Augmenting an Existing Software Development Process with a Team Building Activity: A Case Study

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Abstract
The task of developing software systems not only requires technological aspects but also, and more importantly, human aspects. Here, we argue that every software method/process ought to support the human aspects of software engineering, in terms of 'working teams', as well as the technological aspects. Consequently, we proposed some new process fragments to augment an existing process framework for software development specifically to be able to support the human side of software development that bring together individuals to achieve teamwork for a common purpose. We first discuss the concepts of working teams and team building followed by an investigation of some of the weaknesses with the current software methods concerning the degree of support for the human side of software engineering with particular emphasis on working teams and the team development lifecycle. An empirical study, using Action Research (AR), with a governmental body in Australia was then executed in order to test and validate our theory of augmenting the OPEN Process Framework (OPF) with a new team building activity and a number of tasks for enhancing teamwork. At the end of our longitudinal study we have witnessed a major and successful work culture change that been achieved at our study organization as a direct result of their adoption and diffusion of the proposed OPF that was augmented with new support for the human aspects of software development.

Keywords: Method Engineering, Human Factors, Working Team Development

1 INTRODUCTION

The concept of working teams has become an important concept in modern organizations, including those developing software. Work groups or working teams have always been critical for organizational performance and effectiveness (Roberts *et. al,* 2005). Working teams originated as a solution for many organizational challenges including the need to boost productivity, enhance performance and improve quality. Working in teams brings together and utilizes skills and talents of individuals in order to achieve objectives for a common purpose.

In the context of software development (SD), and particularly in published methodological approaches to object-oriented software development, issues relating to teams have been largely ignored. Certainly some approaches have representations of individuals and the roles they play (e.g. Kruchten, 1999) and even some indication of possible team names (e.g. Firesmith and Henderson-Sellers, 2002) but there is no discussion in the software engineering/information systems literature of how OO-focussed software development teams are created, how they mature and how they succeed or fail. In this paper, we take the theoretical propositions of Serour (2003) and Dagher et al. (2004), developed using non-OO literature such as the management theories of Belbin (1981; 1993; 2000), and test them empirically using data from a software development section within one of the New South Wales (Australia) government departments.

In Section 2, the topic of working teams and team building is discussed, followed by a summary of software methods illustrating their weaknesses in contributing to working teams. The investigated software methods are of two types, being 'formal' or 'heavyweight' and 'agile' or 'lightweight'. However, instead of creating a new method with people support, we have chosen to enhance an existing method-engineering (ME) based process framework, that of the OPEN Process Framework

(OPF) (Graham *et. al,* 1997; Henderson-Sellers et al., 1998; Firesmith and Henderson-Sellers, 2002). In ME (e.g. Kumar and Welke, 1992; Brinkkemper, 1996; Ralyté and Rolland, 2001), *method fragments* are identified, stored in a methodbase or a method fragment repository and then used, lego-fashion, to construct full lifecycle, industrial-strength software development methodologies. To do this successfully, there must be full support in the range of method fragments for team creation, team building and a team focus for the duration of the software development. One goal of this paper is to identify any missing fragments and then to evaluate this approach empirically. In that context, we extend the preliminary suggestions for team-focussed method fragments proposed by Serour (2003) and Dagher et al. (2004) prior to industry evaluation.

2 TEAM SUPPORT IN CURRENT SD METHODOLOGIES

2.1 Working Team and Team Building

Before we attempt to understand the importance of team building, we need to comprehend the notion of working teams. The term '*team*' or '*working team*' is a concept pertaining to the task of getting a number of individuals with diverse skills working together towards a common purpose. Chowdhury et al. (2002) define a working team as a collection of individuals thriving to accomplish a common goal. Similarly, Katzenbach and Smith (2003) define a working team as a number of people dedicated to a common purpose who are mutually accountable for the work they produce. Based on these definitions, we simply define a working team here as *a number of individuals with diverse skills and knowledge working together towards a common purpose to achieve a common goal for a given project.*

As well as studying how existing teams operate, the topic of *team building* or *team development* is also of significance. Tuckman (1965) claims that the team building activity is based on a number of consecutive stages – initially four, but later adding a fifth (Tuckman and Jensen, 1977). These five stages (Forming, Storming, Norming, Performing and Adjourning) create a team development lifecycle. Janz et al. (1997) define team development as a measure of how well the transition to teams, as a strategic initiative, has taken hold in the changing organizations. They also accentuate the significance of team development in noting that, while a team's self-sufficiency may lead to an increased level of satisfaction and motivation, the level of team development and an organization's learning capacity may be finally more important in achieving work outcomes. Ciaburri (1998) asserts that a team requires information skills and thinking power, developed through team building activities. Indeed, an effective team's foundation (selecting team members, team review and team consultancy according to Adair, 1986) is centred on the activity of team building.

2.2 The OPEN Process Framework and Team Building Support

The OPEN Process Framework (Firesmith and Henderson-Sellers, 2002) is a flexible object-oriented software development framework consisting of a repository of method fragments, each of which is an instance of some concept in the underpinning OPF metamodel. Of the various kinds of method fragments in the repository, here we focus on the Producer fragment. A Producer is defined as being "responsible for creating, evaluating, iterating and maintaining Work Products" (Firesmith and Henderson-Sellers, 2002). Producers include people who are assigned roles individually and then often grouped into teams in order to complete the work units to produce work products.

Access Current State (**newly proposed**)
Assess Staff Capabilities (**newly proposed**)
Choose Project Team (**Existing**)
Identify Project Roles and Responsibilities (**Existing**)
Assign Roles (**newly proposed**)
Develop Education and Training Plan (**Existing**)
Assess Resources (**newly proposed**)

Develop and Implement Resources Allocation Plan (**Existing**)
Enhance Teamwork (**newly proposed**)
Review Progress (**newly proposed**)

Table 1 Team building tasks proposed for incorporation into the OPF repository

Examination of the OPF repository shows some existing support for working teams through the high level process fragments in terms of teams, team roles and team structure of a software development. However, it does not specify any *team building* mechanisms. Therefore, in addition to pre-existing fragments supporting team structures, new work units (activities, tasks and techniques) have been introduced into the OPF repository to support team development. Some of these were discussed by Serour (2003) and others by Dagher et al. (2004). In the latter report, one new activity (that of Team Building) was proposed along with some supporting tasks (Table 1). Here, we examine these proposals using empirical data from an Action Research study in local industry.

3 EMPIRICAL EVALUATION

With the purpose of empirically evaluating the proposed additions to the OPF repository, an Action Research (AR) study was undertaken over a period of almost two years with a government department within the NSW government in Australia (called GovDpt hereafter to retain anonymity). The main focus of the research was, firstly, testing the applicability and effectiveness of the proposed team building activity as a new addition to the OPEN Process Framework and, secondly, the examination of a set of effective key factors that surround the team development activity and their impact upon working teams during the different stages of team building. These factors include culture change, resistance to change, readiness and willingness to change, leadership and management commitment and support.

3.1 Background of the GovDpt Project

The case study organization is a well-established governmental department within the NSW state government of Australia that provides public services to more than four million customers in the communities of Sydney and other cities. It has around 3,500 full time staff members in general and about 120 personnel in the IT section headed by the IT manager and made up of a mixture of business and system analysts, developers, testers and providers of customer support. The 120 IT personnel are organized in different teams working on different projects. For example, the online team, which is in charge of all the web development, has 18 members in total. These were divided into 4 different subgroups involved in different tasks such as requirements engineering, coding, documentation and testing.

The main focus of the IT section is developing and maintaining software applications for other sections within the department including human resources, product management and product monitoring. Some years ago, a decision was taken to transition the department to an e-government environment and provide the community with some online services such as paying bills, submitting general enquires and viewing public reports. The compelling reason for this decision is the need for the department to remain competitive in the online public services arena. A new IT manager was appointed to lead the IT organization through their endeavour to change their culture and upgrade and enhance their capabilities to be able to provide online effective products for ultimate customer services.

3.2 Empirical Evaluation and Action Research

Rather than assisting our study organization in a consultancy mode, we persuaded them to be part of an ongoing research project using the action research methodology. Action research is a research

methodology originally used in education research and more recently in information systems research (Avison et al., 1999). Using action research (AR), the researcher proposes a hypothesis and then tests it in an industrial setting, acting as both external observer and internal team member. AR was chosen by our university research team since AR offers the ability of the researcher(s) to contribute both to the practical concerns of people in their immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework (Rapoport, 1970; Lewin, 1974; Susman and Evered, 1976; Hult and Lennung, 1980; Argyris et al., 1985; Reason, 1993; Lau, 1999). The action research methodology focuses on the collaboration between researchers who are aiming to test and/or prove their theory and practitioners who are aiming to solve their immediate problem(s) and/or enhance their current work culture (Avison et al., 1999). In other words, AR has the dual aims of providing a mechanism for practical problem solving (Action) and for testing and enhancing theory (Research). Elden and Chisholm (1993) argue that the dual interest of AR provides a win-win scenario for both researcher and participants and plays an effective role in solving practical problems by increasing the understanding of a given social situation through the direct involvement of the researcher in an organizational change that can also positively affect future decisions and actions based on better understanding of the problem(s) at hand (Hult and Lennung, 1980; Avison et al., 1999). As a result, action research, as an effective qualitative research method, has been widely adopted and utilized for studies in many different disciplines.

In this project, the action researchers proposed a hypothesis that by deploying a software development method/process that is capable of supporting the human aspects of software engineering as well as the technological aspects the organization's work culture would be enhanced, leading to an increased level of organizational maturity in terms of software development and bring together individuals to achieve teamwork for a common purpose. Thus, the research project was established to introduce the concept of method engineering along with the adoption and utilization of the OPEN Process Framework in order to design and construct an organizational method augmented with human and technological support. Within this organizational context, researchers played the roles of co-practitioners in assisting the team members to change their present work culture of software development and introduce the new concept of method engineering. Additionally and during the course of this research projects, researchers carried out other roles in order to assist and support the study organization during their transition process such as:

- Provide adequate education and training on the new proposed concepts of method engineering and the process framework.
- Assist the online team to produce the required process fragments.
- Support the online team in implementing their new method in an incremental and iterative manner and also monitor their progress.
- Review and analyse comments and feedback for process improvement.

3.3 Project Initiation with the Team Building Activity

The research team utilized the OPF existing task of 'Choose Project Team' in order to select the most appropriate team to initiate the transitioning process. Consequently, the research team proposed the idea of starting the whole transition process by transitioning a small team (that is the online team) that was chosen to support the e-government transformation with the anticipation of extending this later to other teams, once initial success had been gained. As well as being more manageable, a small team has a higher chance of success, that success then positively influencing other teams. We call this technique "small wins" (Serour et al., 2002; Serour, 2003) – a technique that has proven to be very effective in changing people's culture and managing their natural resistance.

3.3.1 Accessing the Current State and Staff Capabilities

Understanding the current state of an organization is always an obligatory starting point for a successful change (LaMarsh, 1995). Assessing the organization's capabilities is one of the most

critical elements of self-examination to review its strengths and weaknesses. It is vitally important in plotting a course for the future (Kalakota and Robinson, 1999). This assessment includes the organization's software capability maturity level, individuals' skills and knowledge and resources.

The research team utilized the newly proposed OPF task '*Access Current State*' (Table 1) to identify and examine the existing work culture as an essential first step towards a successful change. Therefore, the first three meetings with GovDpt investigated the work culture in terms of the existing software process in place (if any), software development skills, tools and techniques and the team organization. Also, the new task '*Assess Staff Capabilities*' was used to assess individuals in terms of their skills, education, knowledge, experience and talent, assess team problems, identify their lack of knowledge, discover the existing barriers to team formation, and establish team mission and vision.

3.3.2 The Existing Culture and Necessary Changes

The Concise Oxford English Dictionary (1995) broadly defines human culture as the arts and other manifestations of human intellectual achievement regarded collectively as the improvement by mental or physical training. In particular, Palvia et al. (1996) define the culture of IT professionals as the set of values and practices shared by these members of an organisation involved in Information Technology activities including managers, developers and customers/end users.

The research team learned that the online team usually starts a new project upon receipt of a formal work request from their internal customers. Their projects are limited in size and scope - management calls them "*Tiny Projects*" (less than 20 working days and $50,000 budget). The existing process is to start with the receipt of a work request plus other requirements obtained through informal channels including phone calls, emails and/or verbal discussion with their customers. They usually produce an insufficient set of poor documentation e.g. a one-page text document using Microsoft Word, a few modelling diagrams (ER and DFDs) using Microsoft Visio and some sequence diagrams using Toad. They also use some predefined templates to create other documents such as work estimation and customer acceptance sheets. On completion, they deliver the final product to their customer for acceptance testing, often resulting in requests for some modifications.

During the above assessment task, it was decisively observed that the online team did not follow any method or process for developing software but, instead, every developer was free to choose a familiar way of doing their work by selecting their favourite techniques and tools. Developers had different skills and experiences, with some using non-object technology techniques such as data flows and flowcharts and others using object-oriented techniques, such as class and sequence diagrams, or a mixture of both technologies without any consistency or collaboration and little inter-team communication. They obviously lacked the spirit of working together as one effective team sharing the same vision and mission with their firm. As a result, projects were usually delivered late and, in most cases, over budget. Moreover, the lack of customer involvement was also a major drawback to the whole development process.

Based on the above observations and several recommendations from the research team, senior management consequently realized the need for an immediate solution to their existing software development crisis and recognized the need for the adoption and diffusion of new technologies and approaches to support and fulfil the new e-government requirements.

3.3.3 The Proposed Solution

The IT senior management along with all IT personnel and the research team created a strategic plan to outline the objectives and stages of the desired IT transition process in a totally collaborative manner. The major objectives were building an effective working team, changing the existing software development culture, adopting new technologies and providing IT personnel with adequate resources

and training to master the new e-government culture. A consensus by everyone involved was effectively and quickly achieved to target the following objectives:

- Formation of a working team to carry out the transformation process.
- Construction of a specific agile software development method using a method engineering approach and the OPF in an incremental and iterative manner.
- Adoption and utilization of the Usage-Centered Design (UCD) approach (Constantine and Lockwood, 1999) for designing the user interface of the new e-government applications.
- Adoption and utilization of a specific core set of the Unified Modeling Language (UML) (OMG, 2001) for modelling the new e-government applications.
- Enforcement of customer involvement over the full development lifecycle as a top priority.

3.3.4 The Transformation of Individuals into Team Members

As mentioned in Section 3.1, out of the total of the 120 IT personnel working for the study organization, the online team has 18 members in total. These were divided into 4 different subgroups involved in different tasks such as requirements engineering, coding, documentation and testing. It was clear that the 18 members were working in isolated subgroups as individuals without any intercommunication or collaboration between them. Therefore, it was apparent that the most challenging aspect of the '*Enhance Teamwork*' task (Table 1) was the shifting of their mindset from being individuals and transforming them into members of one team. The first step towards this transformation process was the attempt to change their existing culture of working in 4 isolated subgroups to form one single team with different roles and responsibilities for each member and working within sub-teams instead of subgroups. Initially, a few members showed some resistance to changing their existing culture for different reasons. Team leader (A) rejected the idea by saying "*our jobs are fairly small and so we don't need to work as one team. At the moment, I have 4 group leaders reporting to me. That works OK for the time being*". Another team member (B) opposed the attempt by saying "*our subgroup is only responsible for creating documentations and I can't see any need to work with any other subgroups*". Another member (C) from the testing subgroup expressed her view by quoting "*our job is to test other group's work and it is not wise to get involved in their work*".

It is worth noting that team members resisted the proposed culture change for some personal reasons:

- The uncertainty and apprehension of the new changes.
- Viewing the proposed changes as a personal threat to their existing job.
- The fear of not carrying out the proposed changes successfully.

The research team conducted a special session with the entire online team including their leader and manager to explain and discuss the proposed culture changes and also to analyze their uncertainty and fear. This meeting was a good starting point in managing the natural resistance to change by identifying what they were really resisting and why. By the end of this meeting, the team member started to see the value of working together as one team both in general and, specifically, during their attempt to transform to e-government.

3.4 Role Identification and Assignment

As a major step towards forming an effective team, project roles and members' capabilities must be defined and analysed in order to assign the project roles to the most capable and competent team members. Therefore, the existing OPF task '*Identify Project Roles and Responsibilities*' was used to define the project tasks, roles and responsibilities and the new task '*Assign Roles*' was carried out, with middle-level management and customers, to allocate these defined roles to the team members based on their capabilities. Indeed, it was observed that the early customer involvement helped the online team in clarifying a number of issues regarding their new process of developing software.

3.4.1 Signs of Success

An important observation made here was that the more people were convinced about their assigned roles the more they became committed to performing these roles with high morale. Team members showed their comprehension of their new roles and the importance of working as a team to achieve their objectives. For example, (D) showed their understanding of their project roles and the importance of working as a team by saying 'the assigned roles are not easy to achieve if we don't work together and help each other'. However, there are other, potentially confounding factors. For example, it was clearly noticed that people's resistance to change was mitigated, and in some cases eliminated, as a result of their feeling of having acquired a shared vision with their organization.

3. 5 Enhancing Teamwork

The use of groups or teams often comes at the cost of speed and in most cases increases the chances for conflict, power struggle and resistance to culture change that can get in the way of the organizational performance (Serour *et. al,* 2002). Thus, to attain the full development of an effective working team, team members require continuous observation and mentoring during the project life in order to identify any problems and/or conflicts that could hinder their progress and reduce their performance. Observation is also required to provide working team members with advanced understanding of the identified and assigned roles and tasks that each member needs to accomplish. The newly proposed task '*Enhance Teamwork*' aims to achieve those objectives. It is a major step for building working teams, spanning almost fully across the full team development lifecycle. It starts immediately after assessing the current organizational state and assigning project roles to team members. The major intention of this task is observing and mentoring the working team during the lifetime of the project in order to identify and resolve any problems and also to recognize and implement any improvements to enhance the effectiveness of the teamwork.

During the implementation of this task, the online team members gained further understanding of their roles and surrounding environment. Also, a number of effective teamwork key factors were examined to identify any conflicts and to provide further improvement that might have an impact on the online team's progress. Examples of these key factors are conflict of interest, resistance to change, communications, management support and resources, and leadership.

3.5.1 More Signs of Success

Following the various meetings with the online team and their middle management to further enhance their teamwork, team members were able to further comprehend and accomplish their allocated roles with their associated responsibilities. On the other hand, both project manager and team leader demonstrated their full understanding of the organization's objectives and goals and their awareness of the impact of the transformation process upon the IT department. Based on the new senior management decisions, project leaders had a degree of authority that made it easier for the online team to obtain the needed resources to ensure the success and continuity of the entire project. Decision-making was faster, effective and final. It was clearly observed that middle management played an active role in organizing and managing the transition teamwork.

3.5.2 Researchers' Observation

The observations of the researchers during this stage were more approving and encouraging as management continued to sponsor the project more effectively, the learning of the team continued and a more realistic understanding of the necessary transition and developing working teams were gained. It was also favourably observed that a mutual trust and consensus was established as a new quality of the new work culture. A great deal of consensus, trust and cooperation were instituted between the team members and between the whole team and their direct management and customers. Doubtless the

strong commitment and dedication of the IT senior manager had assisted the entire team in overcoming most of the problems the team encountered during this stage.

3.6 Performance Achievements

Following the principles of the "*small wins*" technique (Serour *et. al,* 2002; Serour, 2003), the research team initiated the culture change process in an incremental, iterative and parallel manner. The online team started the construction of a new agile method by addressing the Requirements Engineering (RE) activity as a major focus to engender everyone's involvement. An initial RE mechanism, using the use case technique, was introduced, as this was non-existent in the existing culture.

Towards the end of the first year, the online team in collaboration with the research team has created the first version of the organization's agile method. The new organizational method was successfully constructed using a method engineering approach with the utilization of the OPEN Process Framework. Due to the full and early involvement of everyone in the online team in the process of creating their own method, they gained a great feeling of ownership and sharing of values with their organization that further enhanced their participation and commitment towards the entire transformation process to e-government. In addition, the online team has successfully adopted the UCD approach for designing the user interface that was efficiently used in the first activity to design and produce effective user interfaces. Moreover, they selected an appropriate subset of the UML that was fully utilized during the activities of system and business modelling.

During the adoption and dissemination process of those new technologies, and in order to enhance the online team's acceptance, the research team, with management's consent, has organized a number of education and training sessions to provide the online team with in-depth knowledge and training on the selected subset of the UML language including use case diagrams, class diagrams and sequence diagrams. In parallel to the above activity, the UCD techniques were introduced to the online team in an incremental way for rapid acceptance and ultimate utilization.

3.7 Review Process (Introspective and Retrospective)

Evaluation is the stage during which appraisal is undertaken on teamwork and team members, with the team reflecting upon their achievements. As soon as the project is completed, the team dissolves to form another team or start a new project. Evaluation may be performed during the life of a project (Introspective) or at the end of a project (Retrospective: Kerth, 2001) or a combination of both. Evaluation is carried out through continuous observation and providing feedback to help the team reflect on its procedures and performance. As discussed earlier, team building, being an important issue, needs continued observation and feedback by the immediate leaders. Observing the team includes being up to date with the schedule, knowing their vision and obtaining skills that are required (Rohlander, 1999). In general, the major objective of the review process is to evaluate and assess:

- Team Performance
- Team Roles
- Communication channels
- Team collaboration

3.7.1 Reviewing Team Progress

During the transformation process of the online team, team performance was evaluated in terms of the successful completion of tasks and objectives such as forming an effective team and adopting new techniques and approaches. The newly proposed OPF task "*Review Progress*" was used to evaluate the performance of the online team throughout the transition process. It was observed that this review process proved to be a learning experience to almost all team members in gaining more understanding and developing new skills to perform their daily work. It was also noticed that the online team

achieved some important objectives including sustaining management support, improving team relationships, resolving any further team conflicts and enhancing team performance.

4. CONCLUSION

In modern organizations, people and team building should become the main focus for any organizational change since effective working teams can enhance teamwork and advance team performance. Here, we have focused on the importance of the human side of the software development process - previously been neglected by researchers and practitioners. We have outlined some of the weaknesses with current software methods in respect of the degree of support for the human side of software engineering with particular emphasis on working teams and the team development lifecycle. We have focused on methodology fragments for an ME approach relevant to teams and team building and sought new method fragments to augment the methodbase of the OPF. Through our empirical study with GovDpt, we have shown the practicality of the newly proposed team building activity, with its associated tasks. GovDpt has achieved a successful cultural change in building effective teams and working collaboratively to achieve their common goals. The IT department within GovDpt has achieved a successful technology adoption by its construction and utilization of an agile method for their software development to replace their old 'ad hoc' approach. They also adopted a new approach for effective design of their software user interfaces that enhanced the usability of all new applications. Moreover, the use of a core set of UML diagrams has eliminated people's resistance to change and enhanced their competence to carry out their jobs in the most effective way. In summary, based on our empirical observations and findings, the following is a list of lessons learned that other organizations can adopt and apply to advance their working teams:

- In the context of software development (and conceivably in other disciplines), human aspects are far more imperative and receptive than technological aspects. Technology alone is not enough unless it utilized by cooperative and effective working teams. Therefore, software methods/processes ought to support the human aspects of software engineering, in terms of 'working teams', as well as the technological aspects.
- Senior management must do everything in their capacity to support the human side of software development, bringing together individuals to achieve teamwork for a common purpose. Senior management must provide working teams with adequate resources and exhibit their commitment and dedication to any organizational changes to enhance people's willingness to participate and mitigate their natural resistance to change.
- To attain the full development of an effective working team, team members require continuous observation and mentoring during the project life in order to identify any problems and/or conflicts that could hinder their progress and reduce their performance.
- Working team members must be provided with advanced understanding of the identified and assigned roles and tasks that each member needs to accomplish

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