Embedding e-Science Applications

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ABSTRACT

e-Science is an innovation process: both technical (distributed high performance computing, storage and visualization) and social (complex multi-organisational, multi-disciplinary interactions amongst academic institutions, government bodies and industry partners), and more specifically, for the purposes of this dissertation, a collaborative design activity that engages scientific communities in the very specific social innovation process of reorganising and renegotiating their communities to enable digital collaboration environments for research.

The research objective is to address how best to coordinate the embedding of e-Science technologies into workplace settings using novel design methodologies such as multi-site ethnography, participatory design and the use of collaboration tools with Access Grid. The research will explore challenges for both the management and design of distributed technology projects and focus particularly on requirements and design activities within a project's life cycle. The dissertation's research outputs will provide guidelines and recommendations for engaging scientific communities in the co-design of e-Science applications.

Keywords

Workplace Studies, Multi-site Ethnography, Participatory Design, Software Development, e-Science.

1. INTRODUCTION

Embedding technology into work settings can be a complex and disruptive process. Its introduction into a domain requires that a new system be inserted into or beside pre-existing systems and work processes. Traditionally, technology projects have been oriented in such a way that one of two outcomes may occur, either pre-existing systems and processes adapt by modifying procedures and practices to accommodate the workflow of the embedded technology or the pre-existing systems and processes technically cannot or culturally will not adapt and the new system is removed from the environment. At this juncture technology adoption is designated as either a success or failure. A much cited report [3] has shown that successful technology adoption has been closely associated with a high level of user involvement during the design process.

This research seeks to understand how best to harmonize the introduction of new systems into pre-existing work, cultural and organisational practices and will provide recommendations for the incorporation of novel design methods into project software development processes. Research outputs will provide methods that may lessen workplace disruption and encourage an increase in the potential for uptake of embedded technologies. To achieve this, the software development process and in particular, requirements and design activities of e-Science projects are examined to gain insight into how these activities support an understanding of a domain's context including both the researchers' work & cultural practices and the organisations' internal & external policies.

2. COLLABORATION IN DESIGN

To begin this investigation a retrospective case study of a flagship UK e-Science project, eDiaMoND[1] has been conducted to understand the issues and challenges that a project encounters in the design of applications.

Broadly stated, the eDiaMoND project was to enhance work practices within the UK National Health Service Breast Screening Units (BSUs) by applying distributed grid technologies to the medical field of breast screening. The system would allow radiologists to share mammography images through a grid infrastructure where they could collaborate in distributed breast screening work across the UK. Four core applications would be developed: a database of mammography images, and screening, training, epidemiology and research applications [5].

2.1 Methodology

This retrospective case study required that data collection be limited to interviews and document analysis. Case study method [5] has been applied to data collection activities. Nine semi-structured, ethnographically informed [2] interviews were conducted that focused on project members descriptions of collaborative design activities within the project. Patterns where identified from their descriptions [1], which highlight the issues and challenges that emerged during the design process. Project documentation was also analysed including; the project proposal, requirements and project management documents.

2.2 Preliminary findings

This section broadly highlights six key findings from the eDiaMoND retrospective case study.

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[1] http:// www.ediamond.ox.ac.uk

2.2.1 The project vision

Only when requirements and usability activities were initiated did it become apparent that clinician work practices would need to be modified to conform to the specifics of the proposed vision and technical solutions [5]. However, it was difficult to incorporate these findings into the design process because of three main constraints; pre-defined technical goals needed to be fulfilled; fixed start and end dates for usability activities; and internal project pressures on its members to develop working prototypes that could be demonstrated at conferences. Developing solutions to pre-defined technical goals took priority over refining what could have been a malleable project vision that incorporated the findings specific to the work practices of radiologists and BSUs.

2.2.2 Constituencies of infrastructure

There are many interested organisations and individuals associated within an e-Science project including: the target domain, research councils, academic institutions, virtual organisations, researchers, application developers and system administrators. And as e-Science projects mature, others will have an interest such as schools and the general public.

For this case study, interviews with application developers were initially conducted to understand how the software development process supported their level of engagement with clinicians. Developers turned the discussion around by asking the question 'usability for who?'. What followed was a discussion of infrastructure usability with developers describing the difficulties of integrating their tools into a series of infrastructural standards and APIs[2]. According to application developers, the design of infrastructure can have implications for how applications can be designed, because they must take into account the workflows and constraints built into infrastructure components.

2.2.3 The software development model

The software development model constricted efforts to involve users and developers together in co-design activities. This could be attributed to the project plan, which did not explicitly support these activities. The project followed a work package structure that was transposed from the proposal, carried into the project plan and on to the software development process. The work package structure implicitly supports a Waterfall software development model, which consists of five sequential stages: requirements, design, implementation, verification and maintenance.

2.2.4 The role of documentation

Requirements documents are useful for high-level definitions and organisational accountability but when the contingencies of the situated practice of design commences these documents are at times unable to provide developers with the guidance needed to deal with dynamic design situations. The use of documents requires bridging work from requirements engineers to communicate user requirements, and translation work from developers to come to an understanding of how document descriptions can be transformed into technical designs.

[2] Application Program Interfaces are pre-define functions that enable communication between software components.

2.2.5 Software development culture

Tight timescales, pressure to develop demonstrator tools and technical complexity created an environment in which developers worked under stressful circumstances that required them to produce solutions quickly. In such a situation requirements analysis activities were positioned as a support for technical design and not necessarily as facilitating engagement with clinicians in co-design activities.

2.2.6 Usability isn't enough

Software development is a complex arrangement of individuals, organizations and processes. Because of this, e-Science project partners need to expand their conception of the development process to include concerns beyond the operationalization of tasks and user interface design. Although extremely important, it is not enough to evaluate applications at the interface to test for usability. This case study has found that it is also necessary to consider the embedding of applications by taking into account the concerns, work practices and cultures of all project participants.

3. CONCLUSION AND FUTURE WORK

Further case studies will be conducted within the UK e-Science programme. The design of applications will be examined more closely by providing descriptions of current e-Science software design practices to gain an understanding of the social processes involved in technology development. Also, if case study projects express an interest, research interventions will be introduced to the software development process and would include the introduction of novel methods for requirements and design such as multi-site ethnography using Access Grid enabled tools and participatory design practices using novel applications that incorporate the use of recorded log file and video data. These novel techniques would then be gauged for their effectiveness in engaging scientific communities in the effective co-design of e-Science applications.

All further work will contribute to the development of guidelines and recommendations to encourage engagement with scientific communities in the co-design of e-Science applications.

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