5 Practice

Since the mid-1960s, artists have been actively and successfully using digital technology in their practice. Many of these artists can be classified as 'computer expert'. Bringing the expertise of art and technology together has usually been the achievement of one person working alone. As we consider more recent digital art, increasing collaboration can be seen between people of different disciplines and skills. The paradigm for digital art seems to be shifting towards collaborative practice as a norm. A survey revealed that 90 per cent of the artists who were experimenting with digital technology were also collaborating with people in other fields [1]. Whether this pattern of collaborative practice continues to grow or not will, perhaps, change as education develops and responds to the art and technology developments presented here. We may see a growth in the number of artists who are expert in computer technology to a similar level as those in print-making, carving or welding. On the other hand, the advantages of collaboration extend beyond merely the acquisition of technical skills. Collaboration provides opportunities for more ambitious creative projects. Furthermore, the many funding initiatives that explicitly encourage joint activities also contribute to this growing trend.

The artists' reflections in the second part of this book raise issues about the role of digital technology in relation to creative practice as it is seen today. A number of artists have noted how involvement with computers has stimulated them to move forward in their conceptual thinking. They have been encouraged to break with previously established conventions and explore new methods. One artist discusses the importance that digital technology has had in encouraging him to shift the very idea of what he considered to be art. Another found that using a virtual reality (VR) system was the trigger that caused him to reconsider the nature of his paintings. Others found that involvement with computers caused them to reformulate the boundaries of their artistic scope, for example, by adding time as a dimension of the work. In general, the challenges inherent in working with digital technology can have a positive influence in encouraging artists to break with their existing conventions, a development that is a core element of truly innovative practice.

For most digital artists, the importance of using and having access to expert technological knowledge cannot be over emphasized. As the study of collaboration described in Chapter 4 revealed, some find it vital for each member of the team to have a clear and well-defined role. On the other hand, by their own account, some artists have been struck by the

way in which digital art collaborations lead to the blurring of the distinction between artist and technologist. In both situations, access to expert knowledge and opportunities for the collaboration needed in order to acquire that expertise, prove to be essential in enabling the realization of successful digital projects. An interesting aspect of collaboration is the way in which it provides participants with more than one viewpoint about the nature of the creative process. One artist notes how the process of collaboration with a technologist, and the kind of discussion that it requires, encouraged her to reflect on different views about how to proceed with the work and what method to use to produce it. Collaboration helps the participants to address tasks via a number of parallel channels of thinking, which draw upon different types of knowledge. From this process, entirely new understandings can emerge that transform the outcomes of the creative work.

Studies of Creative Process

Understanding the ways in which creative process has been influenced by the growth of computer use is a key concern of this book. Studies of the creative process, as distinct from studies of the outcomes or artifacts of this process, have been much more extensive in the field of design than in art. Although there are many differences between the fields of design and art, they have many similar characteristics in terms of the creative process involved. It is therefore useful to broaden the discussion to examine the issues surrounding creativity in general, but particularly in design practice.

There has been considerable research into how designers carry out design activities. In both product design and software design, common characteristics have been identified. In particular, the view of design as an hierarchically organized planned activity as opposed to design as an opportunistically driven mix of top-down and bottom-up strategies has been explored in a number of empirical studies, e.g. Guindon [2] and Ullman [3]. Maccoby [4] studied prominent designers and engineers whose contribution to their fields was unquestioned by their peers and the world at large. Although they represent a spectrum of different fields and cultures, they exhibit similar ways of thinking and working. Most are “holistic thinkers”, in the sense that they look for an overall broad scope before moving into specific detail. Other studies indicate that design is often solution-led, in that the designer proposes candidate solutions early on in order to scope the problem better. Designers impose constraints that narrow down the number of solutions and help generate new concepts. They also change their goals and add constraints during the design process. Boden [5] makes a good case for the claim that changing a constraint might be at the core of creative thinking.

Taking account of these studies and our own investigations into innovative designers, various characteristics of the creative process have been identified with a view to identifying the kind of computer system that could be supportive to the designers' creative practice [6,7]. New ideas do not just come out of thin air. The conditions for creativity are very important and outstandingly creative people seem to be able to arrange for the right conditions to be available. The use of complex tools, such as computers, forms a significant part of the context in which these conditions for creativity exist. The studies referred to above identified aspects of the creative process that are relevant to art and technology practice. Most interestingly, they relate to artists' observations on working with computer technology that were discussed earlier. Examples of the aspects identified are:

- *Breaking with convention*
  Breaking away from conventional expectations, whether visual, structural or conceptual, is a key characteristic of creative thought. Events that hinder such breaking with convention are avoided, whereas positive influences are embraced.
- *Immersion*
  The complexity of the creative process is served well by total immersion in the activity. Distractions from this immersion are to be avoided.
- *Holistic view*
  The full scope of a design problem is only fully embraced by taking a holistic, or systems, view. The designer needs to be able to take an overview position at any point and, in particular, to find multiple viewpoints of the data or emerging design important.
- *Parallel channels*
  Keeping a number of different approaches, as well as viewpoints, active at the same time is a necessary part of generating new ideas. The creative person needs to work in *parallel channels*.

The creative process includes the following activities, each of which has its own characteristics. Some of the key elements are:

- ideas generation
- problem finding and formulation
- applying strategies for innovation
- acquiring new methods or skills
- using expert knowledge.

Digital artists are very involved in finding support for the last two of these. Much of the collaboration that we observe in the artist's discussions and from the studies of their residencies is addressing these activities. Digital artists are concerned with finding and creating the environments in which they can work productively. The early digital artists had little choice but to acquire the necessary computer expertise themselves if they were to be able to achieve anything at all. Their experiences were rarely collaborative in the sense we mean today where people of different skills and backgrounds combine their efforts to make the technology accessible for art practice.

As an example of the role of digital technology in the development of an artist's expert knowledge, it is interesting to consider two artists whose contribution to computers in art has been very significant over many years.

Digital Technology and Creative Knowledge

Harold Cohen's computer system, AARON, is the best known and most successful example of a computer program that creates drawings and paintings autonomously [8]. Cohen's artistic knowledge about creating drawings and painting was captured in the form of a computer program which could then create new works itself. In the process of developing the program, the artist's process involved evaluating AARON's drawings and re-examining the knowledge in the programs in the light of his judgement. He then modified the program many times to include the new insights in the program. The creative process was one of externalizing his existing drawing and painting knowledge and then, once it was "made visible" by the computer, evaluating the outcomes and making further changes for which he often needed to acquire new knowledge. When he began this work, the drawings were concerned with strictly organizational issues in the sense that they were basically abstract. Cohen has since moved into expressing knowledge about colour in the computer program which, for some time has been generating figurative art works. The figurative knowledge in the computer system required more knowledge about the world, e.g. plant pot relationships to the ground area and the physical composition of human faces, as distinct from the earlier drawing object relationships e.g. perceptual groupings.

For Cohen, creativity is something that is a process of continuous change, as distinct from single events. That change, as his work exemplifies, is in the mind and actions of the human and the process is essentially a directed one. There have been many cycles of his exploratory, pioneering work but during all that time, his goals have been consistent. His work is unique and the basic concept of developing an autonomous creative computer has rarely been taken as far as this. Cohen explores the

implications of his work for art practice and the changes that it has brought about in concepts of art and who owns it later in Chapter 7.

Another artist who has made pioneering contributions to art and technology in quite different ways is Manfred Mohr, whose work has been transformed by the visualization possibilities of technology. Mohr's work involves the construction of two-dimensional views of six-dimensional cubes (hyper-cubes). His goal is to express geometric knowledge about the cube which is encoded in the computer system using a programming language. The computer program then generates graphical entities from which he makes artworks using conventional media such as canvas and laser cutting and often special computer output devices to implement his intentions. The goals of two parties to the process, i.e. the artist and the computer, are clearly differentiated: the computer program generates purely geometric objects whilst the artist makes aesthetic choices on the basis of which he goes on to make artworks. The artist cannot do the bi-dimensional geometry in his head and the computer requires the artist to specify the geometric knowledge in a computationally tractable form. For Mohr, the interactive process with the computer is one with which he extends his capability as an artist:

> what fascinates me about a machine is the experience of a physical and intellectual extension of myself. [9, p. 5-7].

A productive relationship with the computer is dependent upon both the power of the programming language used by the artist and his own ability to develop its capability to achieve his goals. Mohr's approach is to retain ultimate aesthetic control over the final outcomes rather than leaving the final choice to the computer

This symbiotic interaction differs from that of Harold Cohen's. Cohen's primary goal is to have the computer system make the artworks. The role he chooses for himself is to specify to the computer the critical underpinning knowledge about art from which the computer generates the drawings and paintings. In using a computer language to make a computer create works, rather than a software application to create the drawings and paintings himself, he is expressing a fundamental premise on which his whole approach is based, exemplified in the statement:

> I inevitably get nervous about the notion that somebody could make art without a profound grasp of the underlying disciplines involved. [8, p.14].

Cohen's artistic vision places high value on expert knowledge about art and its role in computer-generated art. Mohr's vision involves exploring generative processes that are not accessible to human perception but are, nevertheless, able to be specified using the method he has chosen. The final artworks remain the province of his artistic decisions. For each art-

ist, the particular points in the creative process when he chooses to interact with the computer language and the outcomes it generates, are different.

Contributors

The second part of the book contains articles written by artists and technologists who have been associated with the Creativity and Cognition Research Studios from 1996 to 2000. The articles are personal statements about individual and collaborative explorations in art and technology.

Both Harold Cohen and Manfred Mohr took part in the Creativity and Cognition conference and exhibition series along with Bettina Brendel, Joan Truckenbrod, Stelarc and Roman Verostko, all distinguished international artists. They represent a broad spectrum of digital art practice both in terms of artistic intentions and the purposes for which they employ computer technology.

Roman Verostko has dedicated himself to algorithmic art in which, as he puts it, the computer program acts as a *score* for visualizing the forms. He has a drawing machine, a multi-pen plotter, which is driven by his computer programs and produces his final work. These do not necessarily look as if they have anything to do with a computer, yet they could not exist without it. Verotsko has developed algorithmic systems that, despite their apparent formality, generate soft and quite organic results. He takes his inspiration primarily from artists in the constructivist tradition whilst, from the complex behaviour of his computer programs, he generates work that is far removed from the formal geometric forms with which one associates that tradition. He provides insights into his formative experiences and development as a digital artist in Chapter 12.

Bettina Brendel and Joan Truckenbrod both relate strongly to organic life, whilst finding inspiration in science. Brendel has drawn on analogies from physics for more than 40 years and she has a deep scientific interest. From that perspective, it was not difficult or surprising for her to adopt the computer as part of the armory of her studio. In her case, it did not bring special new conceptual issues into her work, rather it was a natural addition in the context of her interest in physics, as she makes clear in her statement in Chapter 6. In the case of Truckenbrod, on the other hand, the virtual worlds of computing and the Internet add a new dimension to her concerns. The differences and correspondences of virtual worlds and physical ones and transformations between them forms the driving concern for her digital work. See Chapter 11 for her account.

Stelarc has pushed the boundaries forward in a different sense. He is a performance artist who came to the realization that he could explore his human self by exploring the intersection of the technological and the

organic. His work challenges our understandings and expectations of that intersection by treating technological devices and communications capabilities as extensions of himself. For Stelarc, the technology that he uses is at the centre of his conceptual interest. In order to make his work he has to become deeply involved both in the workings of the technology and in the science of biology in respect of the implications for each of the interchanges that he studies. Chapter 10 gives a flavour of the kind of dramatic work he performs using some remarkable and complex technologies.

The artist-in-residencies at Loughborough University in 1996, were held under the auspices of Creativity and Cognition [10]. Three of the four artists concerned went away without complete technological solutions to the problems they had brought to the table. The specific questions they were asking did not have ready-made software or hardware answers. Moreover, the artists themselves found they had to work through the generality of some of the problems they were posing with an expert in another discipline, in order to define more precisely the implications. Until you work through potential solutions, it is sometimes difficult to know what exactly is the right question to ask in order to solve the problem. Sometimes, until it has been worked through, it is not even clear what the problem is.

Of the 1996 residents, Fré Ilgen, Michael Kidner and Jean-Pierre Husquinet have contributed chapters to this book. The artist residencies that followed during 1999 and 2000 were both research and art led. The COSTART (Computer Support for Art) Project, funded by the Engineering and Physical Science Research Council of the UK, which provided support for residency accommodation and subsistence, undertook in-depth studies of collaborative art and technology projects [11]. Of the COSTART artists, chapters by Joan Ashworth, Dave Everitt, Beverley Hood, Anthony Padgett, Michael Quantrill and Esther Rolinson are included. For these artists, collaboration with technologists was vital. Technologists, Colin Machin, André Schappo and Manumaya Uniyal provide their own version of events. The YOTA (Year of the Artist) and AA2A (Artists' Access to Art Colleges)[1] schemes provided financial support for materials only and were aimed at educational and public exhibition outcomes. Of the artists funded by these schemes, Marlena Novak, Jack Ox, Juliet Robson and Ray Ward have contributed chapters.

The Artists

For Jean-Pierre Husquinet and Michael Kidner, artists-in-residence in 1996, the expectation that their work could benefit from computational support was a reasonable one. They were both seeking answers to complex problems that required a significant amount of prior analysis before

a work could be executed: the first was in the area of knot theory and the second in Boolean nets. It did not seem far-fetched to assume that a computational solution would be possible, but before that could be achieved, the first and most important task was to specify the nature of their problem and then discuss with an expert how this could be realized. Working with mathematical and software engineering experts, revealed just how much knowledge was needed and how much effort would have to go into the solutions. They describe their experiences in Chapters 20 and 22 respectively.

In his residency, Fré Ilgen explored his perception and understanding of reality in its various aspects using a simulation of complex movements in three-dimensional objects. Interaction with a VR system proved to be a critical event in the artist's creative process that gave rise to new developments in his art. The technology did not perform a task on the artist's behalf nor did it produce artistic outcomes, but rather it stimulated him to generate new ideas and techniques. In Chapter 21, he gives his own account of the events and outcomes.

The 1996 residency artists were almost entirely new to digital technology. Initially, there were high, and perhaps unrealistic, expectations of what the technology could do to help solve their problems. For the organizers, one important lesson that was taken on board for future residencies, was just how vital it was to provide targeted support from technical experts. These residencies highlighted the fact that using new technology does not necessarily lead to a dependence or focus upon the technology itself, but rather to a change in the artist's understanding of his or her own creative process. It also demonstrated a need for greater understanding of the artist's process on the part of the technologists. We came to understand most particularly, that the availability of a support environment for art and technology explorations required the right combination of human expertise and the technological tools.

All of those experiences in turn led to the formation of the Creativity and Cognition Research Studios (C&CRS), a joint operation between the Computer Science Department and the School of Art and Design at Loughborough University, UK, as described earlier in Chapter 1.

The C&CRS artists who came in 1999 for the COSTART Project were all familiar with digital technology of one form or another. Some had already made extensive use of the technology in their work. These residencies were established as collaborative projects and had a dedicated technical environment allocated to them. Lessons from 1996 were applied to the development of resources and facilities as discussed earlier in Chapter 2.

Joan Ashworth, Professor of Animation at the Royal College of Art, London, is a professional filmmaker, animator and teacher who has first-hand experience of the rapid changes taking place in the film industry as digital technologies take hold. Her desire to bring such technology into

her personal creative practice, without abandoning the tactile qualities of traditional animation methods, shapes her approach. This had an influence on her collaboration with the computer animator, Manumaya Uniyal. It was an intersection, not only between people of different knowledge and skill but also of goals and communication styles. Just as her "Stone Mermaid" project had a long gestation, so the partnership between artist and technologist required time to develop successfully. For this artist, her initial scepticism at the outset developed into an understanding of what was technically feasible and, moreover, where learning would have to take place on her part to make it an enduring process. The collaboration opened up new avenues and encouraged her to learn new skills in order to exercise more control over the process. She discusses her views in Chapter 17.

Beverley Hood's residency had some parallels with that of Joan Ashworth. However, her work is primarily directed towards developing static visual models rather than time-based work. She characterizes her creativity as a form of "hybrid invention" in which she explores the relationships between disciplines (e.g. sculpture) and diverse media (see Chapter 19). She has embraced digital technology as an artist but feels strongly that, without access to good digital facilities combined with the skills of technologists, there will be serious limitations to the take-up in the art world more generally. Ashworth points out that it is already the case that prejudice against computers operates within art circles, where the results are perceived as either computer generated (and, therefore not the artist's own) and/or "computer-styled" (i.e. bearing the hallmarks of the software rather than the artist). Either way, both the art world and the technology world have an uneasy relationship at this point in time.

Joan Ashworth and Beverley Hood both explored the possibility of using VR technology to realize their aims for the computer modelling of two- dimensional objects. For different reasons, they decided to use standard three-dimensional animation software believing that a VR environment was detached from important points of contact with the physical environment. By contrast, for Fré Ilgen, it was the unique ability of the technology to provide a non-physical environment that appealed to him. For example, he was able to work with sculptural objects without gravitational pull. For someone whose models were heavy and difficult to manipulate in the world, the out-of-world experience of VR was a liberating experience.

Both Ashworth and Hood are concerned with the interrelationship between the physical and digital worlds and what this means for their personal creative process. Hood is exploring the connections and differences between traditional and digital forms at the conceptual level, whilst Ashworth is keeping both traditional and digital techniques in play because neither satisfy all her creative needs. She is trying to utilize the benefits of the digital and yet retain the pleasures of a tactile experience. This

arises, in part, from her frustration with the limitations of digital technology in its familiar forms. She writes of the stifling effects of the mouse, keyboard interaction methods on gesture and movement and effort required to develop creative ideas. Typical interaction with a computer is not only a sedentary activity but also a tightly restricted one, where all the effort goes into finger-tip movement or small slight traces of a pointing device across a tiny mat. Haptic environments that incorporate force-field interaction, offer a way towards addressing the need for physical interaction through gesture and movement. An example is the Reachin Technologies system [12].

One factor that influenced Ashworth's decision not to pursue the VR route was the requirement to specify the conditions and parameters of the environment to be modelled in advance. This, she felt, limited the opportunity for a more spontaneous process of developing ideas. For a software engineer, the artist's preference for an opportunistic, iterative approach is not only an unfamiliar way of working, but is usually considered to be undesirable. These differences between the intersecting disciplines of software engineering and art practice in formulating ideas and making artifacts can lead to mismatches.

When both computer science and art disciplines co-exist in the same person, there can be conflicts that create blocks in thinking, as Mike Quantrill discovered. This situation illustrates that working with the complexities of real or simulated physical worlds can be problematic. Quantrill is that rare person who is formally trained in computer science but whose central concerns are with art. He assumed the role of technical expert providing advice and programming support for the projects of Anthony Padgett and Esther Rolinson. At a different time, with Dave Everitt, he formed a joint residency project in which he was able to pursue his personal artistic goals. This collaboration developed into a partnership that proved to be successful and sustainable. His contribution in the book focuses upon his own work. In Chapter 26, he describes how the close coupling between mind, hand and body and the technology itself is a transformational experience. He characterizes his work as an intertwining of human and machine processes leading to unexpected outcomes such as the time-based dimension of the work.

Quantrill reflects on his interest in how the use of the technology could lead him to new understandings. Finished artworks are of a lesser concern. A problem that is often referred to in relation to the use of computers is their relative lack of support for sketching and tentative processes. The pencil seems much better for this purpose. Quantrill, however, describes much of his computer-based work in terms of producing "sketches". His drawing on the electronic Soft-board [13] consisted of physical mark making with felt-tip pens and could be termed sketching where an informal or tentative approach is being taken. On the other hand, his work with the sensor grid in the interactive environment did not involve

making marks at all. In this case he refers to his computer programs as 'sketches'. He approaches programming in a way that takes deliberate account of the tentative and uncertain process that he is involved in. Each version of a program is seen as a tentative experiment leading to ideas for the next 'sketch'.

There is also a much more important sense in which Quantrill's work with the sensor grid extends the notion of sketching. He is experimenting with interaction spaces in which the position and movement of people, the participants, constitute the primary or only input to a computer system. Whilst the participants are not making marks on paper, their physical activity is recorded and leaves a trace within the computer system. In effect, Quantrill sees them as sketching with their body. One way that he looks at his work is as an investigation into languages of interaction: this is a form of correspondence between human movement and formal representations within the computer. Understanding such processes forms the core of his explorations. In doing this, his relationship to the technology is very close and he explicitly refers to its role as actively informing the work. For this artist, the computer is much more than just a tool.

Dave Everitt, in his collaboration with Mike Quantrill, experimented with interactive pieces using the sensor grid. He describes his way of working as maintaining a number of simultaneous lines of enquiry from which ideas emerge and bear fruit at times in the form of art projects. He draws on mathematics through contact with the Magic Cube interest groups on the World Wide Web and works increasingly in collaboration with programmers to develop his ideas. During his residency, he worked with computer scientist, Greg Turner, who helped him to realize his magic square concepts in computer programs that drove interactive artworks. His approach is eclectic, concerned with issues that have cultural, social and artistic implications. The creative driver for much of the work of Everitt seems to come from the intersection of disciplines and is brought about largely through collaborations of various kinds, from direct partnerships to Internet discussion groups. He discusses these issues and poses a number of questions about art and technology in Chapter 18.

Another artist for whom collaboration is central is Jack Ox. The primary goal of Ox's work is to create an intimate correspondence between visual and musical languages. In Chapter 24, she describes what she does as a form of 'translation' of music into sets of visual languages. To achieve this, she has to determine structural parameters of the piece of music to be visualized, which take the form of operating principles and data sets that are encoded in MIDI files in the Color Organ. A critical part of the process over many years has been her collaboration with composers and experts in digital technology. She has moved on from the formula of having a technological assistant to one of having a technological equal partner and co-author of her art. She also finds that such collaborations provide the triggers for significant creative advance. The

importance of finding the right people to interact with creatively has driven her to seek out particular individuals over a wide geographical area. She acknowledges the fact that the kinds of works she is interested in are expensive to develop and difficult to market. However, she has no patience with the idea that an artist should rely on financial subsidies and has been exploring ways of using the Internet to make available high quality prints from electronic works for sale. Her participation in conferences, giving talks, writing papers and demonstrating her works is part of an entrepreneurial spirit that seeks to disseminate innovative ideas to international cultural communities and the public at large. In doing this, Jack Ox is not just promoting art. It is her experience and firm belief that, in the technology and art collaborations that she finds so necessary, the technologist has much to gain and that the artist should positively engage in achieving such benefits as well as progressing their own art practice.

Marlena Novak is also very positive about the importance of collaboration, both with technologists and with artists in other fields, particularly in music. The most significant conceptual step that the computer has enabled her to make is to add a time-base to her previously static work. It is from this step that the concern with correspondences between time-based visual art and music arose. As well as adding a new dimension to her work, it seems that there was feedback from the music. Her direct concern was with composed, rather than improvised, music. That is to say, the time-base from the music was fixed and the sequence of sounds determined. From a visual point of view, this directly relates to film. Naturally, therefore, Novak was able to make great use of software tools that had been constructed to support film making. Her time-based work could not be called film, but its fundamental structures correspond to those used in film, hence the tools work for her. Whereas most film represents real or imagined worlds, Novak's work is generally abstract. Nevertheless, a correspondence at the level of the underlying structure of the work is sufficient to enable the same tools to be employed. She provides interesting insights into her formative ideas and the development of her recent work in Chapter 23.

Esther Rolinson works with natural elements and architectural structures and creates installations in the physical world. She is developing an interest in using digital technology to control her light structures and to explore the way it affects the relationship between the object and the viewer. The project she carried out during her artist-in-residency involved collaboration with two technologists, Colin Machin and, with his technology hat on, Mike Quantrill. The work involved the development of both hardware and software for the piece itself, but it also became apparent that the ability of the computer to provide visual simulations of the intended work was also valuable to her development process. A third

technologist, Dave Garton, eventually joined the team to develop this simulation, as described in Chapter 14 by Machin.

Iteration and flexibility in the creative process proved to be important as Rolinson's ideas evolved in response to new developments as they emerged. In her case, the enabling of the flexibility was very much a technologist's problem. She chose not to develop specific expertise herself but to rely on her partners, putting her efforts into defining and communicating her intentions. This is always particularly hard in relation to software development, on which she worked with Mike Quantrill. She stresses how important it was that he was also an artist, and therefore, that the communication between them about complex issues was eased. Nevertheless, from time to time, she indicated concern about how much control over the process she might have to relinquish to the technologists because of her lack of programming knowledge. In Chapter 28, she describes some of her experiences in collaboration and the influence of this on her artistic development.

Anthony Padgett began as a sculptor exploring different forms of bringing art and nature together. The spiritual dimension of his experiences has taken him into the potential of digital technology for extending the range of interaction between artist, viewer and the physical and spiritual world. He has found the interactive sensor grid system an experience that frees the participant and blurs the distinctive boundaries between technology and human being. He is not the only artist to have found this system a liberating experience from the usual forms of interaction with computer systems. Although Mike Quantrill also had a similar view, Padgett saw the opportunity in explicitly spiritual terms. Spiritual as his viewpoint might be, he was very clear about the importance of well-organized teamwork. He draws an analogy between digital art collaborations and film crews, in which each person has a clear well-defined and distinct expert role. It is also interesting, as he describes in Chapter 25, that he ran an experiment involving art students using the Soft-board as part of his exploration of the creative space that the device offered.

Ray Ward is another artist who sees himself working as part of a collaborative team. He accepts that he may not have all of the skills needed to make a work and points out that there is a long tradition of artists working with others in this way. Being adept at communicating with other members of the team is, however, a vital skill. The research studies reported earlier also noticed that there is much more than the need for help from others required for making a collaboration work. Particular kinds of communication and collaboration skills are important if teamwork is needed. Ray Ward noticed how important it was to learn to understand just how slow the development of computer systems can be. The speed of the computer does not equate with the speed of the development process. As he points out in Chapter 29, digital artists have to understand

and to come to terms with this if they are to be successful in their collaborations with technologists.

Juliet Robson, on the other hand, found how important the attitudes and availability of the technologists were to the creative potential of her work with technologies. When successful, her collaborations were characterized by the existence of clear and distinct roles. As with Padgett's film crew analogy, Robson was more concerned with the best way to facilitate communication than with finding the best way to learn everything herself. The communication aspect of collaboration was more important to her than simply getting things done. It was also a significant stimulus to creative thinking. The intersection of disciplines through the meeting of experts in those disciplines seems to have been a significant trigger for her work. The most important trigger, of-course, was the very particular constraint that disability brought with it. The viewpoint of a wheelchair user led to some very innovative use of the technology. Perhaps the most important aspect of her relationship as an artist with the technology was to insist that the "normalizing" of her use of it was not the main point of her work. In Chapter 27, she describes how she sought ways of reconceptualizing the technology from the point of view of her physical situation by, for example, abandoning the wheelchair and exploring the opportunities for relating to and through the technical systems from that perspective. For example, she used a movement tracking system that is often applied to the identification of physical problems in order to explore and, indeed, celebrate her own "language of movement". [14].

All these artists are concerned with issues of art practice and reflect upon the changes that digital technology is bringing to their practice. In their writing, it is not the "nuts and bolts" of practice that concerns them most, but conceptual shifts and opportunities for extending collaboration. Where the artist cannot find a way to exploit the technology, the reasons are rarely a failure of the usability of the software alone. As these artists demonstrate in their own words, the mapping of artistic goals and intentions to digital methods often requires transformations not only in the technical solutions but also in the artist's thinking.

Notes

[1] YOTA and AA2A are two examples of support for residencies from publicly available sources that were acquired for C&CRS artists: YOTA (Year of the Artist) 2000 was a UK Lottery Funded Scheme and AA2A (Access to Art Colleges) 1999–2000 was supported by the National Association for Fine Art Education in collaboration with the National Arts Association of the UK.

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