CHALLENGES AND OPPORTUNITIES: E-SCIENCE AND THE PERFORMING ARTS AND MEDIA

This document is intended to stimulate debate and discussion during the E-science Scoping Study Expert Seminar. It is a tentative, partial, personal and therefore controversial delineation of the challenges and opportunities that the E-science agenda presents the Performing Arts and Media sector. It proposes areas of specific activity that the sector may benefit from addressing. It also delineates a series of barriers – some of which are beyond the scope of the Performing Arts and Media to resolve.

I begin with five discussion points of what could be achieved using the tools and approaches of E-science.

1. Performing Arts and Media as Virtual Research Organisation
2. Perfoming Arts and Media as Spatial Data Infrastructure
3. Visualisation and simulation: interpretation and methodology
4. Resource creation and delivery
5. Globalised Research

This list is not intended to be exhaustive and participants are invited – indeed encouraged – to make new proposals or to propose that items are removed. I am especially aware that most seminar participants already use a range of high-performance computing technologies in their research practices, from virtual environments to telematics to live sound and vision processing. My role in this seminar is therefore one of facilitation in order to link the E-science agenda with the significant research and development opportunities presented by the Performing Arts and Media.

Within the five discussion points a range of specific issues can be identified:

1. Content creation and digitization
2. Information and knowledge management
3. Information retrieval from disparate sources
4. Legal and copyright issues, including access, authentication, IP, Creative Commons, collboration among HE and non-HE members
5. Processing of large volumes of data, including cross collection processing
6. Understanding user requirements, and building usable and accessible interfaces to large datasets, and e-science technologies
7. Resourcing and support for mixed-mode research practices
8. Role of the performing arts in technical research and development
9. Effective transdisciplinary collaboration with ICT specialists
10. Identifying and disseminating skill sets, resources and project details

The Current State

While most of us make wide use of standard ‘personal’ computer tools (as in word processing, internet browsing, bibliographic databases and email), in the Performing Arts and Media arguably our use of other E-science technologies is very much research activity dependent.

For those of us who carry out what may be broadly termed historical research, the prevailing model might be:

1. Carry out research, using a range of text- and object-based materials as 'sources' of information. These are often supplemented by materials in digital form and digital methods (bibliographic databases; electronic journals; email contact with colleagues; internet searches)
2. Craft that primary research into a word-processed file — *research output*
3. Pass the word-processed file to a publisher who turns it into print for publication — *research dissemination*

For those engaged in what is broadly termed practice-led research, or mixed-mode practice, primary research practices are animated through a range of activities other than, or in addition to, critical-reflexive writing. This is not the place to rehearse definitions of practice-led research. Suffice to say that researchers frequently mobilise myriad computer-based technologies from lighting desks, to live sound processing, to immersive environments, to robotics, to virtual choreographies, to social software environments, to motion capture…the list is endless.

This seminar therefore has an important role to play. Not only has it the potential to connect the E-science agenda with the broader field of computing in performance, I hope that those of you working in cutting-edge practices that incorporate computing technologies will contribute to future E-science research and development.

The Performing Arts and Media as a Virtual Research Organisation

E-science is about collaboration. The Performing Arts and Media are therefore well placed to contribute to and benefit from E-science: so much of our research, particularly that which is practice-based – or mixed mode – involves collaboration mediated by a wide array of computing technologies. The Performing Arts and Media as a sector is smaller in terms of number of active researchers than in many of the scientific disciplines. While this may make collective decision-making and agenda-setting easier there is also a tendency to localisation of research interests and a surprising lack of awareness of cognate research activities.

Collaborative tools, often termed though loosely specified as Virtual Research Environments, are being used extensively across our sector. Document and media sharing and personalisation tools have been adopted in many projects, but what is perhaps key for our sector is our use of these tools within creative practice rather than as simple aids to produce research outputs. A great example of this is the AHRC-funded Performing Presence project based in Exeter (Nick Kaye, Gabriella Giannachi, Mel Slater and Michael Shanks) the site of work is based in Stanford's Metamedia lab and is referred to as a Collaboratory (http://presence.stanford.edu/). In fact, the Metamedia lab is home to a wide range of collaborative performance research (http://traumwerk.stanford.edu:3455/MetaMedia/485).

The Metamedia lab might be seen as a portal, although not in its strictly defined terms. Furthermore, as it is not open source there are implications for our discussions here (specifically, JSR 168 Portlet Specification standards). Less visually impressive, but open-source, is Moodle. We are currently using this in Bristol in order to foster collaborative, interdisciplinary research into material performativities (http://mash.ilrt.bris.ac.uk/moodle). It requires registration and login so for us represents a useful, quasi-private space to produce and present work. These tools present clear benefits to our sector, where our research activities are given form through various media, from writing to video.

Over and above online collaboration on specific research projects, arguably the Performing Arts and Media are closer than most sectors to occupying the space of a virtual research sector. We know that our disciplines act as persistent consumers and producers of information through continuous collaborative cycles that involve a wide range of practitioners. An early attempt to visualise this complex ecology is PARIP Explorer, a Friend of a Friend (FOAF) based Semantic Web database. Although development has been painstaking, PARIP Explorer presents an early opportunity for a wide range of research practitioners in the sector to describe in a fluid -- dare I say performative way -- themselves, their activities, the resources to which they have access, the projects in which they have been involved. Although it is a database, I suggest that it is a virtual research environment in that it produces online complex networks of practice and allows new connections to be made over time that reflect our myriad research processes. With its eventual user-input interface, a range of debates about the research that we do may be produced iteratively.

Challenges presented to our sector (whether in performance-based research or in archive-based work) by the range of virtual research environments might include:

- The creation of data resources within virtual research environments needs to be properly stored and managed in order for it to be as searchable as possible. There are clear questions about taxonomies and classification. How do we organise and describe this information while remaining alive to the concerns of individual projects?
- There are significant legal and copyright issues, including access, authentication, IP, Creative Commons, collaboration among HE and non-HE members. While some have approached these issues pragmatically, in our sector we are particularly alive to (although not always respectful of) the ethics of collaboration and the re-presentation of performance research in different media.
- Resourcing and support for mixed-mode research practices; Identifying and disseminating skill sets, resources and project details; effective use of limited resources across the sector.

Performing Arts and Media as Spatial Data Infrastructure

One of the familiar metaphors in E-science is the idea that an entire network (or grid) of computing power acts as a single but infinitely extensible computer. Clearly there are echoes here of the work that we do in our sector, particularly within practice-led research. Whether we work with archives and writing or through a range of creative practices, at the heart of our sector lie concerns with space and time.

It is likely no surprise that three of the most high-profile UK-affiliated practitioners who work with computing technologies to explore distributed performance are Johannes Birringer (http://www.aliennationcompany.com/) Paul Sermon (http://www.paulsermon.org/) and Stelarc (http://www.stelarc.va.com.au/index2.html). They do not work with Grid technologies per se, as their practices focus on distributing and spatialising presence and creativity via the internet. Birringer's telematic performances utilise low-cost camcorders, laptops, webcams and Apple servers to produce distributed choreographic pieces. Sermon has worked from the early 1990s with available technologies: he was a very early user of ISDN video conferencing in his artwork. Stelarc of course aims to explore the post-human body through various electronic/robotic interfaces and 'virtual' performances. The numbers of scholars in our sector exploring similar questions is significant and ever increasing. Thus, the potential uptake of Grid technologies in this sector should make E-science developers take notice.

Access Grid would seem to be of clear interest to us, but so too are the wide range of grid computing platforms that allow collaborative, international work without the need for locally held data. Within Grid technologies proper there are limitless tools and projects that we would like to get our hands on and develop. Even something such as the 'Spatial Data Infrastructure' (http://www.gsdi.org/SDILinks.asp), which has emerged to describe a global model of shared services, protocols and processes that are envisaged to facilitate interoperability in the geospatial data sector, presents opportunities for those of us working in pervasive and locative arts practices to generate, manipulate and access geographic information. The result – at least in theory – is a comprehensive, persistent and distributed set of tools that reduces the barriers to integration and use of diverse data sets. Moreover, because systems are able to default to mutually comprehensible spatial syntaxes, diverse and specialised data forms and processes can be reconciled. In this way, SDI can be said to have many of the characteristics envisaged for the semantic web.

The barriers to more widespread access and use of Data Grid are not dissimilar to those that affect our use of virtual research environments, but specifically:

- Training and communication
- Intellectual property rights
- Authentication and archiving
- Standards development and implementation

- Resourcing, support, ongoing investment at institutional and intra-institutional levels
- Understanding user requirements, and building usable and accessible interfaces to large datasets, and E-science technologies
- Role of the performing arts in technical research and development
- Effective transdisciplinary collaboration with ICT specialists

Visualisation and Simulation: interpretation and methodology

Many E-science projects have used or developed visualisation and simulation tools as a basis to solve problems, especially in disciplines where visualisation and simulation are familiar methodologies. Uses include using E-science resources to visualise, analyse and share the outputs of CT scans, microscopes and other sensor arrays.

Arguably in our sector, computer-based (re)constructions range from teaching and learning-based outputs through to creative research practices. The way in which these visualisations are understood also ranges from a fairly unproblematised focus on dissemination and facilitating distance learning to more critical approaches in which the process of visualising is seen as productive of the research itself.

Perhaps the most familiar visualisation technique is the standard VR model. Richard Beacham and Hugh Denard's 'Theatre of Pompey' project and the multi-partner Theatron (http://www.theatron.org/) project all explore extensive and highly detailed computer modelling of ancient theatre architecture. Other initiatives include ARCHES (Antiquity Related Collections Harnessed for Educational Scenarios, http://www.warwick.ac.uk/ETS/arches/) and the King's College Visualisation Lab, co-directed by Hugh Denard. And Manchester Visualisation Centre has been conducting more recent research into haptics and immersive environments. In all of these, the aims are largely archaeological. That is, to produce, from a range of material evidence, an approximation of an historical theatrical space. Again, this seminar is not the appropriate context in which to debate the epistemological issues brought to bear through such exercises. However, the more our sector engages in these areas the more likely it is that any easy relationship between the spaces and events of performance and its mediatisation through visualisation techniques will be questioned. There is a clear opportunity for our sector to feed into these debates, and thus into a more theoretically sophisticated understanding of the role of visualisation in our research.

Another visualisation platform that has been popular within our sector are CAVEs. The first CAVE (Cave Automatic Virtual Environment) was presented at the 1992 SIGGRAPH meeting. It took the nascent immersive VR tools (headset and gloves) to the next stage, whereby users can freely move inside the immersive environment where 'reality' is produced through an array of computer workstations and multiple data projection. In the science and technology sector CAVEs are used in research and development. In the creative and performing arts and media, however, CAVEs have been quickly taken up to explore a range of questions. Most recently, the Performing

Presence project is using the CAVE at Imperial College to host a series of research activities aimed at understanding presence: http://presence.stanford.edu:3455/Collaboratory/371

There are any number of smaller-scale visualisation projects that also have a lot to offer researchers in our sector. There has been a huge amount of research into the construction and use of avatars to explore questions around movement, response and interaction. A critically interesting approach to this is Carol Brown and Mette Ramsgard Thomsen's collaboration on *Spawn* (http://www.carolbrowndances.com/spawn_changingroom.html), which used a camera tracking system to interpret the physical presence of a performer. Statistical data generated by the system is used to kinetically model a virtual dance partner. The interface examines the sense of presence in the virtual environment through experiments with live dancers and is a robust response to the history of motion capture visualisation strategies – with their focus on joints as points of movement rather than working with the body as a somatic flow -- that have dominated dance and performance.

Barriers to visualisation and simulation in the performing arts and media:

- Preservation of and useful access to previous models
- Copyright, Creative Commons, etc
- Training and technology
- Risk of disconnection from the mainstream research
- Publication and recognition of visualisation outputs
- Entry costs can be high
- Epistemological/theoretical issues brought to bear in the archaeological problematic of reconstruction

Resource creation and delivery

E-science relies on the ability to locate, deliver and process information so a number of core applications and tools have emerged that support or extend these functions for the E-science community. While E-science is neutral about the approaches used to discover and deliver resources, the dependence on the ability to do so means that changes in technologies which support these functions are important.

Resource discovery in our sector is largely based on the metadata model. In this model, a distinction is retained between the resource descriptor and the resource itself: the former is indexed and searched, the latter is delivered. This model works well for mixed analogue and digital resources and for data formats that cannot be indexed efficiently by computer. It is a familiar model from the library community and is the model used by 'metasearch' Internet search engines. But this is not the only model for resource discovery that exists nor is it necessarily the most suited to our needs. Full text keyword searching has supplanted metasearch as the dominant paradigm for Internet search engines and the boundaries between data and metadata are not clear-cut. Moreover the emergence of conceptual reference models holds the

promise of semantic interoperability between different information communities. This has been the remit of PARIP Explorer, with our recognition that consistent, coherent taxonomic frameworks are hugely problematic in our sector. What is of more interest for us is the development of ongoing metadata generation that can be contested via the very workings of the database.

The semantic web has great potential, but will rely on the agreement of standards by subject experts: for example what is a primary source, and what is a secondary source? The semantic web may be too difficult to understand -- certainly more so than html -- which limits its potential. The automated production of ontologies using the processing power of the grid may be a future development that would aid the Performing Arts sector, but relevant tools and technologies have yet to be implemented which would do this in a trustworthy and useful manner.

There is also the evolution of organic metadata in the form of ‘Folksonomies’ to consider. These organic ‘ontologies of how the world works’ are very different from formal ‘top down’ Metadata methodologies. Created by users, rather than professionals, folksonomies are the network of interconnected terms used to describe data, such as the picture content in Flickr, and are chosen entirely by the general public, developing a structure through the volume of entries received. Naturally, this might theoretically be a great asset to the production of metadata vocabularies and taxonomies, but folksonomies have their drawbacks. They sometimes apply only for a limited time -- for example ‘Danish’ and ‘Cartoons’ have become related words in response to developments in the news -- but in time these words will have lost their association. Sometimes they can also be judgemental. For example, ‘Bush’ and ‘idiot’ are related words in the Googlesphere. None the less, the ‘folksonomic’ approach still appears best suited to our sector based as it is in a dialogic iteration of the communities’ understandings of what we do.

More pragmatically, a great deal of attention has been paid to resource discovery but relatively little attention has been paid to issues associated with the completion of the transaction after discovery. For example, persistent identification of resources remains problematic and such identifiers as exist tend not to operate below the level of filenames. Consequently it remains difficult to cite a data point within a file and be able to access it consistently. This is not a failing of resource discovery per se, but of fulfilment. Likewise accessing data points within a file normally means disclosure of capabilities via an independent schema and markup. Markup standards have received some attention in the performing arts and media, but tools remain largely under-deployed, making completion of transactions an ad hoc affair. These issues are by no means unique to our sector, and it is not yet clear whether the E-science community has working solutions.

The relative immaturity of digital services in the performing arts and media also constrains and hampers what we can deliver and process. Non-digital source material is still arguably more important across archaeological research than the entire digital corpus. Bristol University’s Theatre Collection

and the Theatre Museum in London have still only tentatively moved into the database sector. The Backstage database is a text-based catalogue that brings together the catalogues of various institutions with performing arts holdings. However, it remains a modest resource that will not replace on-site archive visits.

It is also unlikely that E-science will resolve our analogue backlog digitisation issues, though it is clear that action is needed. Moreover, the tendency for parallel services to provide duplicate records without revealing their authority and the surprising proliferation and fragmentation of services makes it hard for users to keep up with services that exist, let alone make sense of data sets that they find through them. All of this points again to the potential benefits of a widely agreed data infrastructure that supports organisational and semantic interoperability.

Barriers for resource discovery, delivery and processing:

- Persistent identifiers and ‘deep’ linking
- Research skills training in resource discovery
- Depth of cataloguing and indexing
- E-Science, metadata, ontology
- Intellectual property rights vs web services
- Markup standards and (practical) implementation
- Completion tools to import and connect data sets
- Non-digital backlogs
- De-duplication of similar sources
- Fragmentation and proliferation of services

Globalised research

E-science allows researchers in many parts of the world to collaborate in real time over sustained periods. The performing arts and media are both international and cross-sector constellations of practice. The internationalisation of our disciplines means that differences in methodologies and institutions in different countries need attention.

Of particular interest to us would seem to be the opportunities afforded by E-Science to facilitate dissemination of research without resorting to documentation, per se. While clearly reliant on a range of camera-based technologies and the binary coding of events, E-Science provides the opportunity for international event-based research, via live iterations among data. The politics of this is highly contestable. However, our sector is perhaps ideally placed to take on and work creatively with the politics of E-Science in a global research market. And E-Science has the potential to trouble the still-dominant Anglo-American model of research collaboration.

Challenges for working internationally are:

- Different traditions of recording and reporting and standards
- Cross border funding
- Different traditions of research validation

- Organisational interoperability
- User requirements: The uptake of all technology is dependent on the technologies matching user requirements and those technologies being easily implemented, managed, and used. E-Science technologies remain obscure: both in function, and availability. How can E-Science systems be developed which look seamless and are intuitive for both all users in a globablised market?

Priorities

Certainly, we do not lack opportunities. This discussion document provides ample evidence of the way in which our sector is working and the potential for significant contributions to the research and further development of E-Science. Questions to be addressed in determining priorities include:

1. Should resources go into addressing the impact of E-Science on the stages of the research process, or into addressing its impact across the process as process? (Is this a real opposition?)
2. Should resources be targeted to particular areas ('picking winners') or should they be spread as widely as possible ('support the whole field')? Or: do we give a lot to a few, or a little to many?
3. Everyone agrees that there is an e-publication crisis. Do we address this directly (e.g by direct funding of an e-science library for the arts and humanities; or by expanding the remit of the AHDS, etc.) or seek other solutions?
4. Should we be targeting tools development .. resource development .. upgrading electronic archives .. training scholars?
5. Should we look to expand existing centres of excellence / create new ones – or look to distribute expertise beyond specialist humanities computing officers to humanists at large?
6. Should we concentrate resources on projects/tools enabling collaboration, or on projects/tools empowering individual academics?
7. What balance should there be between 'responsive' and 'pro-active' funding?
8. We do not live in a vacuum. Should we target resources to projects collaborating with groups outside academe (even, with commercial partners); to projects collaborating with academic groups outside our speciality?
9. To what extent should we seek to adapt solutions developed outside the humanities, or should we develop specific solutions for our particular needs?
10. Can we think of any answers beyond: give me more money?
11. Should we more assertively position our sector as a vital research lab, a virtual research environment for developers?