Virtual mobility and distributed laboratories: supporting collaborative research with knowledge technology

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Abstract

Virtual Mobility and Distributed Laboratories (VMDL) is a pilot project in the European Commission, Directorate DGXII programme, Human Capital and Mobility. The project builds upon recent experiences of the Just-in-Time Open Learning project, JLTOL, which was part of the DGXII DELTA programme. The latter undertook field trials of various information and communications technology (ICT) tools and methods for the support of knowledge exchange between professionals. Such exchange can be considered as part of continuous professional development or as simply an aspect of working in a professional community. In either case, ongoing learning is involved. Based on JLTOL experiences as well as others involving the support of distributed collaborative work among professionals, the VMDL project is looking more closely at the processes of distributed collaboration and the technologies and instrumentation that can profitably support these processes.

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1. INTRODUCTION

1.1. Working in communities

European researchers are frequently members of various different distributed communities. These communities can exist in various professional contexts, such as informal or task-specific working groups under the organisational framework of national and international professional societies. They may be stimulated by research opportunities supported by national or international agencies such as the European Science Foundation and the European Commission. They may even exist within the researcher's own institution with different sorts of multidisciplinary interests. The communities with which a researcher is involved may be well-defined, with members who know one another and share common goals, or loosely defined, even to the point of open entry and absence of leadership and task, as can occur with an on-line discussion group. In any case, the members of the community will need to communicate, will need to share and disseminate information, and will need occasionally to work collaboratively. And the community will also have its own internal needs: needs relating to membership, to decision making, to leadership, to organisation, to maintenance of a positive group identity, and to the desire to motivate its members to remain part of the group.

For more formally established research communities, many communications mechanisms are already well established through which research outcomes can be disseminated and new collaborations in research can be organised. These mechanisms include publications, seminars,
workshops, conferences, project meetings, and so on. By and large these are discrete actions or events. Some research groups use other mechanisms for more continuous communication, such as electronic mail and conferencing. Many research associations are now combining discrete dissemination events with on-line, more-continuous services.

1.2. Emerging uses of technology

For a small group of researchers working on a particular project such mechanisms can be difficult to organize. Time, manpower and budgetary constraints are obvious limitations. Because of access to the INTERNET system, most researchers have an immediate way to communicate with one another and to exchange files and are rapidly developing enhanced ways of using these basic functions to support their collaboration (see for example, Harasim & Walls, 1993, for an example of researchers collaborating on a book via time-constrained discussion of each other's draft chapters via e-mail). The use of e-mail has become much more sophisticated than simply sending and receiving a message. It is now frequently the case that distributed researchers will maintain distribution lists to facilitate group mailings, will forward files and messages of interest among themselves, will manage files and messages sent in a variety of directories, will work communally on documents through editing-and-replying mechanisms, or through attaching new versions of pertinent files to mail messages and sending these either to one's specific collaborator or to one's entire group.

More advanced types of technology and instrumentation are increasingly in use among distributed researchers. Computer conferencing systems such as CAUCUS, FIRSTCLASS and COSY can add considerable support to distributed collaborative work when the emphasis is on communication and discussion. Groupware and document conferencing can facilitate distributed groups when access to shared documents and manipulation of shared documents are of particular importance. Real-time desktop conferencing environments which integrate video, audio, and document conferencing, and also support file transfer and e-mail like communication, are now coming into use, more so among the distributed business community than among more financially limited researchers. Thus a number of technically mediated mechanisms are now commonly in use among distributed researchers to facilitate their work and communal learning.

1.3. Specialists in collaboration

In general, however, the use of different technological tools by distributed researchers to facilitate their collaborative work is developing in a non-systematic way, both in terms of the technologies involved and in terms of the researchers' skills and insights into how to work better collaboratively with and through such tools. Such an unsystematic approach would be particularly ironic for researchers studying the nature of collaborative work and learning, or for those studying tools to support such collaboration. For the groups of researchers focused on collaboration and its support as a research area, the need to apply a theoretical framework to their collaborative activity and the need to use the tools available for this domain in an exemplary way are particularly important. These sorts of researchers in particular, both epistemologically and from a tool-handling perspective, should be 'practising what they preach'. When they work together collaboratively, it should not be in an ad hoc and unreflective way. They have a valuable chance to study the process of social constructivism and its technological mediation, through turning a lens onto their own interactions.

1.4 An outline of the VMDL Project

Such is the context for the VMDL Project (Virtual Mobility and Distributed Laboratories), a one-year project (beginning October 1994) within the Human Capital and Mobility Programme of DG XII, Commission of the European Community. The project involves researchers from four universities and a research centre, in five European countries, studying the processes of human networking and the support of those processes through technology. In particular, the researchers involved in VMDL are all specialists in some aspect of collaborative group work and learning, and are using the VMDL experience as a testbed to indeed study, amongst others, themselves as distributed collaborators. The team comprises researchers from facilities and
departments at the Universities of Lancaster (UK), Twente (NL), Geneva (CH) and Coimbra (P), and from the Independent research laboratory, Neurpe Lab in France. The faculties and departments range across the fields of education, psychology, management and information systems, and the staff from those faculties and departments are supported by three 'mobile' research fellows.

In this paper we develop more substantially the goals and procedures of the VMDL Project. However, we begin by an examination of other projects involving similar problem domains. One such project, Just-in-Time Open Learning (JITOL), will receive particular attention as a major source of experience from which VMDL has grown.

2. EXPERIENCE BASE FOR THE VMDL PROJECT

2.1. The JITOL Project

The JITOL Project (see, for example, Lewis, Goodyear, & Boder, 1992), under the framework of the EC DELTA Programme, has been exploring various telecommunications infrastructures to support the professional development of workers in organisations both large and small. While some of the pilot trials used technologies to support learners in specific courses and working towards formal qualifications, other trial domains engaged professionals in their daily work. In all cases, the core elements of the field trials were human-human interaction processes mediated by communications technology and the progressive construction of appropriate knowledge resource bases structured according to community and individual needs. Two trial areas of particular relevance to the VMDL Project were those in a community of medical specialists exchanging diabetic-patient case histories and analyses, and a second (not formally part of the EC work) of managers in a large public corporation responsible for the management of major projects. The work in each of the field experiments was conducted separately with the community participants, but the team supporting the experiments (covering cognitive, management and technical aspects) was the same throughout. One of the core aspects of the JITOL Project has been the challenge of how professional knowledge is shared within a distributed community.

Sharing professional knowledge

The unique nature of the 'open learning' environment adopted by the project comes from building up appropriate knowledge resource bases by constantly integrating users' requirements and inputs. More concretely, representations of the interactions between participants in the system are stored and thereby become additional knowledge resources for subsequent use, a process called reification. Since the interactions mostly emerge from problems that arise in the course of professional work, indexing of these knowledge resources is problem-oriented. In this way, users benefit both from actual interactions on the network and from the subsequent up-dating and customising of resources relevant to their shared professional knowledge base. These two actions respond both to the necessity of assisting professionals in solving actual problems and to their need for more general development and continuous up-dating.

Also, as far as the reification (knowledge build-up) process is concerned, namely the specific method to capitalise upon the know-how captured in the JITOL on-line discussions, we discovered in debriefing sessions with users that they needed the know-how represented in several types of 'knowledge modules'. The variety of needs had not been anticipated in such a way. For instance, some of the users focussed their JITOL activity on navigation in the evolving knowledge base, whereas others focused upon debating. Therefore, the treatment of debates had to take this variety into account. The aspect mostly affected was the kind of links we made between the original interaction of the users in the debates and the different levels of interpretation we made in terms of professional strategies extracted from these interactions. For instance, it proved mandatory to allow users to go back and forth easily between the original debate and our more 'theoretical' analysis, as it was provided in the evolving knowledge resource base.
User acceptance and feedback in JITOL

The process of user acceptance in JITOL was achieved by keeping a constant link with all users. This was true for the preparation and set-up phase, as well as for the actual experimentation. In the preparation phase, users were consulted when the JITOL environment was put together. We needed to know if the human-computer interface corresponded to their needs, if the type of interaction (asynchronous teleconference) was adequate and if the output of the process of interacting made a positive contribution to the tasks at hand. In the experiments themselves, we systematically organised physical meetings, which proved essential. Without these meetings, it is fair to say that we would have lost more than 50% of decisive input from users (Boder & Gardiol, 1994). The most important feedback from users had two dimensions. One was the social process, namely, the difficulties of interactions between different types of users; and the ease with which technical devices could help the social interaction. The other type of feedback had to do with the content of the on-line debates occurring among distributed colleagues when using the JITOL tools and methods. In the beginning the themes were based on what we thought were important issues for users. It turned out that when users were using the JITOL system, they were not as motivated to debate as in other cases where debates bear upon a very special interest, such as a particular person’s project. Therefore, we modified the level of granularity of themes discussed to enhance the motivation to debate. Also the variety of interests of users (some more theoretically oriented than others) obliged us to provide results of analysis in different ways. Therefore, we provided modules in the style of a hot-line, describing critical issues evoked in the discussions and practical solutions one could offer (as some other professionals provided them). At the same time, other modules tried to go deeper into the analysis of what the interventions meant in terms of deep competences simply expressed by experts.

In conclusion, the most important aspect of validation was to keep a constant link with users and to try and ensure that a correct interpretation is made of their requirements. To achieve this, we cross-checked the demands stemming from different groups of users and even across different types of users in different domains.

Lessons from JITOL for VMDL

JITOL has been a complex project. Participants were based in widely varying cultural contexts, were motivated in a variety of ways, had different ‘stakes’ in the work, and so on. The dimensions of the variations include positions in an educational/training continuum, experience and access to technological facilities, and types of commercial/academic environments as home communities which carry with them different behavioural norms. There is not one JITOL system, toolset or methodology but a range of these made operational in a context-dependent way. The richness of the project experience has been precisely this diversity.

In order to learn from JITOL, the VMDL Project has to examine the outcomes of JITOL, in particular issues related to ‘validation and user acceptance’ of the tools and methods used. As the JITOL Project evolved (see a range of papers, Boder, 1992; Boder & Gardiol, 1994; Gardiol, Boder & Peraya, 1993; Gardiol, Bovier, Boder & Menu, 1994; Goodyear & Steeples, 1992; Goodyear, 1993, 1994; Lewis, 1993; Lewis & Steeples, 1992; Haugen, 1993; Sauders & Machell, 1994), the importance of a range of factors which are necessary to consider when implementing telematics systems to support the sharing of professional knowledge have emerged. There was a focus on stable technology available at an affordable cost which led to the conclusion that, for the communities studied in the JITOL Project, asynchronous interaction meets the criterion of being easily integrated into existing patterns of behaviour and allows the use of modest and ubiquitous telecommunications bandwidth for ‘appropriate’ uses of multimedia.

* Note that a distinction is made between the JITOL Project and ‘Jitol’ as a set of tools and methods
2.2. Other experiences forming the basis of the VMDL Project

Although JITOL provides a major base of experience for the VMDL Project, its tools and methods are supported and complemented by a number of other experiences that VMDL partners bring to the project. In particular, the University of Twente team (from the Department of Educational Instrumentation of the Faculty of Educational Science and Technology) has been studying the nature of collaborative work and learning in theoretical and experimental situations through a range of research projects. A core focus in these projects is the design of the instrumentation through which the individual participates in the collaborative activity. Heeren and Collis have this focus in their four-year project on 'telecollaboration support tools' (Eijkelenburg et al., 1992; Heeren & Collis, 1993; Heeren, 1995).

Within this overall project, a number of perspectives are under investigation. One of these is the need for a theoretical framework for telecollaboration, which we are evolving from a synthesis on one hand of key aspects of the CSCL and CSCW literature (Collis, 1994) and on the other, from the literature on group processes and their support (Stanchev, 1993; Heeren & Collis, 1993). While Heeren's work has taken as an experimental focus the support of synchronous collaboration through audio conferencing and shared-workspace environments (Heeren, 1995), we are also studying other technological possibilities for synchronous cooperation, including those involving ISDN and desktop multimedia workspaces (Arav, 1994) and their use within the framework of interactive television for support of professional education on a trans-European basis (Vingerhoets, 1994). Vingerhoets' research, within the framework of the DELTA-MTS (Multimedia Teleschool Project; Reif & Fischer, 1994) is now being extended through our involvement in the Telescopia Project, funded jointly by DG XII, DG XIII, and the Task Force Human Resources, Education, Training and Youth of the Commission of the European Community. In this project, different platforms to support collaborative learning in the context of a range of cases of trans-European course delivery are being investigated (Telescopia, 1994). Collaboration is sometimes more effective in real-time and in other cases more effective when carried out asynchronously (Eijkelenburg et al., 1992); thus we also are studying environments for support of asynchronous collaboration, particularly computer conferencing (De Vries, 1994) and groupware and environments that integrate communication and information resources for distributed learners (Veugelers, 1994).

These research interests are by no means only technically focused; we see technology and the instrumentation of human-computer interaction with the technology as inseparable from larger domains of consideration, not only those of group-processes (Heeren & Collis, 1993) but also those relating to larger questions of the cross-cultural portability of computer-mediated educational resources (Collis & De Diene, 1994); of the organisational impact and acceptance of new forms of collaborative work and learning (Stanchev, 1991; Vingerhoets, 1994); of social and policy issues involved in any serious attempt to integrate such forms in organisational practice (Collis & De Vries, 1993); and of the potential cost-effectiveness of such forms (Moonen, 1994).

The other partners in VMDL also bring with them a range of research activities pertinent to the VMDL Project. Lancaster University is not only involved in the JITOL Project, but also many other activities relating to the support of collaborative work and learning, from the learning-science perspective (Goodyear, 1994) but also from the management-science (Hodgson & McConnell, 1992) and strategic human resource development perspective (Lee, 1991; 1995); that of multi-media distribution (Hutchison et al., 1993) and that of collaborative working (Rodden & Blair, 1991). The University of Coimbra, a VMDL partner, brings with it a research background not only in the technical support of distributed work and learning but work that looks at such technical possibilities within broader conceptual and situational frameworks (Figueiredo & Steele, 1992). The University of Geneva team brings a background in cognitive psychology (Culvernel et al., 1988) and its application to distributed learning contexts. The JITOL work at Neurope Lab has already been cited in the papers by Boden, Gardiol and Lewis.

Thus, from both the JITOL experiences and the broader set of experiences represented by its partners, the VMDL Project is well placed to study the needs of networks of researchers,
3. THE VMDL PROJECT: GOALS AND STRATEGIES

In this section, we focus on the VMDL Project itself, beginning with a brief comment on its situation within the Programme Human Capital and Mobility of DG XII of the Commission of the European Community; followed by a description of its goals and objectives and the current iteration of its research questions; an overview of its methodology; and a comment on its unique aspects and its possible contributions.

3.1 The Human Capital and Mobility Programme

The EC programme, Human Capital and Mobility (HCM), seeks to stimulate the mobility of researchers between European laboratories so that the experience and expertise gathered in one may be capitalised upon in others. In order to achieve this goal, HCM supports institutions which act as hosts to research fellows from other countries, and also networks of institutions working on a common theme. The VMDL Project is one of the latter, supporting the overall goals of HCM but exploring other meanings of the word 'mobility'. Present modes support researchers in gaining experience in host laboratories and taking that experience back to their own institution after a period away. VMDL is looking at ways in which new experiences can be shared continuously through the medium of ICT.

- Can the mobile researchers continue 'as if' they were still working at home?
- How necessary is it to be physically mobile at all?
- Can networks of laboratories be created in such a way that it hardly matters where its researchers are physically based?

Such questions are at the practical heart of the VMDL Project from the point of view of its position in the Human Capital and Mobility Research Programme.

3.2 Goals and research questions for VMDL

Thus the domain for the VMDL research is the use of information and communication technologies (ICT) to stimulate and support collaborative pan-European research. The initial objectives of the research are:

- assess and come to an understanding of the conditions necessary for collaborative work in communities of researchers from different disciplines and traditions;
- assess ways in which advanced ICT can meet certain of the needs arising in these communities as they work collaboratively with one another;
- draw together the expertise which has developed in the two communities of researchers in CSCW (computer-supported cooperative working) and CSCL (computer-supported collaborative learning), both of which are concerned with the complexities of applying ICT to support human interaction, and developing synergy in their experience and goals;
- experiment with knowledge support systems aimed at enhancing the effectiveness of collaborative, distributed working teams;
- evaluate the cross-cultural implications of the changing patterns of work caused by the use of ICT and the organisational requirements.

As a starting point for the VMDL work, an initial set of questions has been developed which encapsulate the above goals:
how do networks differ? are the key dimensions the influences of individuals, technology and organisational structure? how do these interrelate?

what work and communications processes matter within these networks?

how do these processes influence one another?

how can these processes be supported by ICT?

Thus, the metaphor for the research is well expressed by the notion of virtual mobility. We aim to seek ways to complement the aims of the HCM programme by creating distributed research laboratories through the addition of conceptual, organisational and instrumental value to existing communications infrastructures.

3.3. Methodology

The methods being used in the network are directly related to the context of the research. As may be inferred from the earlier paragraphs, the network has three dimensions:

a a human network of individual researchers in European laboratories;
b an evolving electronic network;
c a network of organisations across Europe.

The research task of (a) is to define and experiment with various configurations of (b) in the context of (c). Hence, the project is based on a recursive process whereby the mechanisms for collaborative working being used in the project are the topic of the research itself. That is not to say that the project will rely purely on electronic communications systems: the human face-to-face aspect is seen to be essential particularly for new members of the teams. Rather, advanced communications systems are seen as adding value to more traditional forms of interaction between humans and between human and resources making it possible to extend those connectivities to all the actors in a given community in time and space.

The research outcomes will be experimented with incrementally in a number of real contexts which are exemplified by the pan-European research groups/organisations who have agreed to be involved in the research, both contributing and acting as test-beds for the studies. The electronics communications platform will be INTERNET and the partners will each act as nodes supporting facilities for integrated added-value services including, for example:

- electronic conferencing and mail;
- an evolving, situationally created knowledge resource bases formed by the reification of conference and email interactions;
- a distributed database of 'research people profiles' and X500 piloting projects;
- gateways to relevant, existing databases in Europe and elsewhere;
- as found necessary, specialised databases of research reports, project outlines, etc. on themes not included elsewhere;
- group activity support systems including decision and management support;
- other emerging functionalities such as tele-support tools.

The tasks for this pilot phase of the research include:

- an analysis of existing collaborative research behaviours, strengths and weaknesses in the system, and needs;
- priorities for functionality and methodologies which support these;
- demonstrations of a range of tools (existing and prototypes) at the nodes;
• an enhanced definition of requirements, planning for a second phase of implementation and an iteration around the tasks above.

As a starting activity, the partners are engaged in a range of computer-conferencing discussions under themes related to our research questions, our supporting technologies, our research methodologies, our choice of human networks for close analysis and our own processes for reification and self-reflection. Thus the partners in the research are themselves using the methodologies and evolving outcomes of the research within the project itself and so the project can be viewed as one of situated, action research.

Hence, there are certain distinctive features of this research network and its members:

• it is situated, action research;
• there is continuous formative evaluation of the functionality which is being explored;
• it has iterative cycles of experimentation and implementation;
• the partners are all experienced in innovative methods of collaboration;
• established groups of researchers are engaged as participants in the research and act themselves as one of the test-beds for the evaluation of the functionality.

3.4. Potential outcomes from the research

The expected achievements of the project include:

• a contribution to a growth in the understanding of researchers’ needs, their patterns of usage of ICT and knowledge sources and, hence, the facilities that are required to create a support environment for pan-European research, particularly in the fields of CSCW, CSCL, knowledge and systems engineering and management education;
• pilot implementations of a model (tools and methodologies) of the distributed laboratory which will enhance relationships between teams by supporting the links created by physically mobile personnel and will increase the number of researchers able to participate in pan-European collaborative projects;
• help to arrive at long-term cost assessments of providing these kinds of facilities;
• a greater understanding of the impact of ICT on organisations in a changing environment, and the conditions required if organisations are to benefit from enhanced use of advanced ICT.

The topic of the research itself and the potential engagement of researchers in other fields, offer opportunities for researchers (new and established) to be engaged in the project with the objective of gaining substantive knowledge of their research area through interaction with peers and established researchers. This is not conventional research training, rather research apprenticeship based on situated learning. The quite specific value is that researchers working away from their home laboratory are able to maintain continuing interaction with their original colleagues whilst working with a team elsewhere. This cognitive apprenticeship will supplement more traditional forms of research training which each partner will provide as appropriate.

The physically mobile young researchers create important dynamic social (and academic) links between senior researchers in distant laboratories and will benefit greatly from access to the evolving knowledge resources base and other functionality of the system not only during their period away from the homebase but after that on return.

3.5 Evolution

This paper has been prepared just as the VMDL pilot project gets underway. The detail of the methodologies to be used is evolving as we write; there is a need to build upon existing and
current studies of organisational behaviour and at the same time take a pragmatic approach to our field examination of existing networks. During the short lifetime of the project, the technologies will also change and we see our own project network as the first target for experimenting with new functionalities and methods of Collaborative research.

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