive-compulsive disorder (OCD) and the therapists' voice citing 'contact or noncontact' was clear. Later this 'scientific' communication was emphasized with a larger group of women at a presentation as the protagonist slowly drinks bottled water whilst the pitched declaration that the liquid 'rebalances internal bioterrain' resonates. The continual contrast between the character and the other is emphasized when with her short shaved head and in her security guard uniform, we encounter a recorded monologue of the 'therapist' that is internally rattling through the protagonist's head via her earphones. Here, the female bouncer observes women in sports attire performing meditative yoga moves on a communal floor and from an aerial perspective in her role as 'protector' and 'voyeur.'

FACT are 'ahead of the game' in having the imagination to commission inspirational contemporary artists and technologists who are current and innovative. These exhibitions were most certainly the highlight of the 2016 Liverpool Biennial.

8.5 Arts/Science Collaborations: Lessons Learned (In-Between-Ness: Windows Within)

8.5.1 Publicity, Accessibility, and Increasing Public Awareness

Many art/science collaborations since the turn of the millennium have focussed on the contextualizing science through making its language more accessible to the public via exhibition's performances, festivals, and events that have attracted audiences and hence funding. Professor Mark Lythgoe founder and Director of the UCL Centre for Advanced Biomedical Imaging has been combining science and art to engage the public in the UK since the early 1990s [29].

In 2006, Professor Mark Lythgoe (UCL), Dr. R. Beau Lotto (UCL Institute of Ophthalmology), and Dr. Mark Miodownick (Kings College London) were the first scientists to create an exhibition at the Hayward Gallery, London [30]. The exhibition *AfterImage* investigated the human perception of light and color through the work of Dan Flavin and was attend by an estimated 120,000 people [31].

8.5.2 The Challenge of the Project

Heald and Liggett are interested in art–science collaborations not just as a means of contributing to public understandings of science but as more of a means of interrogating knowledge production. Their aims as artists are to develop a common language, to take creative risks, and to cross-discipline boundaries. Developing this common language was a lengthy process in the arts/science research project *In-between-ness* [32] and the team met for an hour on a monthly basis for three years to reach a common understanding that enabled them to write a convincing research proposal. Working beyond their comfort zones was the most salient risk to the collaboration, and it was only through ongoing dialogue that assumptions were challenged and a common language emerged. Having a committed, patient, and open-minded team with mutual respect for each other was also essential to the success of their research.

8.5.3 Relationship with the National Health Service

The complexities of working within the National Health Service (NHS) had its own challenges; some anticipated and others not. The coordination of participants, medical professionals, and artists in a large rural hospital in North Wales was at times logistically frustrating, but the biggest hurdle encountered was seeking ethical approval. It was a testament to the strength of the team that they managed to get the use of video cameras in a mental health project agreed; provided no imagery of people were included. Participants in the projects faced the same possible misconceptions about the nature and purpose of the research, so a representative was elected onto the team to act a voice for participants. This made them equal partners and had a positive empowering effect on their esteem and sense of personal agency which could perhaps help contribute to recovery from a depressive illness.

8.5.4 Extending the Measurements

The research team is ambitious to test the findings from this pilot project and is working on a large funding bid from the AHRC. The team has expanded to include

Fig. 8.1 Paper Interior, video performance (Heald and Liggett 2013) (reproduced by permission)

a general practitioner and three university professors from Bangor and Liverpool in the fields of social science and mental health. If successful, the project will employ a team of artist–researchers in collaboration with FACT to conduct a large-scale study using the method developed from the *In-between-ness* project to impact collaborative research in the field of mental health and the visual arts (Figs. 8.1 and 8.2).

8.6 Discussion

8.6.1 The Potential of Visual Images

The potential for using visual images to improve the mental health of patients appears to confirm the value of conducting further investigations with the intention of expanding the range of investigations and validating the initial results across a wider range of patients. In addition, given that mental health and social care are currently an underfunded area of healthcare in the UK, any benefits that can be provided can be crucial to patient health both now and in the future.

Fig. 8.2 Paper Interior, video performance (Heald and Liggett 2013) (reproduced by permission)

8.6.2 Applicability

This raises the question of whether there are any further groups in society currently at the margins that could be helped by similar forms of visual treatment. People with health issues can feel frustrated because often the solution to their problem are labor intensive and expensive, possibly delaying treatment. The arts have had a positive impact upon health issues, particularly within the fields of mental health, dementia, and physical recovery. Engagement in the arts can be life-changing and essential for the well-being of a nation.

8.6.3 Efficacy

It is therefore important in the trials that are conducted with mental health patients to understand how, and in what ways, the use of visual images affect processes in mental health, in the thinking processes, the perspectives with which people view the external world, and in the brain as a whole. Do the visual images change brain chemistry, a change in brain thinking processes, or a combination of the two? Do they affect emotional intelligence? How can digital video art be used to express perceptions of self and the world during treatment for depression?

8.6.4 Treatment Strategies

It is also important to evaluate how far treatment strategies could be put online—to allow direct access by those interested and to reduce the current labor-intensive nature of the interaction of those with mental health problems through addressing well-being. The move to online solutions can be successful in addressing the labor-intensive nature of some treatments and maybe the long waiting lists for an initial consultation. However, there is significant scope for developing preventative strategies, possibly online that can demonstrate the economic value with the social return on investment (SROI) as an indicator.

8.6.5 Automation

Can a model be constructed with key characteristics that can be measured? Can these characteristics be measured automatically and be used as a proxy for the condition of the person? If so, can a digital camera be used to record the data? Can an intelligent database be constructed where the characteristics are mapped onto the model and conclusions drawn? This research raises such questions, that although outside the remit of the project, are worthy of discussion to drive innovation in utilizing digital media to address societal problems.

8.7 Conclusions

Today thanks in part to Martin Heidegger's (1889–1976) notion of 'praxical knowledge' or the 'material basis' of knowledge, '*provides a philosophical framework for understanding the acquisition of human knowledge as emergen*t.' He said that 'praxical knowledge implies that ideas and theory are ultimately the results of practice rather than vice versa' [33]. Collaborative research teams that cross-discipline boundaries nowadays recognize what they can offer each other in the pursuit of knowledge, such as artists finding creative uses for the new technologies through the notion of 'play' and 'experimentation' rather than goal-orientated endeavors.

But still, creativity with its fuzziness and subjective emergent themes and tacit knowledge can at times be at variance with traditional scientific thinking. Goethe's book on color published in 1810 that influenced many artists including Kandinsky was initially rejected by physicists because it was not concerned with the analytical aspects of color but with the phenomena of the perception of color [34, 35]. Artists and scientists working together acquire skills and tools with which to reflect on new perspectives within their work. In the *In-between-ness*, project the artists-enabled new technologies such as high-definition video cameras to be used as research tools in ways that perhaps the medical professionals would have considered unchartered experience beyond their practice. Typically, the use of new technologies within art practice is to explore problems rather than to solve them in a context that is never commercially driven, as perhaps is the case in the film industry. Visual artists are increasingly pushing the boundaries to incorporate less traditional aspects to their work. They are incorporating new technologies, collaborating with software engineers, scientists, and inventors to produce work that is often less static and more ubiquitous. This can result in greater reach and impact in areas previously unexplored by artists such as within mental health that was not possible before the digital revolution.

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Chapter 9
Conclusions

Abstract This final chapter summarizes the material presented in this volume, the lessons learned from the case studies, and includes a brief look to the future. Tools for art and design (such as stone, pencil, paintbrush, or iPad) and collaboration opportunities are increasing. Artists and designers are products of their immediate environments to a greater or lesser extent and have both contributed to it, and received cultural benefits from it. Thus, there has been cultural and social interplay between artists and designers and the contextual setting of their artworks and designs. Collaboration across different kinds of creative environments and works can be difficult and challenging because of the cultural norms and assumptions that may be made by different artists. However, it is clear that design processes (particularly for large and extensive projects) can benefit from the involvement of all interested parties from an early stage. The digital revolution has created a connected world. The consequences for artist, designer, art galleries, and museums are significant. Galleries, exhibitions, artists, and designers now operate in a global world as well as the local one. The digital world has also provided many user-friendly tools and facilities at often relatively low cost, or open source, for the artist and designer. It has facilitated the production of new kinds of art, interactive art, and installation art not fully possible before. This has opened up new creative opportunities and horizons for the artist and designer. Modern information technology has also provided low-cost multimedia interfaces and virtual reality. The lessons learned from the case studies are reviewed and summarized.

Keywords Tools and materials · Creative applications · Cultural interplay · Connected world · User-friendly tools · Interactive art · Entrepreneurial artist and designer

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9.1 Introduction

Art and design have used a variety of tools and materials throughout history depending to some degree on their availability. The three age systems of Stone Age, Bronze Age, and Iron Age which refer to the prehistorical and historical periods are identified in general terms by their tool manufacture and use. Although these tools may have been primarily aimed at easing working practices such as those involved with activities such as construction and transport, they have clearly also been utilized by artists and designers for creative applications. Thus, tools and collaboration have always been implicit in art and design to a greater or lesser extent. For example, to learn how to best use a tool (such as stone, pencil, paintbrush, or iPad) and also to interact with other contemporary artists to gain from their knowledge and experience. Thus, artists and designers have demonstrated a relationship with their environments and have both contributed to it, and received cultural benefits from it. Thus, there has been cultural interplay between artist and the contextual setting of the artwork.

9.2 Challenges and Benefits of Collaboration

Collaboration across different kinds of creative works can be difficult and challenging because of the cultural norms and assumptions that may be made by different artists. However, it is clear that design processes (particularly for large and extensive projects) can benefit from the involvement of all interested parties from an early stage. When the design is to a brief, it is also important that the eventual users of the final implementation are able to input their views at various stages in the design and implementation processes in order to ensure that their functional requirements can be fully met.

The digital revolution has provided a wide variety of low-cost interfaces (e.g., multimedia, VR) to enable the viewer to interact with, and explore, large artworks such as installation art which may not be directly physically accessible to viewers. This can increase the dimensions of the observer experience with regard to installation art.

9.3 Development of Technology

In addition, an understanding of artistic and design processes and the various ways of implementing them has been increased due to the development and application of the various technologies (just as current artificial intelligence procedures applied to the learning processes of humans has caused educational researchers to consider in more detail what the learning processes of humans actually are).

The digital revolution has created a connected world. The consequences for artist, designer, art galleries, and museums are significant and far reaching. It has also provided many user-friendly tools and facilities at often relatively low cost for the artist and designer. It has facilitated the production of new kinds of art, interactive art, and installation art not fully possible before. Thus, it has opened up new creative opportunities and horizons for the artist and designer. Modern information technology has also provided low-cost multimedia interfaces and virtual reality. This can provide new dimensions of interactivity with artworks, as well as providing access to remote viewers over networks and the Internet. It has enabled the viewer to use their mobile phone to interact with artworks where this is a facility that has been designed in by the artist as an integral part of the objective of the work. Thus, the experience of the viewer of an artwork is now able to move from passive observer to interactive participant in those circumstances where this is part of the creative purpose of the work.

9.4 Implementation

A wide variety of low-cost, or free, applications software is now currently available—to assist the artist and designer. Similarly, high-functionality hardware to perform functions in art and design that were not possible before, or at least, not easily (e.g., laser scanning, 3D printing, stereolithography) is available at many institutions, or accessible over networks. Software is also available to support art galleries and museums in the management and organization of exhibits, and for artists and designers to organize and keep a record of their own works.

9.5 Summary of Lessons Learned from the Case Studies

9.5.1 Chapter 6—Dr. Tracy Piper Wright

- Use as many opportunities as possible to gain feedback on the technology or product being developed—from its eventual users.
- The research needs to integrate with the participant's life in order to encourage their engagement, and this requirement is likely to increase depending on the extent and severity of their personal barriers.
- Effective communication is vital to successful multidisciplinary collaborations.
- Arts researchers can make valuable contributions to research in an unrelated discipline. The insights brought to the subject from an alternative perspective can often lead to a new interpretation of an existing situation and the development of innovative responses.

9.5.2 Chapter 7—Dr. Stuart Cunningham, Steve Nicholls, and Steffan Owens

- Technology has played a crucial role in the development of music, especially when it comes to the way that it can connect to its audience, and the diverse range of ways that it can interact with learners of differing style and level. However, the introduction of these technologies has, arguably, introduced a divide; the ability to work alone and in isolation affords many resource benefits, but endangers the ability to work collaboratively and learn from more experienced musicians.
- Music has embraced technological change and used it to full advantage, especially when it comes to being able to produce more diverse and larger scale creative works, as well as being able to distribute works in digital form.
- When it comes to training the next generation of musicians, it has been demonstrated that the use of multimedia, interactive platforms, and fast communication mechanisms has made education a more diverse and accessible opportunity.

9.5.3 Chapter 8—Dr. Karen Heald and Dr. Susan Liggett

- Using visual images to improve the mental health of patients has produced positive results and appears to confirm the value of conducting further investigations.
- Possible applicability to further groups in society currently at the margins that could be helped by similar forms of visual treatment.
- Potential for putting treatment strategies online—to allow direct access by those likely to benefit.
- Potential for automating the diagnosis and treatment process by means of digital technology.

9.6 Summary

As the lessons learned have identified, it is important to gain feedback from the eventual users if various kinds of technology are being proposed—in order to ensure that the user interfaces satisfy user needs, and the functionality incorporated in the creative works is able to accomplish both the design objectives and meet user requirements. Clearly, effective communication between artists, designers, and users is essential to ensure these objectives are met.

Technology can enable the creative processes to be advanced and produce new opportunities for the design and distribution of digital works, particularly where they are part of a commercial enterprise such as digital music production and distribution. It has also facilitated in the education of the next generation of musicians.

Visual images have also been utilized in new application areas such as mental health. This could have the potential to revolutionize aspects of health in areas often marginalized in many countries due to economic constraints in health and social care.

9.7 The Future

Entrepreneurial artists and designers who see modern technology as an opportunity rather than a constraint will continue to be able to produce groundbreaking artworks and designs that exceed current expectations, and open up new visions for the future. They will also allow the viewers of artists' works to enter into new kinds of relationship with the works they view. This benefits all parties in the continuing development of artistic and design experience.

Continued increases in power, functionality, and capability in information technology and telecommunications will produce more products and services that could be attractive to many potential application areas in the future, including art and design.

Further Reading

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