Department of Management
Information Systems Group
London School of Economics and Political Science

Working Paper Series

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December 2006

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THE PRACTICE OF e-SCIENCE AND e-SOCIAL SCIENCE: METHOD, THEORY, AND MATTER

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Abstract

Grid technologies are widely regarded as important innovations for drawing together distributed knowledge workers into virtual communities. After reviewing the developments in e-science, we examine the emergence of e-social science and its implications for information systems research practice. We consider what is new about this phenomenon and discuss the issues raised by this particular approach to the virtualization of research practices. Our analysis is organized into three sub-sections that focus on: developments in e-social science research methods; the theoretical issues involved in pursuing an e-social science agenda; as well as the status and nature of the research materials that it gives rise to in information systems.

Keywords: research methodology, e-science, e-social science, grid technologies, distributed work, collaboration

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Introduction

While we are quick to study different kinds of virtual work and virtualization in distinct contexts (Watson-Manheim, Crowston, and Chudoba 2002), it is easy to overlook our own work practices as scientific researchers (notable exceptions include Star and Ruhleder 1996; Olson and Bly 1991). The pervasive use of information and communication technologies has enabled new forms of knowledge work of which research has a fundamental role to play. We should debate the impact of ICTs on

our ways of working just as vigorously as those involved in organizational changes in other professional contexts. In this paper, we discuss the practice of e-science and e-social science in order to consider the insights that the field of information systems can bring to bear on what is a key developmental phase of its emergence. Is this a new era for social science research method or another just an expansion of bandwidth and another instance of the small case letter "e" being put in front of something we already know about? We begin by defining the terms used in the paper and then turn to a discussion about the implication of these technical advances for our methods, the theory that we use to understand them, and their design.

The original designers of the Grid, Ian Foster and Carl Kessleman, define the Grid as an enabler for Virtual Organizations. Grids were developed to overcome resource issues (CPU cycles, disk storage, software programmes, and peripherals) on an external provisioning basis. In other words, the use of the resources is characterized by its availability outside the context of the local administrative domain. The organizing processes surrounding use of the Grid are a fusion of the researchers' home institutions policies and practices with those of the external resource entity. The technological governance of the Grid is managed through its middleware, which represents a formal point of compliance between the Grid context and the application that the researcher works with

The development of e-science

e-science centres upon the use of an innovative, powerful computer-based infrastructure called 'Grids' within natural science with the aim of constructing a "cyberinfrastructure" for research collaboration (see www.escience-grid.org.uk and www.globus.org). Indeed this endeavour has been defined as the "*intersection* of Grid and collaborative research" (David 2004 original emphasis). It is characterised by scientific mega-projects carried out through distributed global collaborations enabled by Internet technology, very large data collections, massive computing resources, and high performance visualization methods (see www.rcuk.ac.uk/e.science). An example of the research activities being organized around the concept of e-science would be GridPP, led by the UK experimental particle physics community (see http://pegasus.lse.ac.uk).

The development of GridPP has been driven by the need to analyse the unprecedented amount of data (some 15 million Gigabytes per year) that will be produced by the LHC (large hadron collider) experiments currently under construction at CERN and due to begin operation in 2008 (Hlistova

2004). To process this data GridPP envisages requiring 100,000 computers forming its associated grids, spread across the globe and incorporating a number of grid infrastructures of which GridPP, from the UK, is one (Faulkner, 2006). Natural science has a tradition of team-based projects and is often cited as an example of distributed knowledge work (Knorr-Cetina, 1999).

The Grid presents natural scientists with significant challenges, some of which are well documented some of which are novel and relate to the particular manifestation of Grid technology with which they are engaged. GridPP's particular concerns relate to the development, coordination and management of such a large Grid resource particularly around data distribution and storage (www.gridpp.ac.uk). Microelectronics groups are employing e-science as a way of approaching the challenges of semiconductor design within which concerns for licensing of software designs and the protection of the intellectual property rights are paramount (http://labserv.nesc.gla.ac.uk/projects/nanoCMOS/index.html). Communities such as Biotechnology and Medicine are concerned with the integration of large data sets for analysis and visualisation in a similar way to Particle Physics (Wouters and Schroeder 2003). Since these fields employ animal experimentation data and patient records they are particularly concerned with privacy and access control (http://www.brc.dcs.gla.ac.uk/projects/bridges/) (Rogulin, 2004).

Within e-science there are projects whose research agenda overlaps with familiar Information Systems concerns. The VOTES project (http://labserv.nesc.gla.ac.uk/projects/votes/index.html), funded by the Medical Research Council, for example is concerned with the clinical trials and epidemiological studies and focuses on issues the Information Systems community may recognise such as patient recruitment, data collection, and the study management of clinical trials. Finally within the e-science community there is a broad concern for the usability of Grids, evidenced by an EPSRC call for research in this area (Venters, 2006, Fry and Whelwall 2006). Although many scientists are comfortable with employing advanced technologies in their research, Grid technology currently requires technical expertise which is not particularly usable. This concern is of crucial importance within e-Social Science where researchers' experiences with advanced and prototype technologies like Grid's is very limited.

The emergence of e-social science

e-social science[1] focuses on the adaptation of Grid technologies and tools that have typically been applied in natural science to advance the social sciences. Social science research has traditionally been based upon individual effort and involves rather different work practices which pose important issues for the development of e-social science. The NeSc note that before Grid technologies can be widely accepted by the broader social science community:

> "…there are significant obstacles to be overcome. These relate to such issues as the commodification of Grid technologies, the shaping of national infrastructures, and organizational contexts as well as developments in research traditions."
> (www.nesc.ac.uk/esi/themes/theme_03)

There are pockets of researchers working on these issues around the world pioneering Grid technologies. The tools that they are developing could prove highly relevant for scholars in the field or information systems particularly those interested in exploring research topics that are multi-dimensional requiring analyses of use, for example over time and space such as Blackberries or mobile phones (see "Replayer" in Chalmers 2006 and "SHAKRA" in Maitland and Chalmers 2006). Other examples of large data sets that can be gathered might include: activity and/or usage data, multi-channel working (for example Instant Messaging), audio data from call centres, geographical information systems data on identity card use, or the digital forensics of money laundering.

In addition to the topic-dependent features of data that can be explored, there a broader range of media that can be stored. There is a new generation of cinematic narratives that can be dynamic and move in time/space; these include wearable ICT and use of mobile networks combined with GPS as well as other sensing technologies. Researchers will have the opportunity to reconfigure the traditional research dynamic by asking research participants to keep their own video/audio journal entries, fill in PDA activity logs in their own time/place, and/or participate in two-way communication at-a-distance. Information systems researchers will surely be interested in the development of Grid-enabled distributed work practices themselves (see Brown 2006 for an example of using Wikis in collaborative ethnography). It is notable that many key figures that have shaped the literature on Computer Supported Cooperative Workgroups (CSCW) and Virtual

[1] Woolgar (2003) notes that some people find the distinction between e-science and e-social science an artificial distinction and would prefer a non-English term like "e-Wissenschaft" to overcome this.

Organizations (VO) have turned their attention to Grid technologies (for example Judith and Gary Olson's interest in the idea of "collaboratories" (http://www.crew.umich.edu/index.html). In the next sub-section, we consider the implications of e-social science for research method in more detail.

Method

As automation increases and technological costs fall the opportunities for curation of digital data expand. Organizations dedicated to the acquisition, dissemination and re-use of qualitative social science research data are emerging (for example, http://www.esds.ac.uk/qualidata/online). Digital curation refers not only to the maintenance of a trusted body of digital data for current and future use, but also involves exploring ways to add value to it (see www.dcc.ac.uk). There are significant challenges associated with combining information from diverse and distributed data sources; the number, complexity, and diversity can be daunting. A recent issue of Information, Technology and People explored the different genres of digital documents (see Kwasnik and Crowston 2005). Preparing the original material for current use by colleagues distributed around the Grid or for digital curation sometimes places a considerable burden on the field worker or data set owner who must conform to set standards in, for example, transcription or format.

A considerable effort has been put into the development of non-proprietary formats and standards for preserving, searching, and disseminating data (see The Edwardians project at esds above). This kind of interoperability is fundamental to the portability and data interchange that underpins the intention of Grid approaches (see http://www.esds.ac.uk/qualidata/online/about/xmlapplication.asp#ten for a draft DTD (document type definition) for a generalised XML qualitative dataset application).

Large scale computing resources provide opportunities for massive data storage and archiving of multiple digital resources (text, video, image, audio), that can enable hyper-ethnographies using video storyboards or video paperbuilders (http://vpb.concord.org). These sensory-rich media forms challenge our current research methods and represent the frontier of pedagogy (Barrett 2000) as well as forming living histories of research practice. However, this only represents a partial realisation of Grid potential. There is capacity for increasingly interactive and dynamic forms of research approach

that move beyond catalogue searching and data download to allow web-based free-text and filtered searching, browsing and retrieval of research data in real time.

Access to archives of qualitative data also presents the opportunity to pursue innovative case study strategies that move beyond snap-shot survey methods and transform multiple case research from the preserve of project-based initiatives (or long research careers) into the realm of possibility for individual researchers and doctoral students. Grid technologies could support the further development of social network analysis as well as stimulating a greater variety of qualitative-quantitative methods of data analysis (see Chalmers 2006). The question of which research methods are more suited to the Grid environment is a contentious one.

For example, the notion of e-social science raises potentially uncomfortable questions for the information systems interpretive research community. In the past, interpretive researchers expended much intellectual energy explicating the differences in their work for the benefit of 'hostiles'. Interpretive research now has a much broader acceptance in the information systems community and is in a phase of constructively examining the interpretive form rather than defending it. Intepretivism is a "set of epistemological assumptions" (Orlikowski and Baroudi 1991) but whilst we have guidelines for good practice (Klein and Myers 1999) and we follow recognised qualitative research protocols there is still high levels of flexibility in the execution of interpretive practice. The epistemological assumptions that Orlikowski and Baroudi refer to serve both as a broad set of co-ordinates with which the researcher can mark the beginning of an intellectual journey and they steer us in the general direction of inquiry (Schwandt 1994). In the process of appropriating these broad assumptions researchers must interrogate and give meaning to them, for they are not neutral axiomatic principles. Each person's interpretation of the assumptions underlying their research approach will have consequences; it will give them eyes to see certain topics or questions and not others; it will influence the way that their research approach becomes enacted in practice; and will influence the status and nature of any contribution that they make.

It could be argued that e-social science lends itself more readily to positivist methodological techniques in which researchers aim to triangulate findings with the aim of finding commonalities and scoping out inconsistencies in the data set. In contrast, an interpretive researcher with strong constructivist leanings might build upon contradictions in the data to reveal political narrative, and

may resist the notion of reducing interviews to codes as the basis for content analysis. Indeed, many established interpretive researchers balk at the suggestion by reviewers that they should explicate formal processes of analysis preferring to stand firmly by the conviction that their findings emerge solely from an knowledge of the field arrived at through reflection, insights, and intuitive induction.

This exhumes some tired controversies that have dogged interpretivism, namely lack of critical purchase, its tendency toward relativism, solipsism and over-privileging the inquirer's perspective, the confusion between the psychological/epistemological and, finally the paradox of how to develop an objective interpretive science of subjective human experience (Schwandt 1994). The creative infusion and adaptation of information systems research methodologies such as interpretivism into the e-social science offers opportunities for new forms of rigor and relevance (see the debate in MISQ 1999 23:1). One would hope that there are those among the interpretive IS community that possess a strong will to innovate and experiment, but large scale research practice does present distinctive issues that would be hard to overcome. While it is for each researcher to take their own position on this, it is conceivable that interpretive IS researchers will largely avoid e-social science.

At the IFIP 8.2 working group conference in Manchester (Kaplan et al 2004), senior figures in the IS field called for more extensive use of multi-disciplinary research and it is possible that a team approach might represents a fruitful possibility for different genres of researchers to engage in e-social science. As we have noted, social science research tends to be a fundamentally individual endeavour. However, there are compelling grounds to consider revising this norm to accommodate other practices. Dennis et al (2006) point out that the IS field "publish elite journal articles at a lower rate than Accounting, yet our promotion and tenure standards are higher" creating a "growing divergence between research performance and research standards". These pressures reduce the quality of worklife experience and job satisfaction for junior colleagues and lead to "increasing faculty turnover, declining influence on university affairs, and lower research productivity" (Dennis et al 2006). One way of addressing the issue of research productivity is to explore the team work opportunities offered by e-social science. This would require support from established senior researchers to mitigate the risks of such an experiment for those already wrestling with the intensity that now accompanies junior academic careers. Of course, multiple author publications also have to form part of a balanced portfolio alongside single authored articles; however the interaction with a

distributed community and teamwork could help overcoming the sense of isolation that can accompany individual efforts to achieve elite publications.

Theory

In this sub-section, we return to the theoretical implications surrounding the development of e-social science. After the presentation of a software tool designed to support the analysis of mobile technologies at a session of the 2006 National Centre for e-Social Science (NCeSS) conference a member of the academic audience commented "That's great, but where is the social theory? Where is the e-social science in your approach?" Are Grid technologies about organizing, storing, filing, communicating, and accommodating ICTs into research methods or is there a theoretical question?

From our perspective, the comment made by this conference delegate doesn't so much set a new design agenda for those developing this software or call for us to develop a theory of e-social science, it poses a challenge with regard to the articulation of the relationship *between* theory and practice. The social science oriented software-based tools being developed for Grid contexts are not being designed to provide explanation and prediction, they represent a distinctive way of gathering and organizing data. However, we wish to pause here to clarify what might perhaps seem an otherwise common sense observation. Our position is that data are a fundamental part of research practice and as part of the pattern of our work are fundamentally social, expressing (or imbued with) a relationship to theory because that is part of our research practice. This brings us to a reflection on the practice of research and a consideration of whether there is theory in our actions. The study of practices has received considerable attention (see *Organization Studies* (2006, 17:5) and *Information Society* (2005, 21) and we draw on it briefly here to explicate our position on the notion of e-social science research practice.

Following Reckwitz, we define practice as "a routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood" (2002: 250). When we engage with data we are, as Reckwitz says "using particular things in a certain way" (2002: 252-3) and when technologies mediate that use it necessarily shapes practice; they "enable and limit certain bodily and mental activities, certain knowledge and understanding as elements of practices.

When social scientists discuss Grid and Grid-focused tools as a context for their work (despite the long discourse in our field on social shaping of technologies) they are drawn into modes of discourse in which it is presented as a sanitary, neutral environment over which they will lay their research practices. As Orlikowski (2000) says it is important to understand both the technological artefact and the technology-in-practice; both have significant implications for understanding developments in research practice. For example, there is regular reference to 'raw data' in the material on e-social science, a notion with which we have take particular issue. When software products gather data they do so under a number or presuppositions or assumptions encoded in their design, function, and use. It is, for example, extremely unlikely that two e-social science software programmes would select the same data, a simple yet powerful test of this point. Returning to Orlikowski's (200)) idea of "in-practice" and "in-use", our point is that it is important to reflect upon the notion of "data-in-practice" and "data-in-use".

Kuhn's (1970) analysis of paradigms in scientific inquiry taught us that "scientific communities are bound together by conventions and commitments that build upon taken-for-granted assumptions". The development and use of particular research methods can be associated with identifiable groups of scholars or what Wenger calls "communities of practice". As Kelly and Jones (2006) note, much of the communities of practice literature emphasises the notion of communities rather than practice. If we take this proposition that theory is expressed through in our practices seriously then we begin to see how particular research identities could colonise and shape the emergence of Grid technologies and the standards embedded in its infrastructure. Following this through, we also need to draw together a body of research that deconstructs the largely taken-for-granted term of "information infrastructure" (Bowker and Star 1999) and assemble detailed analyses focusing on the emergence of specific infrastructures to support particular research practices. This includes understanding the role of agents of change that move between groups diffusing ideas, working toward the articulation of standards, and encouraging "convergence" (Bowker and Star 1999: 82). How do norms emerge in e-social science? How and where does the structuration and institutionalization of specific research practices take place? In the next sub-section, we consider the conceptual and material structuring of research in more detail.

Matter

The development of e-social science is in an interesting definitional phase when its design parameters are relatively open. As dominant research groups emerge we may see the black boxing of both the material basis of the Grid design and the conceptual expression of research methods. Ackoff (1979) maintained that the complex phenomena tackled by social science can often seem like "messes". While "assumptions make messes researchable" it is often "at the cost of great over-simplification, and in a way that is highly problematic" (Morgan 1983: 377). Our experience as information systems researchers should put us in a position to acknowledge that on the one hand establishing standards enables interoperability that helps us to built community infrastructures that link up knowledge workers over time and space. However, embedding assumptions about method into research tools designed to enable collaboration creates a new messy problem.

Burrell & Morgan (1979) encourage us to analyze and challenge assumptions through map-making activities designed to increase awareness of taken-for-granted assumptions that shape social research. We suggest that Grid technologies enable methods whose assumptions need to be deconstructed in order to understand their relationship to methodology and the design of a research strategy.

Building on this, in his book *Beyond Method*, Gareth Morgan argued that we need to go beyond a focus on technical methods to reveal the assumptions shaping research:

> "A knowledge of technique needs to be complemented by an appreciation of the nature of research as a distinctly human process through which researchers *make* knowledge. Such appreciation stands in contrast to the more common view of research as a neutral, technical process through which researchers simply reveal or discover knowledge" (Morgan 1983: 7).

In light of this, how far can we draw together groups of researchers that share assumptions and methods in the way that natural scientists try to do? How far can technological tools used over the Grid enable or constrain our efforts as social scientist? Is the study of social phenomena more art, than science?

Conclusion

At this stage in its development, the emergence of e-social science raises many questions for the nature of distributed knowledge work of which research is a key part. As information systems researchers we are uniquely well positioned to interrogate the design of Grid technologies, their

virtual organization, and their use, building on a rich research tradition in related areas (Jonathan Grudin presented a seminal paper at a conference in Portland, Oregon, in 1988 examining why collaborative technologies for diverse distributed groups fail and the problems associated with the design and evaluation of CSCW). Grid technologies must overcome adoption and use issue associated with all innovation processes and sustainable applications need to be developed (see www.gridappliance.org). As e-social science tools and methods emerge, we suggest they should be accompanied by the development of forms of evaluation and points of access that render the assumptions underpinning these systems available for critique.

The standards and shared approaches implicit in engaging with e-social science enable the exciting prospect of conducting large scale research in ways not possible before. However, we need to move toward the establishment of research standards and shared e-social science infrastructures with informed awareness of the social shaping process (see Woolgar 2003) in which they are involved. The potential for a Grid elite or methodological hegemony to emerge should be regularly monitored and those involved in the developments taking place need to be reflexive about design issues. An important aspect of this is an understanding of the nature of data as well as an appreciation of the relationships between method, theory, and practice. Our interpretation of these relationships matters and will shape research outcomes.

Grid technologies should not just be thought of in narrow terms as the preserve of quantitative or positivistic research. Advances in qualitative and interpretive traditions need to consciously attempt to converge with Grid developments to take advantage of this window of opportunity. Finally, we need to ensure that we don't fall into the trap of fetishising technology and instead remember to nurture the distinctive contributions that come from unconventional, non-standard innovation and openness to diversity of research approaches.

If we put our best effort into designing these research infrastructures to accommodate many different approaches to research and champion diversity, how do we achieve the scale required to realised the distinctive opportunities that e-social science presents? On the other hand, if we announce the use of standards and common approaches, what do we lose in the process? Who will become advocates for particular e-social science research strategies and on what grounds will they claim that their approach should have supremacy over others? These are foundational issues and it is

important for us to deliberate upon them if we are to seize the possibility of advancing research practice.

REFERENCES

Ackoff, R.L. "The Future of Operational Research is Past", *The Journal of the Operational Research Society*, 1979, (30: 2), pp. 93-104.

Barrett, H.C. "Create Your Own Electronic Portfolio: Using off-the-shelf software to showcase your own or student work", *Learning and Leading with Technology* (27:7), 2000, pp.14: 21.

Bowker, G. and S. L. Star, *Sorting things out: classification and its consequences*. Boston, MA, MIT Press. 1999.

Brown, B. "Using Wikis in Collaborative Ethnography" *Proceedings of the 2nd International Conference on e-social science*, Manchester, 29-30 June, 2006.

Burrell, G. and Morgan, G. *Sociological Paradigms and Organisational Analysis*, Heinemann, London, 1979.

Button. G. and Dourish, P. "Technomethodology: paradoxes and possibilities" *Proceedings of the SIGCHI conference on Human factors in computing systems,*1996, pp. 19-26.

Chalmers, M. "Replayer: Bridging the Quantitative-Qualitative divide in Ubicomp Evaluation" *Proceedings of the 2nd International Conference on e-social science*, Manchester, 29-30 June, 2006.

David, P.A. "Towards a Cyberinfrastructure for Enhances Scientific Collaboration: Providing Its 'Soft' Foundations may be the Hardest Part" Oxford Internet Institute, Oxford, 2004.

Davenport, G. and Pan, P "Mobile, Context-sensitive Cinematic Narratives", MIT working paper http://mf.media.mit.edu/pubs/journal/MobileCSNar.pdf, 2006.

Dennis, A.R. Valacich, J.S., Fuller, M.A. and C.Schneider "Research standards for promotion and tenure in Information Systems", *Management Information Systems Quarterly*, (30: 1), 2006, pp.1-13.

Faulkner, P., Lowe, L., Tan, C., Al., E. et al. "GridPP: development of the UK computing Grid for particle physics", *Journal of Physics G: Nuclear and Particle Physics*, (32, N1-N20), 2006.

Finholt, T.A. "Collaboratories as a new form of scientific organization", *Economics of Innovation and New Technology*, (12:1) 2003.

Foster, I. and Kesselman, C. *The Grid: Blueprint for a new computing infrastructure* San Francisco, CA, Morgan Kaufmann Publishers Inc., 1998

Fry, J. and M. Thelwall "Using Domain Analysis and Organisational Theory to Understand e-Science Sustainability" National e-Social Science Conference, Manchester, 2006. http://www.ncess.ac.uk/events/conference/2006/papers/papers/FryUnderstandEScienceSustainability.pdf.

Grudin, J. "Why CSCW applications fail: problems in the design and evaluation of organization of organizational interfaces" *Proceedings of the 1988 ACM conference on Computer-supported cooperative work*, Portland, Oregon, 1988, pp. 85–93.

Hlistova, J. "How is the Particle Physics Community Shaping the Grid in the UK?" Working Paper Series, Department of Information Systems. London School of Economics, London, 2004.

Kaplan, B, Truex, D.P, Wastell, D, Wood-Harper A.T., and J.I. DeGross *Information Systems Research: Relevant theory and informed practice* Kluwer Academic Publishers, Boston, 2004.

Kelly, S. and Jones, M. "Toward a distinctive 'Praxiological' perspective on ICT-enabled organizational innovation", Working paper presented at the Organization Studies Workshop on the Practice Turn, Greece, 2006.

Klein, H.K. and Myers, M.D. "A set of principles for conducting and evaluating interpretive field studies in information systems", *MIS Quarterly*, (23:1), 1999, pp.67-94.

Knorr-Cetina, K. *Epistemic Cultures: How the sciences make knowledge*, Harvard University Press, Cambridge, MA, 1999.

Kuhn, T.S. *The Structure of Scientific Revolutions,* Chicago: Chicago University Press, 1970.

Kwasnik, B.H. and Crowston, K. "Introduction to the special issue: Genres of digital documents", *Information Technology & People*, (18:2) 2005, pp.76-88.

Landry, M., and Banville, C., "A disciplined methodological pluralism for MIS research," *Accounting, Management and Information Technology,* (2:2), 1992, pp. 77-97.

Maitland, J. and Chalmers, M. "Collaborative e-Health Systems" Working paper, University of Glasgow, UK. http://www.dcs.gla.ac.uk/~jules/papers/Maitland_hct2006eHealth.pdf

Morgan, G. *Beyond Method*: *Strategies for Social Research*, Thousand Oaks: Sage, 1983.

Orlikowski, W. "Knowing in practice: Enacting a collective capability in distributed organizing", *Organization Science,* (11: 4), 2000, 404-428.

Orlikowski, W.J. and Baroudi, J.J. "Studying information technology in organizations: Research approaches and assumptions", *Information Systems Research* (2: 1), 1991, pp.1-28..

Olson, M.H. and Bly, S.A. "The Portland experience: a report on a distributed research group," *International Journal of Man-Machine Studies*, (34:2), 1991, pp. 211-228 .

Reckwitz A. "Toward a theory of social practices: A development in culturalist theorizing" *European Journal of Social Theory* (5: 2), 2002, pp.243-263.

Star, S.L. and Ruhleder, K. "Steps toward an ecology of infrastructure: Design and access for large information spaces", *Information Systems Research*, (7: 1), 1996, pp. 111-134.

Schwandt, T.A. "Constructivist, interpretivist approaches to human inquiry" *Handbook of Qualitative Research,* Denzin, N.K. and Lincoln, Y.S. (Eds), Sage, London, 1994, pp.118-137.

Rogulin,D., Estrella, F., Hauer,T., et al. "A Grid Information Infrastructure for Medical Image Analysis", presented as DiDaMIC Workshop, 2004.

Venters, W. & Cornford, T. "Introducing Pegasus: An ethnographic research project studying the use of Grid technologies by the UK particle Physics Community". Second International Conference on e-Social Science. Manchester, UK, 2006.

Watson-Manheim, Crowston, and Chudoba "Discontinuities and continuities: A new way to understand virtual work", *Proceedings of the 35th Annual Hawaii International Conference on System Sciences*, 2002.

Wenger, E. *Communities of Practice: Learning, meaning, and identity* Cambridge University Press, Cambridge UK, 1998.

Woolgar, S. "Social Shaping Perspectives on e-Science and e-Social Science: the case for research support "
A consultative study for the Economic and Social Research Council (ESRC). 2003. http://www.ncess.ac.uk/docs/social_shaping_perspectives.pdf

Woolgar, S., Wouters,P and P. Schroeder (Eds.) "Promise and Practice in Data Sharing". NIVI-KNAW, Amsterdam, 2003.