Project Web and Electronic Process Guide as Software Process Improvement

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Abstract. Software companies have to identify and manage numerous linked processes to function effectively. We describe how a medium-sized software company improved their software development methodology through implementing an electronic process guide. We discuss how involvement in creating an electronic process guide through process workshops influences the use of the guide over time. We have found that the workshop participators were more positive, and had a higher degree of use. Processes developed by the stakeholders themselves seem to be a perfect starting point when introducing a process guide. An evolutionary introduction of the guide created a high and continuous focus on software process improvement in the whole organization. We also found that integrating the existing administrative systems and tools supporting project work with the process guide increased its usefulness.

1 Introduction

Software development is a complex process involving a number of stakeholders, and activities. Software companies have to identify and manage numerous linked processes to function effectively. Process participants need effective guidance when process conformance is important, when a process changes frequently, and when new personnel join a project.

Traditionally, this has been the realm of large organizations, and the way of describing and communicating processes has focused on printed standards and handbooks. However, such handbooks are often of limited use as Software Process Improvement (SPI) facilitators, and especially so in small and medium-sized companies.

1.1 Electronic Process Guides

An electronic process guide (EPG) can be seen as a structured, workflow-oriented, reference document for a particular process, and exists to support participants in carrying out the intended process [1]. The potential of an EPG can only be realized

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when key capabilities are not only adopted, but also infused across the organization. This is complicated by the fact that there is considerable skepticism among software developers to learn from and adhere to prescribed process models, which are often perceived as overly "structured" or implying too much "control" [2]. Therefore, we cannot expect infusion of an EPG unless it is perceived as useful and easy to use in daily practice and consistent with the existing values, past experience, and needs of the software developers [2],[3]. Dybå, Moe and Mikkelsen [4] found that perceived usefulness is a fundamental driver of both usage and use intentions and, thus, that the prospects for successfully infusing EPGs will be severely undermined if they are not regarded as useful by the developers.

1.2 Process Workshops

One initiative to increase the use and benefit of an EPG is to involve the users in creating it. Participation has been one of the most important foundations of organization development and change [5].

Within the context of software development, the software developers and their first-line managers are the main experts on the realities of the company's business with respect to the day-to-day details of particular technologies, products, and markets. Therefore, it is important to involve all those who are part of the software process, and have decisions regarding the development of EPGs made by those who are closest to the problem.

Consequently, and in order to get realistic descriptions with accurate detail as well as company commitment in an efficient manner, all relevant employee groups should be involved in defining processes by using the process workshops [6] as a tool to reach consensus on work practice.

The process workshop can last from half a day to several days, depending of the complexity of the process, and the number of participants. It makes people discuss how they work – which fosters learning even before the process guide is available in the company. It also assures quality – the process guide is developed by people who know how to do the work; it does not describe how consultants or senior staff imagine the development processes to be like. More on how the process workshops described below were organized can be found in [5].

1.3 Kongsberg Spacetec

Kongsberg Spacetec AS ("Spacetec") of Norway is one of the leading producers of receiving stations for data from meteorological and Earth observation satellites. Since the company was founded in 1984 its products has been delivered to a number of clients around the world, with a current export share of 85%. Spacetec has expertise in electronics, software development and applications. 80% of the 62 employees in the company have a master's degree in physics or computing science.

At the start in 1984 the main task of the company was engineering through customer specific projects, and the main customer was the European Space Agency [7]. Because of this the ESA PSS-05 [7] software engineering standards were adopted. The standard follows the traditional "waterfall approach". During the 1990s the market situation changed, and a new kind of customer became increasingly

important. These customers were not interested in how the product was developed or how the quality assurance was performed. Instead of providing detailed requirements specifications they expected off-the-shelf products that could be delivered at short notice. In return for lack of uniqueness the customer expected a much lower price, so it became impossible to charge enough for a product to cover the complete development costs. This made it necessary to develop generic products through internally financed and managed projects [8].

1.4 Motivation

The work described in this paper is motivated by a research question as well as the needs for Spacetec to change their development strategy.

The motivation for the research was to understand how involvement in creating an EPG through process workshops influences the use of the EPG among project participants in a medium-sized software company. The core research question is:

How does the involvement in process workshops influence the use of electronic process guides over time?

In answering this question we focus on finding out if there is a difference over time among those participating in the process workshop and those who did not. The research question is described and discussed in detail in [9]. In particular, we are interested in examining if process workshop participants use the electronic process guide more in what we later will define as three stages of introduction at Spacetec.

To meet the requirements from the new market, Spacetec found that using their old engineering standard suited for large projects was perceived as cumbersome and did not emphasize aspects such as incremental and component development. In order to further strengthen the quality assurance focus, Spacetec became ISO-9001 certified in 1998. The paper based, document-heavy and highly manual quality system came under increasing pressure. It became impossible to follow the standards and even more impossible to do effective quality assurance on all projects.

The need for improvement became obvious. The new ISO-9001:2000 [10] standard demands a process oriented quality system, and to keep the ISO certificate, a process oriented system had to be implemented before December 2003. Spacetec decided to define a whole new system for the entire company [11].

2 Research Method

To investigate our research question and to achieve the improvement goals of the company, we used the participative research method *action research* [12] We have organized the research according to the five principles suggested by Davison et al. [13]. As for the first principle of researcher-client agreement, this research is done in a general project on software process improvement, where the company writes an improvement plan and the researchers write a research plan. The research plan gives an overview of what data was to be collected during the study, which included semi-structured interviews of users of the process guide and project web, usage logs and minutes from discussion meetings between the company representatives and the researchers.

We followed the action research model (principle two) proposed by Susman and Evered [14] in discussing the situation of the company, planning action, taking action, evaluating action, and finally specifying for learning. We went through three "evolutionary" cycles, one with the main focus on introducing an electronic process guide, one for constructing the project web, and a final cycle for integrating the project web with existing databases in the company, see Fig. 1.

The third principle of theory is satisfied in our research question, inspired by previous work on electronic process guides and the technology acceptance model. We analyzed the qualitative interview material using principles from grounded theory, in the tool Nvivo.

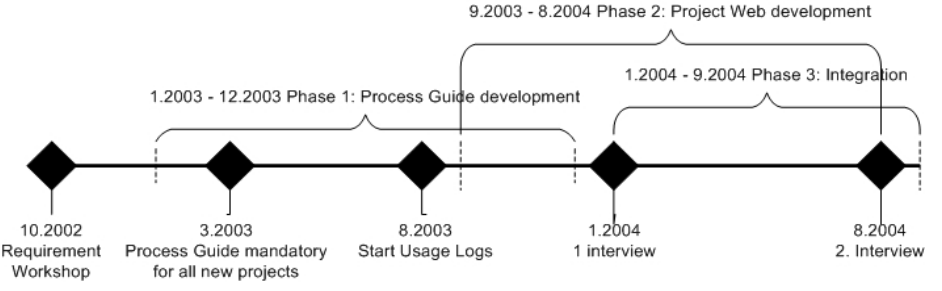

Fig. 1. Project timeline

The fourth principle of change through action is satisfied because of the actions taken prior to each of our cycles, with thorough assessments of the outcome of each cycle – through participation in six process workshops, gathering interview material, analyzing logs and discussing the usage of the web-based tool.

The fifth principle of action research deals with learning through reflection. This was ensured in the project through project meetings where researchers and company representatives discussed actions that were taken and analyses made by the researchers. For example, after the process workshops, we asked participants to comment on the way the workshop was organized, which led to changes in subsequent workshops.

3 Phase 1: The Electronic Process Guide

3.1 Diagnosing

Spacetec needed to improve and document their development methodology. This was important to meet the requirements from the new market, and to keep the ISO-9001:2000 [10] certificate. ISO 9001:2000 requires that processes are documented. Spacetec decided to develop and implement an EPG.

3.2 Action Planning and Action Taking

To get a flying start in planning the EPG, the software company Firm was invited to present their EPG for the quality department and representatives from the

management. Firm had involved their own developers in defining the process descriptions and developing the EPG software [15]. Inspired by Firm's experiences the following tasks were planned:

- An initial workshop defining existing project types, and to decide the format and most important requirements for the EPG
- A series of process workshops involving the employees
- A strategy for implementing the EPG on the company's intranet.
- Dates for interviewing the EPG users and a plan for usage logging.

Spacetec defined four main project types, and they chose "Product Development" - the most common one - as a starting point for the following process workshops. Product development projects were typically 1000-4000 work hours. Other project types were customer controlled development projects, delivery projects, maintenance projects, and studies [6]. After defining the project types, Spacetec defined the most important EPG requirements. In addition to easy access, ease of use, easy to maintain, and up to date, the process guide should provide:

- Descriptions of tasks for the most important roles in a project.
- Checklists for each main process.
- Templates for all documents to be produced.
- Descriptions of best practice.
- Access to project tools (e.g. a requirement and a bug tracking system).

In the first process workshop, "Product Development" was divided into four sub processes: "Specification", "Elaboration", "Component Construction" and "System Integration". "Initiation" was the focus for the second workshop. This process was defined to include "Offer", "Follow-up" and "Blast off". As the initiation of projects is an interface between different parts of the organization, it was important to bring together people from marketing, quality assurance and the development department.

After the two main processes were defined, Spacetec released the first version of the EPG. This is described in detail in [6]. While implementing and releasing the process guide, Spacetec completed 6 more process-workshops.

The workshops usually lasted half a day, had 4-6 participants (researchers not included), and over 20 persons (1/3 of the employees) from Spacetec participated in one or more workshops. The researchers acted as moderators and secretaries.

3.3 Evaluating

The development and infusion of the EPG was evaluated through feedback from users to the quality department, discussions in the project management forum, and through the ISO revision. The researchers got feedback from participating in the process workshops, studying EPG usage logs over 13 months, interviewing the users, and from discussing with the quality department.

The enthusiasm was high after the workshops. Spacetec found it important to give the workshop participants feedback through a running system, even if it was not complete, fearing that waiting would kill the enthusiasm. The early release also resulted in complaints on the user interface and how the information was structured.

Some users never gave feedback on the EPG. This could be because they did not have time or a suitable forum for discussing the EPG.

Studying the usage logs (Fig. 2) we found that the persons participating in the workshops showed a higher use of the process guide than those not participating. We logged the usage of all the 25 persons in the software development department. These 25 were divided into two groups:

1. Participants in one or more process workshops (8 persons).
2. Not participating in any workshop (17 persons)

50% of the persons in each group were project leaders in addition to software developers. Fig. 2 shows the average number of hits for each month per person. In phase 1 (month 1-4) the workshop participants had an average use of 15 hits per person per month, and the rest had only 2 hits. For the whole period the workshop participants had an average of 20 hits per person per month, and the rest had 5 hits.

The results from the interviews confirm that the workshop participants show a higher degree of usage over time and express more advantages with the EPG [9].

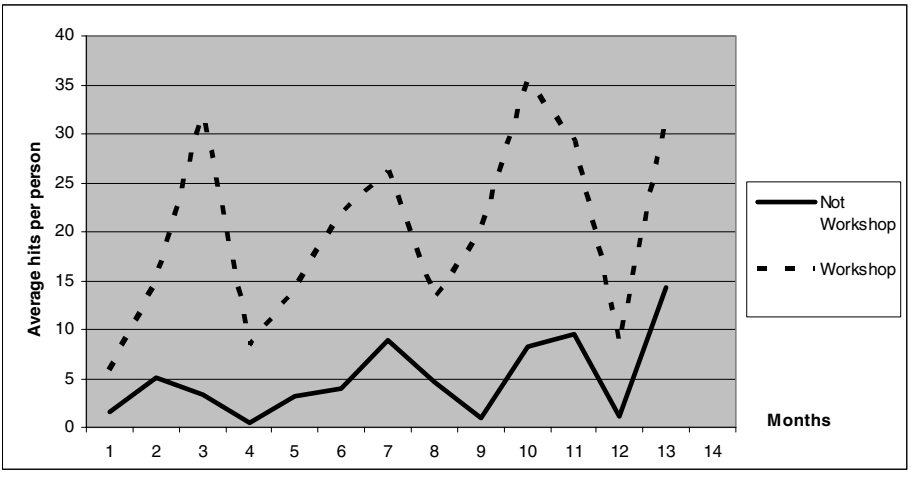

Fig. 2. Usage of process model. First phase = month 1 – month 4.

3.4 Specifying Learning

We found that the workshop participants had a higher degree of usage of the electronic process guide than the ones that did not participate in the workshops. The process workshops were also found to be efficient in terms of resources spent to design the process guide [6].

In [4] we tested the importance of organizational support and four factors on the perceived attributes of using the EPG for its infusion. We found that perceived usefulness is the fundamental driver in explaining current system usage and future use intentions, and furthermore, that perceived compatibility, perceived ease of use, and organizational support were the key determinants of perceived usefulness. Focusing on the early releases at Spacetec may have resulted in too little focus on organizational support, and that the system may have been difficult to use since it was

only partly finished. Several of those not participating in any workshops reported they missed training. The EPG users gave a very positive feedback on the few project tools implemented in this phase. This motivated for the next phase.

4 Phase 2: Project web

4.1 Diagnosing

One of the important requirements from phase one, was the ability to access tools from the EPG. Examples of such tools were: requirements and bug databases, action lists, and work package planning [11]. The tools were never the main purpose of the process guide, rather they where added because they where easy to make and they fitted naturally with the process guide. The popularity of these process independent tools came as a surprise, and they were regarded as one of the major benefits of using the process guide. In addition to the tools mentioned, functionality was requested for tailoring the process of each project, showing project-progress, and organizing the project archive. Implementing these features would make the EPG a complete workbench for the project managers and project members. This workbench was called the Project Web (PW). This was the process guide in practice.

4.2 Action Planning and Action Taking

Loads of suggestions for new tools were received, and a strategy of rapid incremental development and deployment was chosen. It was decided to implement one tool at a time starting with the obvious tools. This strategy made it possible to quickly provide increased benefit to the projects, but it could also result in the most valuable tools not being developed first. It might also lead to early design choices that could cause problems later, e.g. choosing a storage format without knowing all the needed interfaces. The disadvantages of premature design choices were considered manageable, and the order of tools was considered less important as long as the tools were useful and helped boost the productivity. The following project planning and management tools were implemented:

- Work package planning - budget and remaining estimates, progress reports.
- Action-tracking
  - Automatic alerts via e-mail when due-date is reached.
  - Between customer and company.
- Risk planning and tracking
- Payment plan - planning and keeping track on payment milestones
- Project “front page” - documenting key economic and other information.
- Project “end-page” - summarizing the final project status schedule.
- Inventory - tracking equipment purchased, consumed and sent.
- Resource planning – whom and at what time.
- Deliverable list - planning and documenting HW/SW components.
- Archive - Project and contracts archive, links to related projects.
- Statistics - showing changes in the estimated remaining effort over time.

The following tools were implemented to support process activities:

- Requirements tool for writing requirements according to the company standard.
- A use-case documentation tool - a standard way of describing use-cases.

4.3 Evaluating

Analysis of the usages logs (Fig. 3 and Fig. 2) shows that the project web was more frequently accessed than the process guide in phase 2 (month 4-12). Tools were accessed more than six times as frequently as process descriptions (18 000 PW hits and 3000 EPG hits for the whole period), and the workshop participants used the PW three times as much as the other group. These results were also confirmed by the interviews. In addition to a higher degree of usage over time, we found that the workshop participants took a larger number of functions in use [9]. Also the ISO9001:2000 revision of 2004 was conducted with great success, and there were no non-conformances.

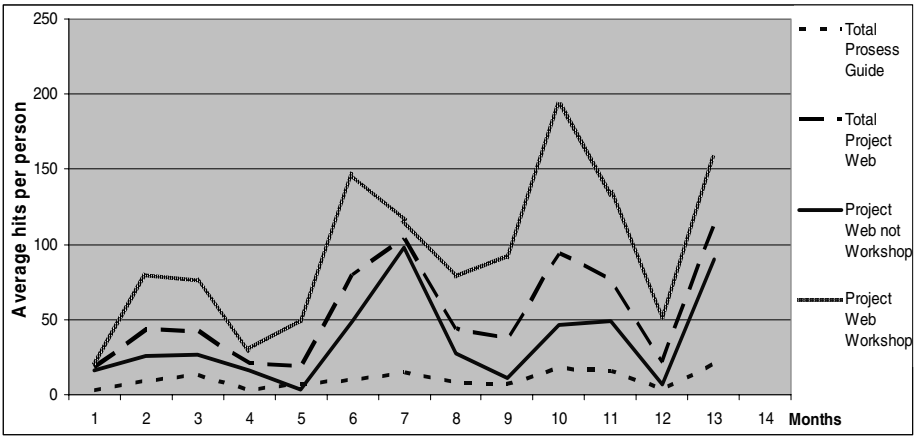

Fig. 3. Hits in project web and process guide

From the logs and dates of new tools being released, not surprisingly we found that new tools increased the number of hits on the Project Web, and this lead to more hits on the Process Guide. We believe tools are one major reason for the popularity of the EPG. Since the tools are integrated closely with the processes they encourage the use of the process descriptions.

4.4 Specifying Learning

We found that the workshop participants had a higher usage level of the Project Web than those not participating in any workshop. Workshop participants are also using new functionality to a higher degree. Involvement and initial use seem to have an effect over time.

With all the tools in place, the Project Web became a workbench for all the projects at Spacetec. The concept of integrating tools with the EPG to get the PW as well as the tools themselves has been well received by the users, and it was also obvious that people got more enthusiastic from discussing tools than process descriptions. The major advantages of the integration were:

- Interfacing to the project process and the everyday tools via one web page encourages people to check up on the process more frequently.
- All project information stored in the same system eases information sharing between projects and swapping between projects. A new project member knows by default where and how to retrieve all vital project information.
- The system becomes an experience database.

There have also been some negative feedback/experiences:

- Many of the new tools tend to compete with the use of already established tools such as MS-Word, MS-excel, MS-project and miscellaneous design tools.
- It is important with more training before introducing new tools. Some project managers and developers kept on using their old tools as well as using the new tools. They complained about double work, and were therefore more negative towards the PW.

It is not easy to decide whether to integrate an existing tool instead of making a new one. The disadvantage of integrating existing tools is that it is hard to achieve a common look and feel. The integration of tools was a huge success. A clear requirement in the ISO 9001:2000 is “processifying” the quality system, which is very well fulfilled through the Project Web implementation. It became obvious that the next step would be to integrate the project web and the tools with the rest of the company administrative infrastructure, making the Project Web and EPG a complete single interface for project work. The first obvious case was integrating the work package list with the hour accounting system. Already the work package tool showed budget and remaining estimate per work-package, it only lacked a column showing actually spent effort per package.

5 Phase 3: Integration

5.1 Diagnosing

With the implementation of tools and realisation of the project web in phase 2 the project management process had become easier and consistently integrated with the EPG. Even though this helped in generating and maintaining the project plans as well as reporting status, a substantial manual task of collecting and organising data remained. In order to have complete control of the project it is also necessary to know how many hours have been spent, the status of invoicing and payments, the status of equipment orders and tracking of correspondence. To get even larger benefits from the PW, it was clearly desirable to integrate with the other company administrative

systems. In addition to the benefit of easy access to vital project data, automation has the potential of increasing accuracy and keeping project status up-to-date at all times.

5.2 Action Planning and Action Taking

When planning the integration focus was placed on:

- Technical feasibility of integration - cost and possibility of integration.
- What kind of integration gives the best value for the project manager?

The following administrative and economical systems were integrated:

- The financial/economic system - project costs such as purchases, travels, sub contractors and other expenses
- The hour accounting system
- The vendor database - containing all approved software, hardware suppliers
- The mail journal system - registers all incoming and outgoing paper mail
- The module, component and product software databases
- The bug database - errors in software during formal testing
- Document database - all documents produced in the last five years

After integrating these systems, each project member should easily find what job or work packages he or she was supposed to perform; how many of the estimated hours were used and how the total engagement was for the next 5-6 months. From the progress indicators it was now very easy to see who had not delivered progress reports, what projects run financially badly or well, and which schedules and milestones to monitor.

5.3 Evaluating

It was not possible to measure the exact use level of the integrated systems. These integrated systems have all been included in the tools developed in phase two, and do not have separate web-pages on the intranet. But from comparing the dates when new systems were integrated with the usage logs (Fig. 3) we have seen that this has increased the number of hits on the EPG. The QA department also reported that the integration phase significantly improved the reporting from the projects. Earlier the progress reporting task was mostly concerned with collecting data and performing calculations, but now it had been transformed into reviewing facts and planning ahead, as it should be.

5.4 Specifying Learning

The cost of the integration phase per system has only been from a couple of hours to a week, which is considered “cheap” compared with the benefits gained. The integration has improved the quality of the project reports and decreased the time for making them, and made it easier to get an overview of the status in all the projects.

With continually increasing functionality and provision of new services the enthusiasm was still high after 13 months, which was confirmed by the interviews.

6 Conclusion and Further Work

We have learned that it is indeed possible to find solutions that satisfy all stakeholders – from top management down to project members. A process guide with processes developed by the stakeholders themselves is a perfect starting point. Next the development of tools and "views" can be done evolutionary, with frequent feedback from the stakeholders. The evolutionary approach resulted in a continuous focus on software process improvement in the whole organization. The high degree of involvement is probably the reason why the project web is considered a success. The strategy of focusing on tools and integration made the whole system more useful. The Process guide and Project web also made it possible to keep the ISO 9001:2000 certificate.

The results show that usage of the Process Guide and Project Web differs between the groups who participated in the workshops and those who did not participate in the workshops. The workshop participators were more positive, and had a higher degree of use through all three phases, of both process descriptions and tools. The implication of these findings is that users of a process guide should be involved in developing it.

6.1 Further Work

In the future, we will continue to follow the evolution of the electronic process guide and project web through several other data sources such as quantitative surveys of process guide use over time, and project inspection to find out more on the use level.

Acknowledgement

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