

Grids Knowledge Infrastructure: A case study of the LCG computing Grid at CERN through a practice lens.

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The development of Grid infrastructure within High Energy Physics is a highly collaborative, highly distributed and dynamic enterprise. Developing the LCG (Large Hadron Collider Computing Grid) at CERN involves coordinating the actions of a huge range of people of different culture, education and skill, all working within different institutions around the globe. Vital in this enterprise are the ability to share knowledge about the project, and to support innovating new technology and new work practices. In part, this is achieved by careful attention to developing a sense of community among participants, and through constructing a range of repositories of information about the project, the people, the grid itself and its performance.

Within this paper we explore the way in which the construction of LCG has required the development of such a knowledge infrastructure (Hanseth 2004) that, in many ways, parallels that of the Grid's more technical infrastructural elements. This view reflects Jankowski (2007) suggestion that "the organizational infrastructure required by e-science initiatives may be, in fact, more important than the internet-based tools for data collection and analysis". Indeed, we argue that the Grid is only made a sensible concept if we consider three elements – the Technical Grid (consisting of computers, middleware, networks, sensors), the Practiced Grid (consisting of people and their work practices) and the Knowledge Infrastructure which binds these elements together providing the structures by which knowledge about practices and technology is constructed and shared. The focus of this paper is the final of these three elements – a Grid's Knowledge Infrastructure.

The empirical basis of our discussion is the work practices of GridPP, the UK contribution to LCG. Data collection for the paper was undertaken through over sixty interviews, participant observation, attendance at major GridPP meetings, site visits, and through three week long visits to CERN.

In exploring our concept of a Grid's Knowledge Infrastructure we employ a range of theories from organization science with a specific focus on practice (Feldman 2000; Schatzki, Knorr-Cetina et al. 2001). Practice for us is the often taken for granted actions of people in their work; "a routinized way in which bodies are moved, objects are handled, subjects and treated, things are described and the world is understood" (Reckwitz 2002). Our analysis is presented from four interconnected and constitutive perspectives relevant to practice theory: social structures, history and culture, materiality and knowledge. These themes reflect the call for studies of knowledge management to consider the cultural, historical and technical context within which they reside (Venters and Wood 2007).

- 1) Knowledge : Knowledge of the project is vital and flows around the rapidly changing GridPP community providing it with a propensity to act. Such knowledge has a tacit dimension (Polanyi 1967) enacted in practice and shared by those participating in the community, but hidden from those not yet inducted. We discuss the relationship such knowledge has to the enactment of practices and to the learning of new members and users. We discuss how such knowledge cannot be made explicit within the materiality of projects and therefore the importance of face to face socialisation to Grid development.

- 2) History and culture : We discuss how the cultural context of particle physics and computer science impact the knowledge related practices of this community. Much of the debates on knowledge fail to acknowledge the historically contextual nature of practices, and their embedding in culture. We aim to show that the trans-national nature of Grids presents particular challenges as practices of those involved are rooted in history and culture of their work (Traweek 1988)

- 3) Materiality : GridPP rely upon a range of material 'stuff' in creating and sharing their knowledge. These range from monitoring applications, websites, blogs, Wikis, video-conferencing and e-mail. We discuss how these technologies constitute the Grid as socio-materiality (Orlikowski 2007) and cannot be separated from the project's sense of identity or from its technical fabric. We therefore anchor the Grid in terms of such materiality agreeing with the practice theory notion that the "social is a field of embodied, materially interwoven practices"(Schatzki 2001), yet linking this knowledge-materiality to the technical fabric of the Grid which it aims to represent.

- 4) Social Structures : Drawing on the notion of a Community of Practice (Brown and Duguid 1991; Wenger 1998) we discuss how the construction of a Grid creates a sense of community for GridPP and in doing constructs an identity for GridPP and for those involved in its construction. We discuss how learning about the Grid is a social process, in which the Grid must be learnt not simply as facts, but as an ability to act in a socially recognised way (Brown and Duguid 2001). This discussion outlines how one becomes seen as a knowledgeable practitioner of Grids.

Through an interweaved analysis of GridPP using the above framework we describe the complex knowledge infrastructure which accompanies Grid development. The paper draws upon recent literature in organization science and knowledge management to provide recommendations to those involved in the development of Grids, and provides a checklist of necessary practices for those contemplating a distributed Grid development project.

References

- Brown, J. S. and P. Duguid (1991). "Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation." *Organization Science* 2(1): 40-57.
- Brown, J. S. and P. Duguid (2001). "Knowledge and Organization: A Social-Practice Perspective." *Organization Science* 12(2): 198-213.
- Feldman, M. (2000). "Organizational Routines as a Source of Continuous Change." *Organization Science* 11(6): 611-629.
- Hanseth, O. (2004). *Knowledge as Infrastructure. The Social Study of Information and Communication Technology: Innovation, Actors and Contexts*. C. Avgerou, C. Ciborra and F. Land. Oxford, Oxford University Press.
- Jankowski, N. (2007). "Exploring e-Science: An Introduction " *Journal of Computer-Mediated Communication* 12(2): 549-562.
- Orlikowski, W. (2007). "Sociomaterial Practices: Exploring Technology at Work." *Organization Studies* 28(9): 1435-1448.
- Polanyi, M. (1967). *The Tacit Dimension*. New York, Doubleday.
- Reckwitz, A. (2002). "Toward a Theory of Social Practices:A Development in Culturalist Theorizing." *European Journal of Social Theory* 5(2): 243-263.
- Schatzki, T. (2001). *Introduction: Practice Theory. The Practice Turn in Contemporary Theory*. T. Schatzki, K. Knorr-Cetina and E. Von Savigny. London,UK, Routledge.
- Schatzki, T., K. Knorr-Cetina, et al., Eds. (2001). *The Practice Turn in Contemporary Theory*. London,UK, Routledge.
- Traweek, S. (1988). *Beamtimes and lifetimes: The world of high energy physics*. Cambridge MA, Harvard University Press.
- Venters, W. and B. Wood (2007). "Degenerative structures that inhibit the emergence of communities of practice: a case study of knowledge management in the British Council." *Information Systems Journal* 17(4): 349-368.
- Wenger, E. (1998). *Communities of practice : Learning, meaning and identity*. Cambridge, Cambridge University Press.