

Report for AHRC e-Science Workshops Programme

Building the Wireframe: e-Science for the Visual Arts



Introduction.

In November 2007 the Visualisation Research Unit (VRU), supported by the Midlands e-Science Consortium (MeSC), presented a series of workshops under the theme 'Building the Wireframe'. The interest in this area in the visual arts had been building for some time, though there remained considerable confusion and contradictions about what e-Science was and what the potential benefits for the visual arts might be. The VRU, as a flagship research centre dealing with digital technology and the arts, felt we should be well positioned to offer some definition to the opportunity, and be able to present the main themes of e-Science in a way that would be acceptable and creatively driven for the community we wanted to address.

The main motivating factor in applying for the award was linked to the use or exploitation of e-Science style processes in the in the creative industries, to which the VRU are strongly connected. However, this was only a partial driver considering the VRU were perceived to be amongst the best place to understand the technologies, but we ourselves had long struggled with locating a serious and useful definition of the area. In addition, our experience of developing ideas and applications relating to new technologies in the arts suggest that, whilst our own understanding may well be superficial, it was clear that opportunities for the creative industries would require further partnerships in the region. Our discussions with MeSC and through them with CERCIA (Centre for Research in Computational Intelligence and Applications) made clear to us that our own resources would be inadequate for explaining the concepts and systems that underpinned e-Science as an idea. Equally, from these early meetings, it was also clear that we had much to offer in terms of developing applications for e-Science processes. Whilst the basic hardware questions could be responded to fairly simply, there was a complex and difficult creative challenge beneath these, to which the arts would be able to contribute solutions and develop applications for the technologies. This development of a constructive partnership with e-Science oriented computer scientists was an important part of our original brief, given that we were interested in doing more than receiving ideas in e-Science, and were actively promoting the importance of creative approaches in technology development. This would prove a very interesting and at times contentious position, and has certainly helped developed our thinking about this area since we first heard the term 'e-Science'.

Additionally, we felt some strong obligations to the regional arts community. Our position within the structures of higher education had assisted us to acquire capability in technologies for the arts and also serious capacity in the area of e-Science through the acquisition of a gridded x-serve computer. It seemed to us at the time (and indeed, despite our best efforts it remains the case) that digital technologies are seen as an area of great potential within the arts, but were being neglected for a number of reasons. Principally, cost was often cited, though this seems to be less of a practical concern as prices of high quality computing hardware and software regularly tumble. The issue of cost seemed to be often related to training, or the lack of training in digital technology during undergraduate studies and so a community of potential users of e-Science technologies were uninformed or misinformed about what it is, what it can do or how it can be applied in the practical world that is art making. The logical extension of this idea was to use e-Science processes, or some sort of approximation to them, as the means of dissemination of our ideas and the activities we were developing. So, from the planning stages, we intended to present our work in formats that creative people would want to engage with. In addition to our physical programme of

workshops, we planned to present as much as possible of the resources we would develop from a web-based platform, using the tools and technologies available to us as part of the new creative environment.

The ultimate aim for the programme was to define what kind of infrastructure would be best suited and most possible to support in the region, bearing in mind the potential partners could bring to it, and to identify the benefits to the creative and computing community interested in participating would be. This aim would throw up some interesting options and discussions through the course of the workshops and eventually lead to a range of new thinking about the relationship between e-Science and the visual arts to be discussed below. It should be clear, however, that the VRU was seeking a genuinely open discussion between institutions, artists and researchers about what and how e-Science processes could be explored through the arts and what the creative community had to offer e-Science processes that was substantially different and useful. The long term development of resources and support was one of the crucial features of our original thinking, brought into closer relief by the reality that as a major technological resource, the VRU and the relationships we could broker with other institutions could enable a larger community to participate in the cultural change being brought about by the introduction of computers into the artist's studio.

The Programme. Amendments to our original programme have been discussed elsewhere, but we were very keen to retain the continuity of the programme, and to promote consistent attendance by key constituencies. The original themes were framed to make them attractive propositions for practising artists and computing researchers alike to take part. Whilst it was not practical in the end to deliver them across five weeks as originally intended, the themes were thoroughly canvassed in the reconfiguration of the programme and still provide a framework for discussion amongst the researchers involved. The original timetable can still be found at <http://www.biad.uce.ac.uk/vru/escienceworkshops/index.php> together with links to the many resources generated by the workshop programme. The three workshop sessions all took place at the Ikon Gallery in Birmingham, with the Daniel Hunt Lecture taking place at the Midlands Institute, also in Birmingham. Below is a short description and summary of the activities undertaken.

Workshop 1. 'Building an e-Workspace' was designed, as a title, to encourage the development of a metaphor that made the network another place for the practice of art, rivalling the studio as a site for creativity. The creation of an environment for creative practice appeared as an early theme in preparatory discussions with artists, who most often would ask exactly how they might find themselves working. It should also be noted that many artists, having attempted to adopt computing as a tool from early on, were dismayed by both the technical demands earlier computing had made on them, and the unreliability of the hardware, resulting in many attempts to create work using computers or through the network in failing for lack of useful and informed support. As part of the promotion of the event, the notion that e-Science was the means by which new art and artists would emerge was strongly accented, together with the need for artists to understand these technologies as a new means of artistic production. Accordingly, the very healthy turnout at the event (23 participants) who represented the mixture of artists, computer scientists and institutional interests we had felt necessary to develop a healthy debate, took part in a vigorous discussion across the full day's activities. Given the criticality of the question, the lack of understanding of the underpinning technology and the models of practice it might support, the day began with an invitation to contributors to define e-Science.

Gregory Sporton's introduction to this is available on the [resources website](#) as both a PowerPoint presentation and an mp3 file, as are the presentations by MeSC's Thorsten Shnier and Russell Beale. The aim in the structure was to open the very serious question about defining e-Science from the perspective of the arts before examining the perceptions of e-Science in the computer science community. The point was that, at the present time, the concept remains incomplete and is often considered cynically as enabling a category of funding rather than as a field in itself. This being granted, there

are a number of important points to be made.

The first is the reality of networked technology. This in itself turns the existing practice in arts through computing on its head. Much of the appropriation of digital technologies in the arts has been replicating the existing models of artistic production, where an individual uses their computer as a tool to produce work from its resources. This has been the standard model in the development of technologies for creative practices. These have mostly focused on creating digital models or processes that closely follow existing analogue ones. The example of digital photography and its focus on the replication of the work-flows of the old studio methods into digital form as a means of making these processes more efficient (and, indeed, less messy), and consequently lowering production costs is one obvious example. However, the basic work of the photographer as a person who takes a photograph, and then treats it, has remained, with ever improving digital results. Whatever the objections to differentiations between analogue and digital practice in this area, it is only recently coming to be more clear about the implications of the change in the means of production. Working with digital images produces different results to the analogue forms they replaced, whilst conserving the existing relationship between photographer and their work.

e-Science on the other hand encourages the pooling of computing power in a structured way in order to provide additional functionality. This makes it less of a digitised process of an analogue form than a new environment that artists need to learn to use. In particular, the nature of this new environment already moves the means of production and distribution away from the structured industries that have grown up around creative practices. e-Science platforms are enabling structures rather than vested interests, and as such allow considerable autonomy to those that exploit them. The challenge in the arts is to judge the extent this way of working will redefine notions of authority, skill and meaning in relation to the production of art. As Sporton says in his presentation, 'the vacuum of meaning about e-Science is a creative opportunity that looks something like post-modernism. It is up to users and practitioners to define its meaning in relation to creative practice'. This moved forward to discussions about the social ownership and benefits of e-Science technologies, particularly in the area of technological development, where it was suggested artists need to have a major role in future.

However, the key point in this introductory presentation was about the use of e-Science as a means of developing new forms of creativity. The nature of the network, rather than the historical models of art and art education, were likely to form the basis for a different type of art. This would be one that examined the nature of the technologies and responded creatively to the challenges, rather than attempting to digitize an existing creative practice. This means acknowledging the collaborative nature of e-Science technologies in the creative process, where the interactivity of creative minds suggests a shift away from the cultural model of the artist as individual genius. Additionally, the potential for digital resources to be reformulated, theoretically endlessly, may well mean the emphasis in future e-Science style applications for arts is on providing resources rather than creating final products. Offering resources in a network context provides creative opportunities for other sharers, implying that there need not be a final aim or finished work, but rather one whose resources can be creatively reused by any number of collaborators. In turn, this then raises questions about what it is to be creative, and what implications there may be for training and education in the arts.

The final question suggested in the presentation was to ask participants to consider what kind of infrastructure would actually work in the visual arts. How does technology link to creativity? Setting aside existing models of technological collaboration in the arts, where is the locus of creativity in an e-Science powered creative world?

Thorsten Schnier's presentation ([also available from his website](#)) examined the same question, 'What is e-Science', from the perspective of the computer scientist working with creative applications. Noting that even the Edinburgh e-Science Centre refers to

the development of a definition at some point in the future, Schnier discussed the issue of definition in the context of infrastructure provision. The components of an e-Science work environment would include access to computing resources in the form of CPU power and storage, and networking these components together. The network functionality is extended by the development of e-Science specific technologies seeking to use the network to share information and encourage collaboration. This can be done without the inefficiencies of travel and independent development in collaboration, through auxiliary applications in video conferencing and programmes that use the network to encourage information sharing and development in real time.

Noting that these auxiliary functions are not specific requirements for the arts, Schnier went on to discuss what he sees as amongst the biggest opportunities in e-Science; the development of Grid-based services. An interesting opportunity exists for developing brokerage of CPU power and storage facilities for potential e-Science clients. In addition, the creation of e-Science based middle-ware that can link resources constitutes another opportunity being actively explored in the computing world of e-Science. Examples like [Se3d](#) were presented and discussed as possible ways towards filling the e-Science concept with tangible and definable content, putting together, as it does, the needs of users (in this case animation rendering, a process long dogged by lengthy rendering periods) with the CPU power to allow creative artists to see and revise work at higher speeds and potentially greater efficiencies.

One of the crucial questions for Schnier was the extent of the technology push from e-Science to demonstrate a functionality before identifying a specific demand. The research processes within Grid computing were currently a rich source of support for grid technologies, but whilst the applications in science are obvious they are also finite, and the move towards the arts was one with possibilities for using the technologies effectively. Having discussed successful examples from the sciences in terms of suitable applications for e-Science, he concluded by suggesting a number of challenges. These were the development of software specific to e-Science style technologies and their ability to cope with a growing mistrust between users and sharers of computing resources. The security issue is a significant challenge to a fluid experience of gridded computing, particularly where the benefits of e-Science depend on collaborative sharing of resources either in computing terms or as human communication.

Moving towards uniting the experience of the arts with the possibilities of computing, [Russell Beale](#) gave a further presentation in this session discussing the overlaps between practice in the arts and in computing, especially considering usability. Once again, the issues about the meaning of e-Science came to the fore, with an acknowledgment of the existence of a title or label can bring with it opportunities for support in identifying the real issues through proper research. The commonality of principles of design to science and the arts were raised, with some time being spent on 'slanty' design as a problem solving technique, employed to reduce the functionality of an object as a means of improving its usability. He also suggested a sea change in the practice of science towards the identification of anomalies rather than patterns, as has previously been the case. The functionality of the web has also often meant a much larger role in data collection being played by non-scientists in terms of pan-regional surveys of bird or insect populations, which could be a potential model for artistic practice through the Internet.

The afternoon session was given over to a comprehensive discussion of the issues raised in the morning session. The session was chaired by Mike Priddy and Gregory Sporton, who used an e-Beam, a networked interactive whiteboard, to record issues and suggestions throughout the discussion. Much of the session circulated around the so-called Web 2.0 technologies and how they are being increasingly used to draw together resources drawn from across the web into specific places, like MySpace, or distributed in the way Flickr does. The tension between the development of closed systems and applications by artists and open ones that remix and reuse broadly based resources was a significant area of interest for participants, coming closely as it does to

the potential impact of e-Science on the arts as a practice. This led to significant (and quite educative) discussions about how networks actually operate, with Russell Beale and Thorsten Schnier explaining this to a substantive level of complexity, and once again asserting that whilst networks can be structured, it is the surface layer of usage that often becomes messy and fragmented, and is invariably the most likely place to find human creativity. The need for an e-Science facility that could support collaboration and production was also raised by several participants. This area included a consensus about the false distinction between 'real' and so-called 'virtual' experiences, suggesting that experiences are also real in the augmented space of the Web. This principle was applied to creative space too, and it was argued that the Internet is itself a space for making and presenting art.

This workshop was satisfactory in terms of drawing out a number of important themes for the development of e-Science practice in the arts. Apart from the serious and as yet unresolved issue of definition, the distinction between e-Science approaches and generally digitised creative practices was made and understood. Having done this, the different type of creative challenge presented the artist/s through e-Science was also aired, noting that the actual media and function of e-Science was, again, distinct from being creative with a stand alone computer. The potential and impact on individual practice was noted. The role of the institutions of culture, particularly the Universities, in giving access to the facility and functions of e-Science was also clearly expressed as a crucial one of e-Science based arts practice was to develop.

Workshop 2. The second workshop, '**E-Science for Creativity: Methodologies with Practice**', was intended to pick up on some of the themes discussed the previous week and to show how they may work in a practical setting for artists. Accordingly, the day focused on issues for artists in dealing with technology, with examples of creative work shown and discussed by the participants.

The first presentation was from Michael Takeo Magruder, an artist in Internet technologies, whose work can be seen on his [website](#). Building on his comments the previous week about developing closed and evolving systems, he presented his work '[headlines](#)', a work whose structure Magruder has created and whose content is derived from the photographs and news items from the electronic version of the Dutch newspaper 'De Volkskrant'. The constant updating of these and rotation in the paper's content means the work is never the stable, and works on refracting the large database of information in the visual framework. The work was originally installed at the Coultauld Institute in London, and set up in such a way as to carry through into the physical installation the refraction process easily discernible in the web-based version, where the images are, at first sight, impossible to decode without getting further away from them. In discussing the developments in his work, Magruder notes the use of technology, but does not accept the idea that the creative process with which he is engaged is determined and promoted by the technology itself. 'Technology and the media have always been a way to explore ideas,' he said, 'I have no desire to put technology on display and call it art.' During the presentation he very much attempted to link his activities to the historical models of art making, noting that he was simply using the materials to hand in the time in which he lives, and the networked component of his practice is, for him, a logical extension of this principle. His correlation between his own creative process and the writing of code, for example, posited the absorbing creative activities of development as similar regardless of the field of action, a sentiment that was met with considerable sympathy.

The second presentation of the morning was designed to encourage a discussion about how adoption of e-Science techniques in the visual and creative arts may come about. Working from an existing understanding of how technology has already transformed some practices, Jean Ensells, the textile designer, and Matt Gough, dancer and choreologist, were invited to make brief presentations about the impact of new technologies on their practice, and how new technologies came to be accepted as a part of the craft training of their areas. This was set up with a view to adumbrate the potential issues and problems for adoption of e-Science style processes. Gregory

Sporton introduced the discussion by presenting what is known about this area, noting the loyalty to craft practices that typifies education in the visual and performing arts, partly as a reflection of how those training students were themselves trained and partly reflecting the expectations of students who choose those particular subjects to study.

Matt Gough discussed how the practice of interpreting graphical scores for dance led him to considering the possibility that machine coding into various forms might produce answers to long unresolved problems in dance of representation and reconstruction of dances. In particular, the opportunity to enhance or augment performances by reformulating the data in real time as part of the decoding process was something that appeared to Gough only achievable through the application of technology. The advantage of the technology was in freeing the operator or researcher from existing schemes of practice that focused on still positions, when to the dancer it was the movement that was important. The potential for a 3D transcription of the dancing was a breakthrough for representations of the body and its movement.

The first point Jean Ensell made was to state clearly that she was 'not a person who likes technology for technology's sake', and that incorporating technology into her work came about through wanting to extend her creative work. Ensell retains a strongly traditional practice, and produces textile designs that are invariably thought of as traditional in design and manufacture, albeit these days enhanced with CAD based technology. Retaining this link has been an important issue for a designer like herself, and it was the possibility of using technology to extend rather than replace her practice that attracted her to it in the first place. She began using painting as the basis of her textile designs, reducing these in size and scale with digital photography to create a design. Wanting to retain the handmade look and finish to her textiles, she used cameras to code images for use in digital fabric printers, though in her experience early digital fabric printers represented the designs in ways that looked all too clearly as if they had been digitised. This practice extended to incorporate other techniques using digital processes to develop new designs for fabrics, including fabrics for garments. Ensell also raised the issue about what happens to the experimental processes once the large scale institutional infrastructure is no longer available to the artist, citing her experience of being able to develop her work whilst a graduate student, then struggling when this came to an abrupt standstill after graduating. Her journey towards using the computer for the entire work-flow of her creative ideas was outlined, with physical examples presented as well as slides, including a description of the design process for Camilla's wedding dress on which she worked.

The ensuing discussion, starting with the presenters and then moving on to comments and perspectives from other participants, talked about the adoption issues, with views ranging from rejection of the technology as a destructive force on creative practice, to the embracing of technology as a new means of creativity. The sensuality of creative processes, especially as represented by the presenters, was seen as an important part of the feedback process in creating something. Coming to grips with the media of digital technology, essentially its malleability as data to be transformed into potentially many forms, is clearly an important issue in developing an understanding of the exploitation of the technologies.

Having encountered practical examples of artists working in digital media, the afternoon session was given over to a demonstration of using networked technologies to create work in real time. Composer Jonathan Green, artist Keir Williams and dancer Suzanne Grubham presented '[The Networked Mash-Up](#)', drawing together a series of resources across the network to create a performance in the space at the Ikon. With each of the collaborators operating independently from the others, the resources they offer can then be manipulated by various means (including Grubham's movement) to create an improvised performance. Green's [discussion](#) of this makes clear that the distribution process involves computing power and data, but does not inhibit the individual contributor's specialist skills in creative response, or their function in contributing. This significant principle moves the work a long way from parodies of computer generated, given that the process includes the human intervention as a necessary condition of a

possible interaction. Green and Williams, the developers of the system, view it as a modular process, not limited to the factors used in this particular demonstration, but capable of fusing content designed and delivered remotely in a real time opportunity. The nature of the data sent is at the discretion of the contributors, and as such creates a different method for collaboration. Green states 'If scaled up, the Networked Mash-Up idea could bring together artists from diverse backgrounds and working practices in a non-location specific manner (although the location of nodes could be conceptually exploited)', hinting at potential development of the system through a network of users. In addition, as [Williams notes](#), 'Since usability has been a priority in the conception of the system, performers...are liberated from the burden of poor software interfaces and are instead free to concentrate on interpersonal communications and the reactions of other performers'. Green and Williams have developed the system as a web interface, as a means to overcome problems with firewalls and to enhance the potential of interoperability between contributing nodes. This was a hugely interesting demonstration of the principles of e-Science as creative practice, and the subsequent discussion, whilst often preoccupied with the technical processes employed, also acknowledged the value of systemic infrastructure capable of carrying more than conventional communications data between creative practitioners.

Workshop 3. The Accessible Grid. The final workshop in the series was dedicated to example e-Science technologies and discussion of their potential impact or extension into the world of creative practice. The first part of the day was dedicated to a discussion between Robert Sharl (BIAD) and Andy Pryke (MeSC) about their perceptions of how e-Science operates in practical terms for the benefit of users whether they be creative practitioners or not. Sharl's assertion was that the way to view the technologies was not as some kind of tool that could be used as an external means, but as an environment to be populated. This paradigmatic shift from the utility of the computer to its place as a functional habitat for artists seemed the logical conclusion from the premise that what happens online is no longer virtual but reflects the actual experiences of users and affects their world-view. His view that 'any sufficiently advanced technology is indistinguishable from magic' was part of an encouragement for creative play in the new digitised and networked environment. The crucial point of his presentation was reiterating a theme running throughout the workshops: that e-Science technologies will, through the originality of their platforms, offer up new models of creative practice, processes and products as they develop. Additionally, the importance of artists being involved and engaged with those possibilities at the point of their nascence was also restating a common theme of workshop discussions. His positing of creative artists at the centre of technological development as a means of harnessing their energy and ideas was a clear call for serious engagement between the artistic and scientific communities. He also suggested that in the development of computing, the most important component is already the network and access to it, and that the unpredictable transformative effects of networking are less of a problem (sometimes seen to be so where they do not replicate perfectly analogue world functions), but are potentially a source of great creativity.

Andy Pryke, a computer scientist with strong interests in the arts, presented a different picture of the developing world of grid computing, focusing on the geographical distribution linked to 'official' versions of the Grid, on to ad hoc definitions of grid computing drawn from computer scientists. His conclusion was that in many respects, there is nothing new about the Grid, simply an extension of a long held human need to communicate through a set of agreed protocols in visuality and language. Linking the developments in computing to the creation of writing systems and the introduction of the printing press, for Pryke the Internet is simply a speeded up process, a logical progression for the ambition of humankind towards the communication project. The network is essentially a social tool rather than an environment, in a complete inversion of Sharl. He notes the advent of creative collaboration tools such as [Wikipedia](#), [Flickr](#) and [B3TA](#), and sees this as an enhancement of social experience rather than something unprecedented. Noting the possibilities of developing virtual versions of analogue artifacts, he presented an animation dealing with the manufacture of a virtual guitar for '[Second Life](#)', suggesting there remain many questions about how 'new' this new media

was, and how artists could interact with it.

This was followed by a presentation from Mike Daw from the Manchester Access Grid Support Centre, delivered on a recorded PowerPoint show (given the external firewall prevented a live connection). Daw's presentation included information and examples of Access Grid implementation, including some projects involving artistic practice, and the development of the [memetic](#) software tool as a potential virtualised research environment. The kind of research possible would, like other e-Science technologies, depend very much on what users were looking to create or extract from the experience.

The final session of the workshops was presented by Gregory Sporton, who was looking to find a practical demonstration of the possibilities of e-Science processes in participatory form. Wanting to move away from sending video and audio across a network, Sporton was also interested in bringing the discussion back to something held closely to visual arts practice. Using an [e-Beam](#) and six wireless networked tablet computers, participants were able to share in the collaborative development of a drawing. The e-Science aspects of this activity were obvious, given the relay to the e-Beam server in the US of the data being created on the tablet computers in the room in Birmingham and projected up on the main screen, whilst individual computer drawers contributed their ideas in real time on the tablet PCs. This process was both amusing and thought provoking, with a fuller account given on VRU [e-Science Resources](#) website. In addition, the transformatory aspect of the technology was also much discussed. Drawing is usually considered a private, solitary activity, personal and intimate. The networked version, which mimics the actions of drawing (in the sense that it continues to be done with a pencil on a flat surface), turns drawing into a social activity, and subject to immediate critique and even amendment by fellow drawers who happen not to like what you have drawn. It was a useful demonstration of the technology, but also the manner in which e-Science applications can transform our ideas about a practice.

[The Daniel Hunt Lecture](#). The final event of the e-Science Workshop series was a public lecture about creativity and digital technology given by techno-guru Momus. Momus was chosen due to his prominence in the creative computing community, being engaged with digital technologies through his music and video, as well as his well-known blog '[Click Opera](#)'. This also enabled the participants of the workshops to be augmented by a more general audience of creatives interested in the development of new technologies in a larger venue. The lecture was well attended, with more than 100 people, and presented at the Midlands Institute on central Birmingham. The event attracted considerable interest across the creative community in the UK, as Momus rarely makes appearances in Britain, and in addition to the live lecture, it was later offered as a podcast that proved very popular. Momus' conclusions about the creative technology environment were strongly informed by more general ideas about culture, asking what will happen when network technologies simply become part of the background to our living and working lives. As technology stops being the foreground of creative culture and blends into the background as, he argues, has happened to other great communications breakthroughs like television or telecommunications, what remains is the social web of humanity. This was a very interesting event, and an appropriate closing event to the series.

Conclusions. Many useful questions about how the relationship between e-Science and the visual arts might develop were raised in this series. Some of them have been discussed above, in the context of the workshops themselves, especially the perceived dichotomy between technology on the one hand and creativity on the other. This has emerged as the single most important idea raised through the workshops and subsequently to them (through various follow-up activities, conference papers and discussions that have taken pace since). On the one hand, there appears a technological world into which the artist enters late, only to complain they do not understand it, and have had no part in creating it. In addition, it often appears that e-Science threatens the basis of a craft practice that artists hold dear. Part of this suspicion is based on the current situation where there are few e-Science applications

or opportunities that artists can engage with and feel these are extending the world of their creative practice rather than usurping it. On the other hand, it is clear from the discussion in Workshop 2, for example, that where technology becomes a creative opportunity, artists will embrace it. The current absence of art-driven technology in this area tends to marginalise potential adopters of the ideas and concepts that e-Science can support, and thus rob the field of energy and ideas.

Redolent throughout the workshops was the interesting redefinition of creative practice being developed through network technologies. In examples like Michael Takeo Magruder, or Green & Williams, it may seem that an understanding of the underlying technologies is as important as the creative ideas that appear to the viewer. This may well be a false presumption, given the dependence of the surface appearances on those 'technical' aspects that support them. In other words, creative work in e-Science is likely to include a profound understanding of the underlying structures as condition of existence. This suggests the traditional division between a technical process and a creative one may not hold in creative practice in this area, at least at this point where the technologies themselves remain challenging to harness and implement. However, there does seem to be a significant community of interest developing who recognise the mutual dependence between certain aspects of computer science and certain ways of developing creative practice. These people depend on interdisciplinary working rather than collaboration (in the sense of the aggregation of skills). Inherent in this is a challenge to the cultures of the visual arts and of computer science to draw together to resolve some of these issues, especially so when the role of training for the next generation of computer users will be considerably more sophisticated given their advanced starting point.

What the more successful examples encountered in the workshop series had in common was the ability to use the underlying technologies for their own properties, rather than attempting to force them into tasks for which they are ill-suited. Thus, Green & Williams' work uses network technologies to bring resources together, or Magruder exploits the ever-updating, never complete web-based news as the material for his practice. Sporton, on the other hand, has attempted to transform an existing practice by networking it. These approaches draw on unique features of the technology, developing ideas from capability rather than the imposition of existing models of visual arts practice. From that point of view, e-Science may well prove a fruitful channel for artists to create the previously unimagined and unimaginable. It remains a task for the participants to develop an agenda for e-Science in the Visual Arts, as a means of promoting the creative exploitation of the functionality of e-Science.

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