

Arts and disability interfaces

new technology, disabled artists and audiences
part 1 of 4: study and recommendations

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About the four papers comprising this study

distech-study.doc (this document)

The paper you're reading is the overview, with recommendations for further research. Authored and formatted by Dave Everitt, with input from Juliet Robson and Joanna Buick.

distech-report.doc

A factual report on technology, with examples and links. Authoring and initial research by Greg Turner, further research by Mike Quantrill and Dave Everitt, final authoring, editing and formatting by Dave Everitt.

distech-images.doc

The images that accompany the above document. Assembled by Dave Everitt.

pervasive-technology.doc

A special report on a development in computing with crucial relevance to the aims of this study. Authoring and initial research by Mike Quantrill, extra material, light editing and formatting by Dave Everitt.

Abstract

This paper is the first part of a study commissioned by the Arts Council (commencing April 2002) to scope and define a long-term project (to follow this study, possibly commencing late 2002) that will research new and emerging technology of existing and potential use to disabled artists, arts practitioners and audiences. As a scoping study for the long-term project, it aims to suggest directions for future research and activity and to describe key relevant technologies in clear language. The focus is on new or emerging technology and the methods being developed to interact with it, rather than on standard technology that has replaced older methods (as in animation and film, for instance). Issues of aesthetics, access, disability and other social or cultural factors are introduced (mostly under the next heading 'Issues') only where they are pertinent to the aims of this scoping study.

Issues

Technological inequalities and access

There is an immense array of technology available for use in the arts; the contents of this study are framed against this broad background. Counter-issues to availability exist in financial and cultural boundaries, and in assumptions concerning access to that technology. For instance, high costs place new technology beyond the personal reach of many artists, and emerging technology that fails to address access issues can also disable artists and audiences from utilising innovations. Many universities and some manufacturers maintain special labs in which users are invited to experiment with emerging technology, and although some of these are specifically aimed at artists² those who use either disability-specific or specialist technology, or material still under development, can only serve to drive accessibility and usability in innovation if such establishments promote channels of communication with developers and manufacturers.

'Artists can augment the research process in several ways. They can define new kinds of research questions, provide unorthodox interpretations of results, point out missed opportunities for development, explore and articulate wide ranging implications of the research, represent potential user perspectives, and help communicate research findings in effective and provocative ways. They can bring centuries of artistic experience to bear on the technological future.'³

When this process works, it gives artists an opportunity to shape the tools that may become their future everyday equipment. When it doesn't, the period of residence or involvement can end without any sense of continuity or real impact on the very technology the artist wishes to help develop. Unless artists are willing to dive in and become technologists themselves, creating a sense of ownership is another issue when the technology and any related software is developed by people and organisations outside the everyday world of the artist, sometimes heedless to any access issues (although there is a growing research trend towards specific assistive technology).

Under such circumstances, making work that requires new technology available to wider audiences remains an issue. Venues need to invest in or plan to maintain the required digital equipment, and experimental or custom equipment might not yet have become commercially available or cheap enough to purchase. The work has

to include the materials and, where new technology is involved, initial costs and exhibition overheads can be high, since emerging or experimental technology is not subject to economies of scale until it is adopted by the market. This leaves artists dependant on the goodwill - formal or otherwise - of research labs, owners and developers, or in a position where they need to raise the kind of funding for which traditional 'materials' funding is inadequate.

In a wider context, although the international business of technology may be almost contemptuous of national boundaries, the self-defined boundaries of distinct cultures and sub-cultures (disability arts being one example) are relevant to the way individuals adopt and employ that technology. For instance, relative wealth, combined with attitudes towards disability in differing cultural sectors may have an influence on disproportionate uptakes of emerging technology by disabled artists in those cultural sectors⁴. This issue - beyond the scope of this paper - is well worth further investigation, possibly in association with (for instance) current research into disability and ethnicity.

Therapy and/or creativity?

The distinction between therapy and creativity is part of a long-standing debate in disability arts relating to the empowerment of disabled artists under the social model of disability, and the need to define roles that are not derived from the therapeutic agendas of some organisations who work with disabled people, some of whom may be, or may become, artists. The issue of whether a technology is used/adapted creatively and/or therapeutically may be clarified by the following guidelines from work commissioned by East Midlands Arts from the Disability Advisory Group⁵:

- The goal of therapy is to cure
- The goal of creativity is to produce
- Non therapy based art is generally self motivated.

This issue is raised because of the history of disability art movement, the emergence of art and disability as a distinct creative culture, and the path some disabled artists have taken that draws in elements of therapy, creativity and the politicisation and/or transformation of their own experience from the medical to the social model of disability. It is also relevant wherever non-therapy based organisations working with disabled artists retain vestiges of the medical model.

Terms defined

Technology

In the report 'distech-report.doc', technologies of current or potential use to disabled artists and audiences are grouped under two main headings:

- generic computer technology
- specialist and disability-specific applications of technology

additionally, this study divides technology into three groups, relating to history and current state:

- a. existing technology ('new media', etc.)

- b. emerging technology ('cutting edge')
- c. experimental technology ('blue sky')

Group (a) is currently commercially available and well-tested; group (b) may be commercially available or about to become so, but is largely too new, experimental or costly for widespread use; group (c) may be commercially available in part (components, for instance), but usually requires expert input, and may be the result of research still in progress, or of a specialist adaptation or combination of existing technologies.

Disability

The social model of disability⁶ prevails throughout this study. In the case of artists, identification as disabled is determined by self-definition on the part of the individual. As a cautionary note for future research, quantitative material regarding disabled audiences from venues/organisations (such as box office data), specialist lists or qualitative accounts is likely to be inaccurate. For example, disability may not be declared, or immediately apparent, or require assistive technology. These factors skew statistics drawn from box office records towards inaccurate, but more accepted, models of disability. As a further example, artists who might identify themselves as disabled individuals do not always make work - or choose technology - from their own experience or history of disability, neither may they choose to present themselves primarily - or at all - as disabled artists or individuals.

Introduction

Disabled artists working with technology do not form one homogenous group, and share common ground with non-disabled artists regarding the use of technology in art. This document and its two companion papers reflect the fact that all technology is of potential use to the aims of this study. However, some work by disabled artists, or work aimed to be accessible to disabled audiences, requires, adapts or invents specific technologies. The personal narratives that help define disabled artists are therefore likely to result in unique applications of chosen technologies. Finally, the creative nature of art-makers means that the inventive use of technology can follow unpredictable paths. These are most apparent in

- experimental technologies that have yet to take a settled form
- non-standard use or combinations of such technologies by artists.

The expert nature of the technologically-related sciences invariably involves collaboration as a significant component of the art-technology interface. This area in itself deserves focussed attention and further research (see 'Study collaboration, communication and the social element' below). It is crucial to the development of sustainable art-technology partnerships, and to the adoption of technology by artists and curators as a natural medium, without the need to invoke specialists.

We are in a transition period between the nature of the computer as an object to be switched on, started up, consulted and used, and the 'pervasive' or 'ubiquitous' nature of computing as environment- and bio-enhancement (which will be ongoing for the foreseeable future - see 'The machine disappears...' below). Support structures during this period are likely to be as important as the motivation of artists to explore technology. The study consequently makes recommendations regarding support, and the fostering of persistent structures and lasting arrangements that imply a high level of commitment from all participants.

Natural virtual partners of this external commitment are already present in the form of online groups, and in a resultant sharing of experience by those using digital communities. Connections made in online groups tend to transcend social, geographic and disabled/non-disabled boundaries, bonding possibly disparate individuals into 'inner' interest groups that (may or may not) thread in and out of any 'outer' groups to which they belong.

In the following sections, four key areas of emerging technology that deserve special attention are identified: two of immediate availability, and two that are likely to emerge for wider use very soon.

The near future

The machine disappears - pervasive and ubiquitous computing

One of the most significant current developments in computing has yet to settle on a fixed name. Various descriptions as ubiquitous, pervasive, or persistent, it includes such developments as wearable technologies, intelligent environments, and personalised 'information spaces'. Some developments suggest a 'Star Trek'-like scenario where we simply walk into a room, say (for instance) 'computer, lights,

medium intensity' and it happens, thanks to an array of sensors and devices that may not be immediately apparent in the environment. Others suggest an environment augmented by ambient devices from which we are able to gather and exchange information almost subliminally. Using sensors, image and voice-recognition software, with wireless devices and communication systems for connection, this kind of scenario has already been achieved in many small ways within the limits of existing technology, and some of these achievements are already commercially available. However, the seamless integration of this vision into our everyday lives is far from realisation due to several factors, some conceptual, some technical:

- low expectations of technology
- under-use of existing technology
- lack of integration with building and architectural disciplines
- availability of suitable wireless and broadband network infrastructures
- lack of inexpensive terminal devices and components
- software reliability
- processing power
- component costs
- established standards lagging behind research
- competing technologies still emerging

Because of the special relevance of pervasive computing to the aims of this study, a more detailed account 'pervasive-technology.doc' has been commissioned to report on significant research in this area. To be of maximum use to potentially interested parties, it contains a fair amount of technical information.

Extending the human - sensing the environment, sensing the body

One particular component of pervasive computing - sensors - has enormous potential for creative adaptation and the integration of disabled audiences. It is also be relatively cheap. Sensors exist to detect movement, motion, proximity, position, temperature, humidity, electrical resistance, and countless other conditions that exist as part of human life and the environment in which we live. They are also crucial to the extension and augmentation of human senses; for instance, through physical implantation or wearable technologies that filter and re-present incoming and outgoing information.

In their 'raw' state, sensors come so many forms that it would be limiting to suggest applications. Viewing the list of available sensors from online vendors, it rapidly becomes apparent that most of them simply output raw electrical signals that need interpreting by some kind of software. Bundled software (if any) may be of use to the artist, but the real challenge is to provide a creative context, and to design software that helps strengthen that context.

The farther future

Nanotechnology and micro-machines

'The central thesis of nanotechnology is that almost any chemically stable structure that is not specifically disallowed by the laws of physics can in fact be built. The possibility of building things atom by atom was first introduced by Richard Feynman in 1959 when he said: "The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom."⁷ [US spelling retained]

Nanotechnology is only briefly covered in the main report on technology, as work in the field is a little to one side of the aims of this study, but it is mentioned here as one of the 'hot topics' of scientific research. Attempts to make human artefacts at the atomic level have already succeeded, and further research focuses on applying findings. Although artists have already embraced the philosophy and science associated with nanotechnology (some landmark images in nanotechnology were created by artists) and medical implications have already been identified, it is not yet clear how this technology might become accessible to disabled artists and audiences. It would be prudent occasionally to monitor the progress of nanotechnology for relevance to the aims of the further research recommended by this scoping study.

Neural connections and the digital/atomic interface

One of the barriers to truly pervasive computing identified by computer science is the apparent chasm between the 'bits' of digital technology and the 'atoms' of the physical world. In attempts to bridge the chasm, groups are working on ways of translating the apparently 'messy' biological signals of muscles and nerves into the 'clean' or ordered information streams required by digital equipment. Consequently, ways are being sought to translate digital signals into information that a neurone can recognise. The aim is to enable the brain to 'understand' digital signals, and vice-versa. Direct thought control of technology (as output) and the perception of digitally gathered information (as input) is the main goal.

The techniques of positron emission tomography (PET scans), electro- and magnetoencephalography (scalp electrodes) are beginning to allow the exact location of areas of subjective experience within the brain, including such elusive perceptions as 'sensing a presence', 'out of body' experiences, certain emotions, or even the existence of deity, as well as more prosaic abilities such as face, number or language recognition^{8, 9}. Indications are that areas of this research are heading towards a connection between technology and the brain that has hitherto only been suggested in science fiction or - since the budgets of military establishments allow them to be first in line as adopters of experimental technology - in military scenarios. Significantly, it is often people with unusual mental experiences or with brain damage and differences who volunteer for some of the pioneering research into mind-mapping technologies.

Recommendations for future activity

Publish and distribute the technology report

In conversation with some of the artists consulted for this study, it has become apparent that most of them are unaware of the huge array of technologies that are available. It is therefore recommended that the technology report 'distech-report.doc' is distributed to disabled artists and publicised to other interested parties and organisations, in order to serve as a rough guide that might encourage involvement with key existing and emerging technologies, and to allow readers to feed back ideas for the implementation of the technologies covered. The most accessible way of doing this would be to re-purpose it for the web.

The case for good practice and continuity in support structures

The development of new technology is invariably connected with establishments that are able to source the funding to provide the necessary expertise and environments. Although programmes exist where artists can be visitors to such establishments, those that encourage the development of a framework that allows an ongoing dialogue have only recently begun to emerge.

Simply putting a scientist/piece of technology together with an artist/group and allowing them to interact does not address the need for cultural bridges (see Translators... below), or allow the time for the artist to 'find a place' or personalise their space. Added to other needs a disabled artist may have, these issues can make research/University environments unintentionally disabling in subtle ways, despite equal opportunities policies.

To explore good practice a (possibly decentralised) pilot project could be set up, including some of the venues, research labs, artists and curators suggested during additional research for this study. The remit would be to produce a series of accessible technology-centred works and work-in-progress, produced by disabled artists and shown in accessible events and exhibitions. To further strengthen continuity, some follow up needs to be made to the Arts Council's previous work in the field, by surveying and inviting artists covered in (particularly) the *Digitising disability* report¹⁰ and delegates to the *Access Denied!* event¹¹, together with other key events and contacts. Some of these individuals might be invited to form the main part of an independent steering group to guide and help populate the project. The aim of such a group might also include a survey on what disabled artists are currently working on, and what they would intend to do, given knowledge of the possible resources. As a starting point, a list based on recommendations from Juliet Robson has already been compiled, considering disabled artists and a selection of relevant contacts. A document based on this work can be prepared and made available to the group during the next phase of the research.

Identify research, funding and other partner facilities

In line with similar mapping exercises in the arts, an ongoing survey of existing establishments that already work, or could be approached to work, with disabled artists using technology would provide a valuable information resource. This should include relevant commercial and non-arts organisations. For new locations, access audits would be required before inviting participation involving disabled artists.

Some new thinking on arts funding is already recognising the increasing value of non-arts funding partnerships. In such a climate there is the genuine possibility of working with large industry organisations such as the DTI to connect disabled artists using technology with DTI innovation schemes and similar well-funded incentives (the DTI Enterprise Grant Scheme or Regional Development related funds, for instance). Apparently, this is already being investigated by the DTI¹², but could be tied in with research into new Arts Council's funding strategies. Consortia of disabled artists teamed with members of regional organisations have already become a possibility under the Regional Arts Lottery Programme (RALP), but similar methods might also be supported to form groups that could be eligible for industry-based sources of funding to cover disabled artists working with technology. Under such a system, the Arts Council might work as a partner in ongoing research into artists, audiences and technology, perhaps by acting as a broker for resources currently beyond its capabilities.

Most emerging and experimental technology has an international scope, and it follows that disabled artists working with such technology will inevitably be presented with opportunities for international work and collaboration, or would benefit from such opportunities. Relations with international partner organisations could be researched, with the aim of supporting and co-funding disabled UK artists to work with equality of opportunity in what is essentially an international field.

Translators to demystify specialisms and break down cliques

Digital art has produced some groups that can appear cliquey and exclusive to anyone unfamiliar with technology-based art, or harsh to emerging artists who wish to find an entry point into work with technology. This phenomenon may simply be a product of the need to specialise or focus on a particular element of the *zeitgeist* seen by a group as crucial to its identity. Artists who desire to work with technology are also often faced with a formidable wall of specialism or - particularly in university settings - even protocol, which makes it difficult to communicate with (or even locate) the very technologists who can enable them to realise their ideas. Further, some less visible access needs can also be completely overlooked in environments that profess to be accessible.

During many conversations with artists working in this area, common experiences in overcoming 'concept barriers' often crop up. Technologists are often educated to be concrete thinkers who use language precisely. The same phrase can thus mean different things to people with differing backgrounds. The artist attempting to describe a process can end up finding that the technologist interprets their explanation in a more literal manner; one that matches, say, a computer programming language. Conversely, in order to collaborate, a technologist may require more rigorous logical thinking from the artist in order to understand and then achieve the desired result.

On top of all this, those working with disabled artists need to possess some degree of disability awareness, or at least feel comfortable working with disabled people, and this is not always the case. Although disability awareness training is regarded as essential for those who work regularly with disabled people, it does not

necessarily figure in those establishments that bring artists, technologists and scientists together.

People rarely want to maintain a prohibitive image. However, those who are able to straddle the conceptual worlds of the artist-technologist, the new audience member, the interested but technologically inexperienced and disability-aware curator, and the aspiring disabled artist who desires to work with technology, are rare. Identifying those who have such 'translating' skills and employing them to open up territories and break down barriers would be a valuable contribution to the aims of the further research outlined in this study. The activities of these individuals would help both disabled artists new to technology, and new audiences, to engage with work and environments using technology without feeling intimidated or overwhelmed. Mentoring by experienced disabled artists who have carved their own path through these issues might contribute to solving some of these problems.

Recommendations for further research

Convene a short-term group to examine issues

In discussions during the research for this scoping study, several issues around disability and technology were raised. Briefly, they are as follows:

Social/political issues:

- choosing the 'usual suspects' as an easy way of 'ticking the disabled box'
- gravitating towards 'easy' or more socially acceptable disabilities, and excluding those with challenging behaviour or communication styles
- examining media attention/representation, and how to use or manipulate it
- how to sympathetically market work and build accessible commissioning models
- how to determine quality¹³
- how to arrive at sensitive categories, definitions and terms
- how to ensure ongoing support while including the freedom to investigate and explore - a factor identified as 'crucial to the future'
- how to identify/include non-declaring disabled artists/audiences

technical and research issues:

- how new technology might be 'fed' to interested disabled artists
- enabling disabled artists to feed information from their own experiences into current research and conferences
- support the writing up and publishing of findings by disabled artists in journals relevant to the development of technology, to ensure that ongoing research and development is informed by any issues identified
- inviting disabled artists/audiences to become involved in research proposals
- locating key emerging technologies to research how access might be made a consideration from the start
- locating disability-specific computer research and assessing it from the perspective of disabled artists/audiences

The latter three points are partly addressed under 'Commission technology-watchers' below.

A small short-term working group is recommended (similar to the East Midlands region's Disability Advisory Group) to discuss and report on the implications of these issues on future policy. Crucially, they could also assess which of the recommendations in this study warrant further attention or clarification, and suggest priorities regarding the proposed research and activities.

Commission technology-watchers

Two or three individuals could be commissioned to monitor emerging technology and its use by disabled artists, venues and curators (perhaps a few hours, quarterly throughout the year) by:

- identifying a small number of key technology websites for monitoring
- using an interactive website for the findings (possibly a Wiki¹⁴, perhaps within part of an Arts Council's site)
- discussing recommendations for action and research based on the findings
- monitoring research projects for relevant new technologies

An ideal starting point for monitoring research projects would be the list of IT research applications awarded by Environmental and Physical Sciences Research Council (EPSRC), especially Human Factors¹⁵, where some of the leading UK research is to be found. A small sample of current titles will give a flavour of the kinds of project supported:

- A whole utterance-based communication aid for people without speech: An office workplace implementation
- Assessing the ability to detect changes by normal and special populations
- Biocybernetic Control of Adaptive Automation
- Efficiency of human suprathreshold visual detection

Partnering disabled artists, interested curators and venues with sympathetic research projects would be the next step - a demanding creative process in itself.

Explore critical frameworks

Do disabled artists need to search beyond current critical frameworks in order to further examine the social and scientific concepts driving the technology they use or desire to use? For instance, complexity theory¹⁶, mathematics, computer science and the logical frameworks of programming (Boolean logic, pseudocode, modelling languages) are all part of the vocabulary of technology, and crucial to an understanding of the field on its own terms, rather than as cultural commentary. The term 'sci-art' has come to mean something quite distinct in current art practice, as perhaps observing a separate aesthetic and a critical framework that often engages more with the philosophical and logical elements of the sciences than with the post-modernism critical theory. Internationally, this may be less of an issue, but the UK has a special relationship with the academic side of art theory, and in some

quarters the 'high art' - 'sci-art' division can influence decisions about funding and quality. In reality, the spectrum of art practice world-wide blends gradually from one side to the other, and artists often define their own terms, meeting the criteria of a culture's critical frameworks or not, as they wish. The position of disabled artists within this debate may not have been adequately considered; additionally, if there are cognitive access issues around the use of post-modern critical languages, this needs to be examined.

Study collaboration, communication and the social element

The complexity of social groups, the conditions that allow for the emergence of creative properties within those groups, the need for communication, translation, and the basic psychological needs for support, continuity and connection, are all crucial to building an effective support structure for encouraging disabled artists and audiences to engage with technology. These essential factors can be overlooked in the process of attending to more immediate work, but they really need to underpin any developments that concern collaboration.

How can the peer-to-peer networks that typically emerge from the social interactions of artists and disability groups be sustained within the largely hierarchical structures of established organisations? This is an issue that can determine whether the 'feel' of a place works for disabled artists or not. Connections within social groups are often unstructured and dynamic, while established organisations typically operate as fixed hierarchies with their own internal protocols. Listening to the experiences of both, and examining some of the research into how one style of working sees the other¹⁷, would provide good foundations for further strategic development. Such research might inform a strategic approach to fostering effective support structures from the ground up.

Biographies

Dave Everitt

Freelance artist and researcher in computer science, the author's connections are with the computer science department of Loughborough University and with disabled artists and related organisations. He has worked in industry, in arts and disability, as a disabled artist and as a consultant. He was a member of the steering group for *Access Denied!* and *Wired and Dangerous*. At the time of this paper he was involved in three main projects: Infoscape (3D interfaces for large and complex bodies of information, piloted on arts and disability data in the East Midlands Arts region, with Loughborough University Computer Science Department); FASED (an organisation by and for disabled artists and arts workers); and - with Fred Brookes and François Matarasso of Comedia - in the development of the Arts Council project 'artsInfo' (working title - a toolkit for standardising the collection of quantitative data on the arts in the UK). His own work involves mathematics and biological input in interactive art, and the production of digital art in non-gallery situations.

Juliet Robson

Juliet is an artist and disability consultant, with a special interest in and extensive knowledge about how disabled artists want to be represented. She co-curated Vital, a ground-breaking city wide event in Nottingham, highlighting new work from international contemporary artists, with and without disabilities. She is currently working with a bursary from Arts Admin and studying for an MA.

Greg Turner

<http://www.gregturner.co.uk>

Greg is a software engineer and musician with an interest in combining the fields of art, technology and human-computer interaction. Following an MSc in Computer Science at Loughborough University, Greg is pursuing these interests by embarking upon PhD research in creative environments at the University of Technology, Sydney, Australia. Previous work includes collaboration with Dave Everitt on an interactive, internet-based artwork cubeLife, research work on intelligent aircraft cockpit user interfaces, and extensive web design and animation work.

Mike Quantrill

Mike is currently researching pervasive computing for his PhD in Computer Science at Loughborough University. Mike is a disabled artist and computer scientist, who developed the interactive infra-red sensor grid space in the Human-computer Interaction department's Creativity and Cognition Studios. Previous projects as the Emergency Art Lab (with Dave Everitt) include a live digital performance at 'Wired and dangerous', and 'Club confessional' a commissioned piece performed in two night clubs at Cambridge and Tilburg, Holland.

References

¹ This is included in the format recommended by the Dublin Core Metadata Initiative, which aims to make all documents and online resources extensively searchable via any digital network or a future world wide 'semantic' web that encourages precise information to aid the location and searching of online resources. It may be used in any future online publishing. See <http://dublincore.org/documents/dces/>. For examples in use see <http://www.ndltd.org/standards/metadata/current.html> and <http://standards.edna.edu.au/metadata/elements.html>. It is of note that, at the completion date of this document, there is no metadata standard emerging for the arts (as there is, for instance, in the fields of law and education), nor is there any working party that is likely to compile such a crucial standard.

² Kevin Kelly, founding editor of *Wired* magazine, describes on his website how his 'life long interest in art and science is converging to an exploration of how artists might benefit corporations'. For his list of organisations working with artists see <http://www.artistinresidence.org/>

³ Wilson, Stephen, Professor Conceptual Design, San Francisco State University, *Art as Research*, 1996 <http://userwww.sfsu.edu/~swilson/papers/artist.researcher.html>

⁴ An often-quoted source on internet use demographics is the GVU (Graphics, Visualization, & Usability) Center at the College of Computing, Georgia Institute of Technology. It has detailed statistics up to 1998 at http://www.cc.gatech.edu/gvu/user_surveys/, which may be a rough guide to the kinds of cultural issues raised by relative access and perceptions of technology. The new home page at <http://www.cc.gatech.edu/gvu/> and the main research page (which also covers work on experimental technology) at <http://www.cc.gatech.edu/gvu/research/index.html>, do not appear to have any newer statistics, so the following alternative sources (unchecked in any detail because beyond the remit of this paper) are offered: <http://www.nua.com/surveys/> and http://cyberatlas.internet.com/big_picture/demographics, although non-US statistics take some finding, and there are some UK-based sources not listed here.

⁵ A temporary advisory body of disabled artists and arts workers convened by (the then) East Midlands Arts in 2000 to help direct and inform policy decisions concerning the various interactions of art and disability.

⁶ Explanations of the social and medical models of disability are available elsewhere. It is presumed that anyone reading this document will at least understand the distinction. If not, see <http://www.innotts.co.uk~deveritt/matrix/able.htm>

⁷ Frequently Asked Questions about Molecular Nanotechnology:
<http://www.foresight.org/NanoRev/FIFAQ.html>

⁸ Dohaene, Stanislas, *The number sense*, Oxford University Press, 1999

⁹ Carter, Rita, *Mapping the mind*, University of California Press, February 2000

¹⁰ *Digitising disability*, Arts Council of England, 1999

¹¹ *Access Denied! - Disability, Technology and the Arts*, the fifth conference in the *Get Wired* series, Eastern Touring Agency and the Arts Council of England, Sadler's Wells, London, 2000

¹² From conversation with Allan Smith, Communications and Information Industries Directorate, DTI, October 2002 at the Creativity and Cognition Conference, Loughborough University.

¹³ known work on determining quality is being undertaken by two thinkers: François Matarasso of Comedia, and Tân Draig at Q Arts, Derby. The latter source is particularly concerned with art and disability.

¹⁴ Wikis are websites where groups of users can edit content and create new pages. They are ideal for group research. See the original at: <http://c2.com/cgi-bin/wiki>

¹⁵ Current EPSRC support in IT & Computer Science Programme, Human Factors (summaries of supported projects):
<http://194.66.183.26/WEBSITE/GOW/ViewPSP.aspx?PSP=98&bannerlink=Programme%20support&G=OFF>

¹⁶ see <http://www.santafe.edu/sfi/People/mgm/complexity.html> and <http://www.emergence.org/index.htm> for more information about how complexity theory permeates a wide range of non-arts research

¹⁷ Candy, L. and Edmonds, E. A. (ed), *Explorations in art and technology*, Springer Verlag, 2002