

Building Virtual Research Environments and User Engagement

Annamaria Carusi & Marina Jirotko

Oxford University Computing Laboratory, Oxford UK

Annamaria.Carusi@comlab.ox.ac.uk

Abstract.

Virtual Research Environments (VRE) have the potential to re-shape the research landscape at academic institutions. The Virtual Research Environment (VRE) programme is currently underway with the development of 15 VREs that are investigating the development of an infrastructure to support research activities over a wide variety of disciplines ranging from the Arts and Humanities to the Sciences. User engagement in the in these extremely complex domains, as in many other development enterprises is seen as central to project success. In this paper we report on preliminary findings from an ongoing case study into user engagement experiences of the various VRE projects. In particular, findings relate to contextual issues and, most specifically, researchers' understandings and practices of collaboration.

Introduction

Virtual Research Environments (VREs) are widely acclaimed to offer the potential to support research activities in a variety of different ways in an increasingly complex research landscape. In the UK, the Virtual Research Environment programme¹ is currently underway with the development of 15 VREs that are investigating the development of an infrastructure to support research activities over a wide variety of disciplines ranging from the Arts and Humanities to the Sciences. A key feature of this support is seen to lie in the ability of the infrastructure to support collaboration. However as is evident from research conducted over the last thirty years, there are many different views and understandings of the nature of collaboration. In addition, there have also been different views concerning the ways in which technology could support collaborative activities, and the challenges that emerge when attempting to do so. In response to this, researchers have adopted various strategies and approaches to the design, development and deployment of technologies to support collaboration. One such approach can be seen in the attempts to improve requirements and design for such systems through the user engagement process.

In this paper we attempt to discuss some of the strategies for securing user engagement adopted by the various projects involved in the development of VREs. Our investigation is at an early stage. To date, we have conducted unstructured interviews with one or two project members from 12 of the 15 VREs in the programme. Those interviewed so far have been project managers, those responsible for the requirements gathering, and potential end users. From our very preliminary observations, we begin to outline what strategies appear

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to be working and where significant challenges seem to lie, in the hope that this may encourage new projects, or those currently underway, to learn from the practical experiences these projects have encountered whilst developing strategies for user engagement in this domain. These strategies relate to increasing our understanding of how to secure user engagement in relation to developing the infrastructure to support collaboration.

The VRE requirements process: A general overview

The complexity of this setting should not be underestimated. There is an extensive range of research activities that VREs could potentially support and these, in addition, are embedded in a wide diversity of disciplines from those typically included under Arts and Humanities such as, Archaeology and Music, to complex scientific and medical domains. This complexity is intensified by the broad range of types of collaboration that could potentially be supported by tools. These include collaborations that may be: remote and/or co-present, synchronous and/or asynchronous; large or small scale; in existing communities or new and emerging communities. Whilst each VRE project may be faced with its own specific demands and challenges, there may also be some practices that can be developed and utilised by others, even where research activities in those domains may seem quite diverse.

From the outset of these projects there has been a strong recognition that user engagement is critical to elicit user requirements. In order to overcome the challenge of developing innovative technologies in such complex settings, one key approach adopted by many projects has been to develop a functional wish list and then attempt to address features of the wish list in design and development. Potential users participate in the process in that they are fundamental to the development of the wish list. Some projects attempted to engage as many users as possible in sets of focus groups made up of different disciplines and of diverse roles across their respective institutions. However, as is well documented, the problems that these projects face lie in the level of user engagement of this approach (Goguen and Linde 1993) and in the development of the wish list. Getting users to describe the functionality of a system that does not exist, and that they do not know, is fraught with difficulties. These relate to the complexity of generating frameworks for users to understand what is possible of this new technology, how it can relate to their working practices and what potential benefit it may have on their organisational and business practices. Even where the wish list is developed, further difficulties emerge in the attempts to match features of the tools to these wishes and to develop evaluation criteria to assess the success or otherwise of this match.

Due to the specific features of their projects, some exercises have had greater opportunities to develop requirements in more detail. Undoubtedly there is an advantage in having a clear user community that can participate in the requirements and design activities. Continual participation of potential users in these projects has enabled user evaluation of the technology as it is being developed. This participation has not only been in the form of eliciting users views about the technology under development. Some projects have also been able to supplement this with ethnographic observations of users in their work and/or using tools that have informed design. These projects have been able to profit from the ability to evaluate the potential of various tools to support users' work and provide feedback to developers early in the process. In these cases, due to the iterative nature of the development cycle and the participative design process, these projects have also been able

to begin the process of reflection, that is, to consider how researchers' practices may be transformed by the technology, and the potential impact of these tools on the scientific record.

In the following sections, we outline some of the difficulties faced by the VRE projects in the user engagement process and describe techniques that they found useful in overcoming these difficulties. We also offer suggestions that may be useful for related or future projects to build upon these findings.

Perceptions of VREs

Due to the complex nature of the research setting and the exploratory character of VRE development, a certain ambiguity about the vision of a VRE and 'what it should be' may be found amongst project members. However, this ambiguity in many ways has also been perceived as very useful, for it has enabled different projects to develop in specific ways relevant to their research domains whilst at the same time also exploring and determining the boundaries of VREs themselves. Nonetheless, despite this ambiguity, a view that collaboration and communication is an inherent part of VREs is held by most interviewees. One participant remarked that:

One could envisage a portal for one's own research. [I have] heard such things described, imagined. But [this] does not offer more than [your] average computer operating system, or [your] own file structural organisational system. Added communication function sets it apart.

The form that collaboration takes is also understood in different ways and may present challenges for the ways in which users are engaged in the various VRE projects. If a potential community for the VRE already exists, then they may be available for the requirements elicitation or deeper participation in the development process. Where the analyst does not know who the potential community may be, alternative approaches are needed. Therefore, various projects face different challenges in user participation and yet there may be certain practices that have been found to be successful that may be useful for other projects in the early stages of development.

Difficulties securing engagement

It is recognised that where projects that are unable to draw upon existing communities of practice, it may be difficult to secure engagement from participants. Nonetheless, involving users in the design process is also identified as a critical requirement for project success (Standish 1995). However, it is by no means a straightforward exercise either to identify and involve the 'right' people, or to involve them in appropriate ways. Reports and studies that have highlighted the crucial nature of user participation often do not further elaborate on what is meant by this, what form that engagement takes, or how it is to be achieved. This is also a particular challenge for VRE development; not only to secure user engagement in exercises, but also to enable a deep enough level of engagement for users to be able to participate accurately enough to benefit design. To illustrate, where users have understood the nature of collaboration as providing support in the form of tools, for example, for accessing common data sets, they may also not see the need for such a facility in their research and thus reject the notion that they collaborate with colleagues. But interestingly, where the interactions with users have probed more deeply or conducted more extensive investigations into their working practices, it emerges that initially sceptical participants have indeed identified requirements; from quite basic needs such as

the ability to read and comment on colleagues' papers, to more sophisticated requirements such as supporting distributed working on the development of specific models in real time.

Even in instances where there may be considerable challenges in the successful sharing of data with colleagues and others, through the development of prototypes, we can not only determine and test the capabilities of the technology, but also reveal what the significant barriers to be overcome may be. This may be illustrated through the experiences recounted in an interview with a potential end user of a humanities VRE. This participant had previously been part of an extensive development project intended to make specific resources available to other researchers. These resources were extensively used by scholars in this domain and were highly valued both in their own right and for the meta-data associated with them. The tools allowed researchers to make use of these resources, and users were provided with a tool that allowed them to share commentaries about the resources. Whilst participants in this project were happy to make use of the resources made available through the system, they did not take advantage of the collaborative aspects built into the tools. Scholars in this domain had a strong tendency not to contribute to resources (for example, by publishing data to data sets themselves) when they had the opportunity, nor did they use the shared commentary provision. Resonating with research findings in other research settings (Welsh et al 2006, Lloyd et al 2005), this end user identified two main obstacles. First, scholars and researchers in this domain are reluctant to share their data. They are the primary caretakers of their data and as such do not want it to reside anywhere other than on their own computers. In addition, making data available to the VRE by contributing to data sets is not recognised as a scholarly activity in its own right, despite the scholarship and expertise involved in making the appropriate selections, and in the presentation of the material, and thus, is not perceived as offering any benefit to the researcher themselves (cf Grudin 1988).

A challenge here for securing participation is to understand and present areas where users may see how they could benefit in terms of their research practices, or what Okamura et al call contextualising technologies (Okamura et al 1994). Facilitating how users get information or what they get back in terms of information provided by others, might suggest new capabilities for the technology and provide an indispensable support for the successful deployment of the technology. A related approach may be to conduct investigations in order to discover the barriers in attempts to unpack what is meant by collaboration. These may not necessarily be easily elicited by asking users; many might say that overall collaboration is good. However, when a prototype is available for such investigative processes, potential barriers more easily emerge. This may in part account for why several of the projects that build on pre-existing user communities and have some technology available, seem to make progress in trying to support different forms of collaboration.

Difficulties supporting engagement

Some of the VRE projects have clearly defined user groups collaborating as partners and are also building upon prior disciplinary or cross disciplinary projects and/or collaborations. In addition there may be a core technology (e.g. Access Grid) and context of use that provides a focus for development. In these projects, despite the presence of dedicated user groups, further difficulties have emerged related to collaboration and the context of use. This again may be due to the complexity and heterogeneous nature of the collaborations where these projects are attempting to support a range of different collaborative activities across different sets of researchers and user communities.

Supporting heterogeneous collaboration and research practices

Some research practices require the involvement of a range of academics and non-academics, specialists and non-specialists. VREs to support these activities need to take cognisance of users' work processes and organisational structures, as well as of the fact that technologies often have unforeseen effects on work flows, division of labour and processes of authentication and validation. This may be illustrated by an example of a VRE project that introduced hand-held PCs into field work in order better to manage the flow of information between those who found or discovered items, and those who identified and categorised them. On a first iteration, the hand-held PCs made it possible for finders of items also to identify them. It was discovered through the use of this technology in the field that even though this new practice made the process more time-efficient, it gave rise to disputes over the identification of items. Another solution had to be found, which kept in place the previous structures of expertise and authority so that such disputes did not arise.

Understanding the fundamental research practices of the various disciplines in multi-disciplinary groups, and how to support them is the central challenge of developers of VREs. Several of the VREs already have a multi-disciplinary user community, or aim to be extended to other communities after their primary community. VREs must be flexible enough to support several different research practices. If the VRE is to offer genuine support for different disciplines at quite fundamental levels of research, developers must try to grasp what is specific to different disciplinary practices. Take for example the Integrative Biology VRE which brings together computational biologists and mathematical biologists to do biological modelling. The project manager of this VRE described the computational biologists' practice as being geared towards building applications, whereas the mathematicians' is geared towards analysis. This is reflected in their practices at the level of the technologies they use: computational biologists work through computations, mathematical biologists' practices are pen-and-paper based. Thus, the two groups at this stage of their practices require different forms of support in the VRE. Another of the VREs we looked at used ethnographic techniques to elicit and validate user requirements from their end user partners, and was able to develop a set of tools to support the diverse interactions of different groups of researchers.

These multi-disciplinary collaborations involve people of different disciplines working together to create new areas of research or new applications. One interviewee commented on the difficulty of accommodating the different languages, terminologies and vocabularies of each of the disciplines, so that the skills base of each group is mapped into the environment and material is presented in a way that is tailored to their expertise, but which also allows them to communicate on other levels with people from different disciplines. This suggests that there may be more research involved than the development of the technical software. Different types of understandings of others' work may prefigure more formal work on the development of ontologies.

Relationship with users

Various studies of user engagement detail unrealistic user expectations as a source of difficulty. (cf Standish). Users participating in the requirements gathering and design process may acquire unrealistic expectations that leads to project failure. As user groups who participate in the design process acquire a greater familiarity with the technologies, their perceptions of what is possible or desirable may change too, and they start to request an ever longer list of features, which cannot be delivered. This results in disappointment

and possibly even in disaffection with the requirements gathering process and with the technology. An interviewee suggested that it is best to define 'realistic' according to the most sceptical expectations, as 'there have been many false dawns in the past'.

Some project members have made raised further issues concerning various 'dangers of' in relation to their experiences with users that may be of use to other projects. In the following case there is the warning of overloading certain types of users with too many new activities. For example, in a research context where users were graduate students as well as academics, it was noted that introducing too much at the same time could overwhelm people. First trials of the VRE which had introduced intellectually demanding content and activities at the same time as technologies like Access Grid and collaborative discussion boards which were found to be confusing and sometimes even intimidating. It was necessary to find ways of introducing the technologies either independently, or with easier aspects of the work, or even with organisation and procedural aspects ('housekeeping') in order to familiarise people with the technologies in a more relaxed way.

The challenges for supporting user engagement seem to lie in the complexity of the domain. This novel and large scale programme of work is trying to develop technologies to support and transform multifarious research practices whilst, at the same time, attempting to support collaborations across disciplines that may not have collaborated previously, and also to engage different communities to participate in the design of complex technologies where there are no clear requirements. This is further compounded by other recognised challenges in areas such as security and trust. In less regulated environments some collaborations have been perceived as requiring an element of trust in order to work. Collaborative tools that allow participants to share data at various points on the research production process for example, may make abuse of trust possible or easier. Some VRE project members have experienced the possibility that their work has been taken over by others without their consent. Addressing such issues is not a straightforward matter, neither is it purely technical. Various strategies to address security will need to be developed in conjunction with social and community practices and understandings of trust, ownership and authorship in such settings.

Practical Outcomes

In the following we summarise issues and offer suggestions for future research in this area. Though some may seem straightforward it may nevertheless be useful to report on their use in practice.

Ensure user group collaborators are part of the project at inception.

Many of the projects that negotiated a dedicated user community were able to rely on this participation and thus, did not have the overhead, or less of one, of securing engagement throughout the project. Regardless of the development approach selected, potential end users are often very busy and need to schedule their involvement into their ongoing work. In addition, particularly in clinical areas, it may be necessary to consider providing some benefit in exchange for their expertise in terms of the project collaboration (Hartwood et al 2005).

Secure dedicated user group engagement throughout the development process.

Various studies of project failure have concluded that lack of user involvement and changing user requirements are often a commonly cited cause (Standish 1995; Sequent 1997). Various approaches have been developed to involve users in the design process, arguably the most influential being participative design (Ehn 1988, Kyng and Mathiassen 1996). Obviously the way and extent to which users may be involved depend, in part, on the contingencies of the project itself. Conventional requirements techniques such as interviews and focus groups can provide users *views* about proposed technologies and work practices. Ethnographic fieldwork techniques may reveal the richness and complexity of collaborative work whilst at the same time allowing users to continue with their everyday routines. Projects that involved users in an iterative design process, developing prototypes that were evaluated by users *in situ* and that provided feedback to developers, reported very positive experiences of both user engagement and the approach taken. This may require securing a project member with some experience of usability evaluations.

Make use of major research events to secure user engagement

Where end user collaborators were not secured, various projects attempted to take advantage of major events such as a workshops, conferences or seminars to target potential user communities at design workshops or focus groups meetings. Where end users are globally distributed, they may be difficult to engage for any period of time. Key project workshops, or major research conferences are very useful for setting up focus groups and attracting potential users. Where there are time constraints, some projects have put on their own event and embedded a focus group within that.

Envisioning workshops and Designing User Experiences

Projects that made prototypes available early on to users in the development process profited from early feedback for design. In addition they were able to secure the engagement and commitment of users in a participative process. However, even where a prototype is not available or there is not a immediately obvious user group, various approaches have been developed to allow users to envision future work spaces early on in the design process (e.g. Bardram et al 2002, Buscher et al 2004), sometimes only using paper in an attempt to create a user experience (Ehn and Kyng 1992). This might go some way to alleviating the problem some projects have experienced where potential users could not see how the technology might benefit their work. In addition, many users may then become more committed to continuing their involvement.

Understanding the Context of Work

Related to the previous issue, projects that attempted to gain some insight into the context of the research work and the details of how participants collaborate in their daily routines seemed to experience fewer problems with user engagement. In addition, from the investigations, they had a firmer footing from which to design the technology and the evaluation strategies. They also had a starting point from which to assess the impact of the tools on the research activities and the scientific record.

Understanding the broader social and institutional setting of research.

Institutional dynamics may shape the development of the VREs in quite fundamental ways. It may be critical to the successful deployment of the technology to determine institutional constraints and how they impact upon researchers' work in different settings. For example,

in some settings it may be necessary to understand how trust develops and is sustained in professional activities in order to develop a system that does not undermine these relations. Thus, it could be relevant to understand what researchers are willing to share and why and what happens when that trust is broken. In addition, it may be necessary to understand researchers' aims and priorities. As Grudin (1988) identified, collaborative applications may fail because participants must put extra effort into making the system work that will not directly benefit them.

Conclusion

It is interesting to note that many of the findings reported by VRE project participants resonate strongly with issues previously encountered in areas such as Computer Supported Cooperative Work (CSCW) and Participative Design. Within early CSCW in particular, technological visions also focussed on the development of generic tools to support collaboration such as, shared whiteboards and shared meeting tools for research laboratories (Stefik et al 1987; Tater et al 1991). These early CSCW systems tended to support two different kinds of collaboration. First, a sort of unfocussed collaboration typified in groupware where the technology is supporting more than one user. Supporting users was a matter of providing greater access to each other and developing software that added some structuring to coordination. The second was a more focussed form of collaboration that attempted to support users doing the same task at the same time and coordination of activities was carefully managed through the software. Through the development efforts and evaluations of technologies in use, it was determined that what was really needed in order to understand and support collaboration was to investigate in detail how people interact and communicate with each other in a wide variety of settings (Kraut et al 1990). Rather than providing better connectivity to support collaborative work, or developing applications that are replicated on different systems, there was a turn to supporting appropriate collaborative activities. This led to an ongoing programme of research into topics such as maintaining awareness (Heath et al 2002) uses of public and shared displays (Goodwin and Goodwin 1996) and the ability to maintain multiple engagements in activities (Heath et al 1994). Findings from these studies may indeed be relevant to the development of VREs, though requirements perhaps may differ in terms of scale. Nonetheless, within CSCW, challenges remain in the attempts to define different types of collaboration that inform the design and deployment of successful CSCW technologies.

In participative design in particular there has also been a long history of methodological investigation to address the difficulties of user engagement. Various approaches suggest different forms of user involvement. For example, approaches associated with the Scandinavian School have developed techniques for involving representatives in particular design activities and also for participating in design themselves approaches (Ehn 1988, Kyng and Mathiassen 1996). Other approaches involve users through conducting ethnographic studies of users in naturalistic settings and presenting analyses in design workshops (Randall et al 1994). What has emerged are frameworks for understanding users' activities with a whole raft of technologies and approaches ranging from prototype development, envisioning technologies, video prototyping and the use of cultural probes (Gaver et al 1999). Yet there is still extensive work to be done in understanding appropriate forms of participation and how this fits into design activities, particularly in domains such as e-Research where the practices are so heterogeneous.

In this highly complex terrain, the introduction of VREs is by no means a neutral facilitator of research. In the very process of attempting to discover what a VRE should consist of, in the process of engaging users and eliciting requirements, aspects of research processes which either remained implicit, or to which researchers had become so accustomed that they had become transparent or non-intrusive, as well as researchers' attitudes towards them, suddenly emerge as aspects to be taken account of. The possibility of these being re-shaped or changed may be welcomed or rejected. Similarly, practices concerning sharing data, comments, interpretations, working papers and other research items, may become visible in the very process of trying to develop a technological system that will facilitate it, and along with them the institutional power relations in which they are embedded.

The process of designing and developing VREs is still at an early stage, and many issues still remain unclear. Requirements gathering processes in this domain are unlikely to leave the terrain unaffected; if successful in terms of the installation and use of VREs, it is likely that they will create users for technologies as much as create technologies for users. In this sense, more opportunities arise for the shaping of VREs by also securing the active involvement of peripheral communities in order to secure their perceptions and interpretations of VREs (Grint & Woolgar, 1997). In this way, the successful co-evolution of VREs and the research communities they are designed to support may be increased.

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