

Field studies of Requirements Engineering in a multi-site software development organization: research in progress

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Abstract

In this paper we report on our ongoing research into Requirements Engineering practices in a large multi-site software organization. The findings of a field study conducted at the company's site in Australia are presented first, as insights into the current state-of-the-art in RE practice. Characteristic to this company is that the diverse stakeholder groups are scattered along several geographical locations: USA, Europe, Australia, New Zealand and Asia. An analysis of key areas that need improvement reveals that geographical and cultural difference may have an impact on project communication and coordination, and knowledge management during Requirements Engineering. Consequently, a more focused empirical investigation is proposed as the next step in our research, to identify the impact of geographical distribution on the Requirements Engineering practices in this multi-site development organization.

Keywords: RE practice, field research, multi-site development organization

1 Introduction

Global software development is an emerging phenomenon that has attracted an increasing level of interest in Software Engineering research in recent years (e.g. [6,7]). Seeking lower costs and access to a global resource pool are main factors that accelerated the globalization of software development. As a consequence, the communication of customers and developers is taking place in geographically distributed structures [8]. In Requirements Engineering (RE), the negotiation of constraints on software development is an important issue, becoming critical in multi-site organizations that cross national and cultural boundaries.

In particular, research in software engineering has turned its attention towards gaining an understanding of the factors that contribute to the success or failure of virtual corporations. Findings of empirical studies [8] indicate that project communication and coordination across sites are two of the critical problems in global software development. Thus it is becoming important to understand the impact of such problems on the management of requirements in distributed software development.

In this paper we report on our empirical study of RE practices in a multi-site software development company that has stakeholder groups scattered across five continents. The research method is field studies that investigate RE practices in this software company. In the Requirements Engineering literature, field studies of industry practice are both rare (e.g. [2,5,9]) and invaluable in providing empirical data on how Requirements Engineering is performed in practice.

To maintain confidentiality of information, the names of the company and its software product are fictitious, and will be referred to as Global Development Systems (GD Systems) and its product under development Business Application Environment (BAE, pronounced 'Bay'). An initial assessment of the RE practices at GD Systems was conducted in the first half of 2000, in Australia, as a response to the recognition on the part of the company's management of problems in the requirements process. Following a description of the study method in Section 2, context information about GD Systems is presented in Section 3. This outlines the company's geographical distribution and the Requirements Engineering practices at the time of the empirical study. Findings of the field investigation, in the form of key problem areas, are presented in Section 4 as

insights into the Requirements Engineering practice and the problems that software industry is facing.

These findings suggest a number of problems due to geographical and cultural differences between different sites of the company. Therefore the paper concludes with proposing a more focused study at GD Systems, to investigate the impact of geographical distribution on the Requirements Engineering practice in this multi-site software development organization.

2 Method of study

Two of the authors were approached by the GD Systems management in Australia to carry out a critical assessment of the current RE processes within the company, and to offer strategies for improving these processes. A field study was carried out over a period of six weeks, in the form of interviews with appropriate project stakeholders and inspection of relevant documents.

The stakeholders interviewed included the Project Manager, Project Lead, Engineering Manager, Quality Assurance Manager (all located in Australia) and a representative of the Customer Support Group (located in Europe) responsible for the communication with the European customers. Each interview lasted between one and two hours; the interviews were taped and later transcribed and summarized. Some of these stakeholders were later contacted by email for clarification purposes. The report detailing the findings of the assessment at GD Systems was submitted for validation to the Quality Assurance Manager and feedback was elicited.

3 Study findings: Requirements Engineering practice at Global Development Systems

The field study investigated the RE practices for BAE. This section begins by detailing information on the geographical distribution of stakeholders involved in the product development, followed by a description of the types and sources of requirements, and the various activities during the RE process at GD Systems. This information is also graphically illustrated in Figure 1.

3.1 Geographical distribution

GD Systems is a multi-site organization in which the product management, development and customer groups are scattered across five continents. In the development of BAE, the process involves stakeholders from USA, Europe, Australia, New Zealand and Asia, as illustrated in Figure 1 and outlined in the following:

1. Marketing Team (MT) is located in USA and Europe; the communication with the management and development groups in Australia and New Zealand occurs via email messages, teleconferences and exchange of documents. Biannual user group meetings are held with system users at locations world-wide.
2. Engineering and Technical Management groups are located in Australia and New Zealand; they maintain electronic communication and teleconferencing calls with the Marketing Team in USA and development groups at other Australian sites; informal communication occurs with the co-located development and support groups in Australia.
3. Product Development and Support groups are located in Australia and New Zealand; informal communication is maintained within the same sites in Australia and electronic communication or teleconference calls with the Engineering and Technical Management in Australia.
4. Customer Support Centers are located in USA and Europe; communication with customers and end-users is maintained via phone calls or face-to-face meetings. Problems, defects and enhancement requests (ERs) are entered in the company's in-house developed database.
5. Customers and product users, are located world-wide. Feedback is provided to the Marketing Team through Customer Support Centres. Besides biannual interaction with the Marketing Team – through user-groups, the customers have full access to the in-house database to report problems, defects and change to enhancement requests

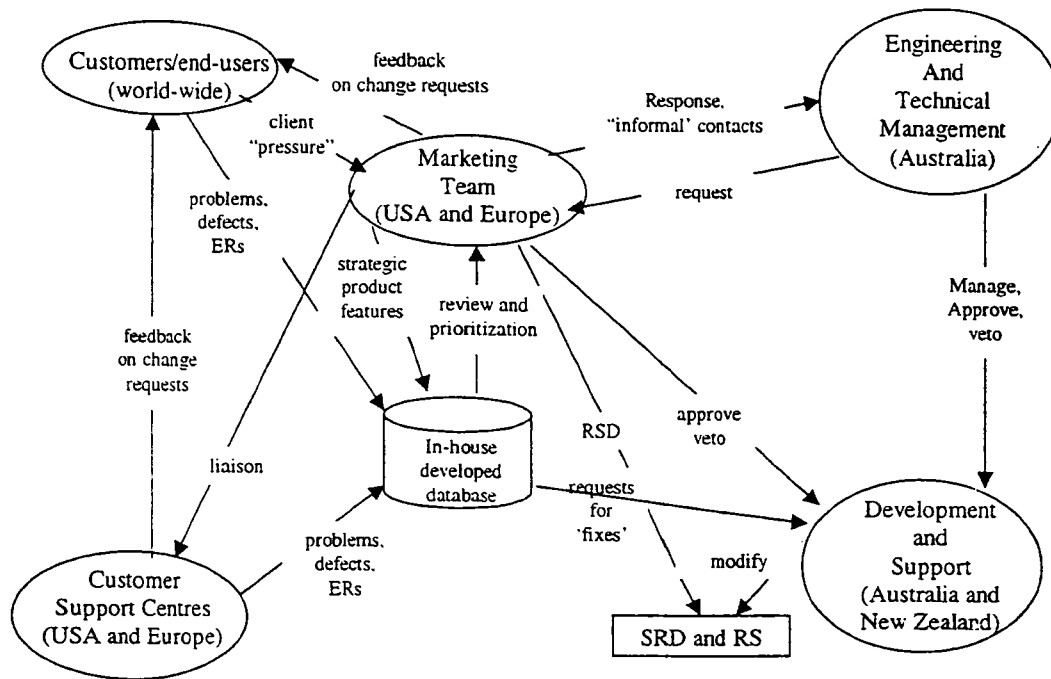


Figure 2. Geographical distribution of stakeholders and Requirements information flow in the development of BAE at Global Development Systems

3.2 Types and Sources of requirements

There are essentially three types of requirements that arise during the RE process for BAE:

1. Requirements formulated by the Product Marketing Team. These are mostly strategically directed requirements and are typically one line expression of marketing intent. These requirements are analyzed, elaborated and documented by the Engineering and Technical Management groups in Australia. Further, these requirements are generally validated through interactions with marketing staff in USA and Europe.
2. Requirements formulated by customers world-wide. These include tactical requirements, modifying systems features and also requirements hidden in bug reports (i.e. defects). These requirements are reviewed by the marketing group and eventually communicated to the development groups in Australia and New Zealand. They are entered on the in-house database.

3. Requirements defined by the Engineering and Technical groups in the Statement of Requirements Document. These arise most often from a technical standpoint, i.e. having to do with new platforms (such as NT), new advances in technology, a new DBMS or MS Windows release, or new compilers.

3.3 RE activities at GD Systems

The following are the activities that typically represent the RE processes associated with a new release of BAE software product:

Preparation of Statement of Requirements Document (SRD)- Product Group Marketing Team is responsible for collecting and analyzing inputs from the marketing divisions, development organizations, targeted customers and other appropriate sources. These sources include change to enhancement requests that are entered on the in-house database by GD Systems customers as well as staff at Customer Support Centers. The Marketing Team sends the requirements in many ways (e-mail being the written media normally, or as minutes to conferences with senior management in Australia). The engineering staff in Australia analyses and complements this list of requirements with other technical requirements and creates the SRD. The

Marketing Team determines the delivery date based on their analysis of what is in the SRD.

Derivation of Requirements Specifications (RS) - The RS is derived from the SRD developed in Australia in accordance with the list of change to enhancement requests provided by the Marketing Team, by a process of elaboration, and typically through several rounds of negotiations.

Approval of RS - The RS has to be approved by GD Systems senior management. This includes people from Marketing (USA and Europe), and the Quality Assurance Manager and Engineering Management (Australia). However, for a major release there are too many approvers of the requirements specification. This results in long delays in development and in the prior approval of the RS. For example for the current release of BAE, there were *circa* 18 months of negotiation before the RS was approved. Moreover, although the number of approvers from the Marketing Team for major releases of software is only a small fraction of the whole list of approvers, their influence on what gets approved in the RS is far greater.

Impact analysis, feasibility and estimation - Investigation into the feasibility of requirements is performed during RS elaboration. At this stage a feature proposal document is prepared. This is inserted in the "technical response" part of the RS and includes an initial close estimate of the size of what needs to be done.

3.4 Key problem areas

The analysis of how these activities are performed revealed a number of 'problem areas' in the Requirements Engineering practice at GD Systems. They represent significant departures from what is generally accepted as recommended 'good practice' in Requirements Engineering (e.g. [9]) and are outlined below. Their order is not significant, and it should be noted that these problem areas are, of course, not necessarily independent of each other.

- **Communication:** Clearly, a complex management communications network exists (see Figure 1), which necessitates informal links in order to maintain reasonable rates of progress. Development/support staff have no meaningful communication links with the customers/users. Not only the entire communication is through the Marketing Team or through the Customer Support Centers, but also there is a lack of regular interaction between the different parties [customers, marketing, development, support etc]

that make up the product 'team'. This results in software developers in Australia and New Zealand lacking a full understanding of the business needs and practices of users world-wide, and their perception of the user requirements is largely based on what has been communicated to them by the Marketing Team (from USA).

- **Planning:** Marketing undertakes an initial assessment and planning, and generally finalizes *de facto* target dates. During this process there is consultation with the Development Group. In the later stages of development the Marketing Team still reserve the right to change priorities with respect to late changes.
- **Management:** At GD Systems the final say on priorities lies directly with Marketing, rather than being consensus based). Frequently, management staff are forced to rely on informal channels of communication for resolving issues if excessive schedule slippage is not to occur.
- **Review Processes:** These are, in general, complex, potentially adversarial, time-consuming and usually divorced from any meaningful customer involvement. The review processes are not formally defined or monitored and they are generally poorly managed and inefficient. The timing of review processes is far from conducive to the effective scheduling of development processes. Review related decision-making is impeded because of the lack of some form of prototyping of critical functionality/features being undertaken as part of the overall review process. The process is cumbersome because of the number of 'sign-off' authorisations required.
- **Validation:** End-user based validation is non-existent. Eventual communication with customers regarding proposed fixes and features is cursory at best.
- **Prototyping:** The overall process is very much 'waterfall' and fails to take advantage of the significant benefits that a more prototyping based approach would bring.
- **Traceability:** Any useful traceability, e.g. RS-to-customer or design-to-RS, is close to non-existent. This inhibits the undertaking of effective impact analyses, for example during planning and when requirements change.
- **Tools:** There is no significant tool support, other than very basic document (e.g. ER, Problem Report, Statement of Requirements) databases. No specifically requirements management oriented tools are utilized.

These findings suggest that the geographical distribution of relevant stakeholder groups may have an impact on how requirements are managed at Global Development Systems. In the remaining of the paper a more focused empirical investigation at GD Systems is proposed as the next step in our research, to identify the impact of geographical distribution on the Requirements Engineering practices in this multi-site development organization.

4 Requirements Engineering in distributed structures

The extent to which geographical and cultural distance within the company affects how requirements are communicated, analyzed, documented, negotiated and managed is becoming an important research topic in Requirements Engineering. Previous research on requirements negotiations in geographically distributed structures has found an impact of geographical distance on requirements activities [3,4]. Results of a controlled experiment of requirements negotiations in distributed structures suggest that the communication of stakeholders from physically separate sites was more effective than face-to-face meetings, in that the physical distribution of stakeholders was in fact more conducive to a more focused and rational approach in the negotiation. It has also been noted that these findings need field validation in order to gain confidence in the results.

In particular, research questions that become relevant in the context of this organization include "Among the identified key problems, which one is most influenced by geographical distribution?", "What is the actual impact?", "What are potential solutions to overcome such problems?" and "Are there any aspects of the distributed communication that in fact are beneficial to requirements activities?"

The second author has already started a case study with the goal of conducting the more in-depth analysis at GD Systems. Her active participation in the project, a new version of BAE software, was granted at GD Systems in July 2001. The company welcomed her into the organization by providing an office and access to all of the relevant stakeholders, and by granting full involvement in the project. Data will be gathered through participation in all Requirements Engineering activities and meetings, participant observation, semi-structured interviews, informal interviews, and document analysis. Based on the preliminary insights presented in this paper, a number of relevant dimensions of the issue of requirements management in global software development become relevant, as outlined below. It is, however, important to note that the exploratory nature of

the investigation implies that other aspects related to geographical distribution in the project may emerge as relevant during the study; the issues presented below are also intended to foster discussion during the workshop.

- One dimension of the problem is the **communication** among the management, development and customer groups in the project. Software development requires much and effective communication in the early stages, when a clear formulation of business, marketing and technical requirements is critical. Whereas in traditional software development the management and development groups are physically co-located in the same building, and face-to-face meetings are more easily enabled, at GD Systems these groups are situated on three different continents (USA, Australia and New Zealand) and the communication channels are predominantly limited to email messages, teleconferencing calls and document exchange. The study findings presented in this paper revealed that it is most often that business and marketing requirements are elicited, analyzed and communicated by the management in USA to the development sites in Australia and New Zealand and, although there is considerable negotiation and refinement, there seems to exist a *de facto* 'wall' – cultural and geographic, which makes effective planning almost impossible.

Also, the validation of requirements by the management group at the Australian sites with the marketing staff in US is not a highly structured process and reviews are generally very time-consuming due to different geographical locations and the number of people involved. The slow process of approving the requirements specification suggests an obvious consequence of this impoverished communication between relevant stakeholders. As mentioned above, for the release of the previous version of BAE software, there were *circa* 18 months of negotiation before the RS was approved. Moreover, there is a lack of direct communication with the customers and in particular with the system end-users, which may be the determining factor in not using any prototyping techniques. The question that emerges is, "Is it a strategic decision or something that is impeded given the geographical distance?"

One aspect that emerges as relevant here is the field validation of the results found by Damian et al. [3,4], that suggest that the use of videoconferencing-based systems created a more conducive medium for the negotiation of requirements. Different communication channels (email, teleconferencing or videoconferencing calls) could be investigated as

part of the proposed research and not only identify whether there is a continuity of the laboratory results (with regard to videoconferencing) in the field, but also explore the suitability (limitations or opportunities) of other multimedia communication channels for requirements negotiations.

- Another dimension worth investigating is the **cultural difference** between the members of the project team. Cultures differ on many critical dimensions, such as the need for structure, attitudes toward hierarchy, sense of time, and communication styles [8]. The software development projects at GD Systems require the close collaboration among management in Australia, senior management and **marketing in USA and Europe**, and customers worldwide (e.g. Japan). Teleconferenced meetings are held and email messages and documents are exchanged between individuals who often have not met before and the different attitudes specific to particular cultures may have an impact on decision-making outcomes.
- **Knowledge management** is also recognized as a challenge in distributed structures [8]. Poor documentation can cause ineffective collaborative requirements management. The findings of the present study suggest that the requirements documents contain requirements from different sources; there are inputs from the management in USA who communicates business and marketing requirements, and which get refined into technical requirements at the Australian sites. Similarly, the customers are updating the requirements in-house database with new feature requests. At the same time, however, the lack of meaningful backward traceability, such as RS-to-customer and design-to-RS indicates an ineffective use of knowledge of requirements. An important question that arises is to what extent this is caused or exacerbated by the geographical or cultural distance between the relevant stakeholder groups.

As mentioned previously, dimensions of the issue of geographical distribution in software development may be at the root of the key problems presented in Section 3.4. It is the goal of the proposed research field study to identify the impact and its results will be presented in future reports of our research.

5 Conclusions

Requirements Engineering is gaining an increased recognition as a success factor in software projects and more evidence about the state of the practice in RE is needed to understand the issues that software industry is facing in managing requirements. This paper discussed

the findings of a field study that investigated the RE practice at a multi-site software development company and proposed a continuation of this research with an emphasis on studying the impact of geographical and cultural distances on how requirements are gathered, analyzed and negotiated. Through such a field study, a better understanding of the factors that contribute to the success or failure of requirements management in distributed development structures is sought.

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