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UNDERSTANDING THE USE OF AN ELECTRONIC PROCESS GUIDE

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Published in Information and Software Technology 44 (10):601-616, 2002.

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Abstract

This paper presents a case study of the installation and use of an electronic process guide (EPG) within a small-to-medium software development company. The purpose of the study is to better understand how software engineers use this technology so that it can be improved and better used to support software process improvement. In the study the EPG was used to guide new processes in a software improvement programme. The use of the EPG was studied over a period of eight months with data collected through access logs, by questionnaires and by interviews. The results show that the improvement programme was successful in improving project documentation, project management and the company's relationship with its customers. The EPG contributed to the improvement programme by providing support for the creation of templates for key project documentation, assisting with project planning and estimation and providing a forum for discussion of process and work practices. The biggest improvements that could be made to the EPG would be to provide better navigation tools including a graphical overview of the process, provide tailoring facilities, include examples and experience and link to a project management tool.

Keywords

Software process improvement, electronic process guide, empirical software engineering, industrial case study

1. Introduction

Process guidance is very important for software process improvement. Once improvements have been agreed and new processes defined, they need to be effectively guided or little improvement is possible [17]. This has traditionally been the task of the printed process handbook, but technology is fast shifting toward electronic process guides – web applications structured according to the process with process descriptions, navigation and searching tools and electronic links to extra information like templates, examples, tools and project databases. As well as providing extra functionality electronic guides can be installed

on a company intranet providing easy access for all process participants and ensuring that all users have access to the most up-to-date version of the process.

Several electronic guides of proprietary processes (like RUP [13] and Mentor [15]) are now widely available and tools such as Spearmint [4], ARIS [2] and Adonis [1] are being developed that allow EPGs of tailored and/or company specific processes to be quickly and cheaply generated. Using this technology multiple process guides can be created for different processes or sub-processes. To facilitate the development of this promising technology there is a need to better understand how EPGs are used in practice and how they can be improved to better support companies in process improvement, for example.

This paper presents a study of the use of an EPG in a small-to-medium software development company. The EPG of a streamlined version of the ISO 12207 Software Life Cycle Processes [10] standard was generated using the Spearmint tool and installed at the company. The company added their own templates to the EPG and then used the EPG initially in one project and later more widely. The use of the EPG and opinions of the users were monitored over a period of eight months to determine what the EPG was used for, how it was used, and to find out how it could be improved. Data was collected through periodic surveys of users, the EPG server log, interviews with users and records of on-line discussions. The analysis distinguished where possible between effects of the process and effects due to the EPG.

The results of installing the EPG and the process were very positive with users reporting improvements in project documentation, improved project planning, estimation and management, greater awareness of process among developers and improved customer relations. The main uses of the EPG were to provide information for the creation of templates for key development documents and to define a task list for the project. The EPG was also used extensively as a discussion forum to ask questions or comment on document templates (resulting in improved templates and a better understanding of development processes). Surprisingly, the EPG was not used to guide process execution during projects or to provide convenient access to templates. The major improvements that could be made to the EPG are better graphical overview and navigation tools, integration with a project management tool, providing tailoring facilities and including examples and experiences.

The next section presents background to this study including claims made about the potential benefits of EPGs. In Section 3 the method for the study is described including the context, approach and measurement instruments. Section 4 describes the process improvement effort at Allette Systems and how the EPG was implemented and Section 5 explains the data collection. In Section 6 the results are presented and the implications are discussed in Section 7. Section 8 discusses the limitations of the study and Section 9 concludes the paper and proposes future work.

2. Background

Many approaches for software process improvement have been proposed including Assessment schemes, such as CMM [17] or SPICE [7], goal-oriented measurement approaches, such as GQM [22], or the introduction of a new process. All of these require that the process is efficiently communicated to process participants. Without effective process guidance it is difficult to effect software process improvement.

Process communication has traditionally been the domain of paper-based process guides. These are used especially by larger organizations to communicate their company-specific processes. However, in the past they have proven to be large, bulky, complex and expensive to produce and maintain. Experience indicates that process handbooks in this form are not widely used (Kellner et. al.[12]). Several organizations have started to distribute their process handbooks in a file-based format, such as pdf, ps, or even html. However, in most cases these electronic documents still reflect the bulky format of the original process handbook.

Kellner et. al. have proposed basic requirements and design principles for an electronic process guide based on their experience with paper-based guides and industrial needs. Using this experience, they have defined the recommended content, structure and functionality of electronic process guides. Basically, an electronic process guide should contain at least the information described in its printed counterpart, however, it is recommended to split process information into more manageable pieces that are easier to understand and digest for process participants. Some of the possible benefits of an electronic guide are easier searching and navigation through a hyperlinked structure that suits the complexity of commercial process models, easy access for all participants to the current version and electronic linking to supplementary information such as templates, examples or further information pages.

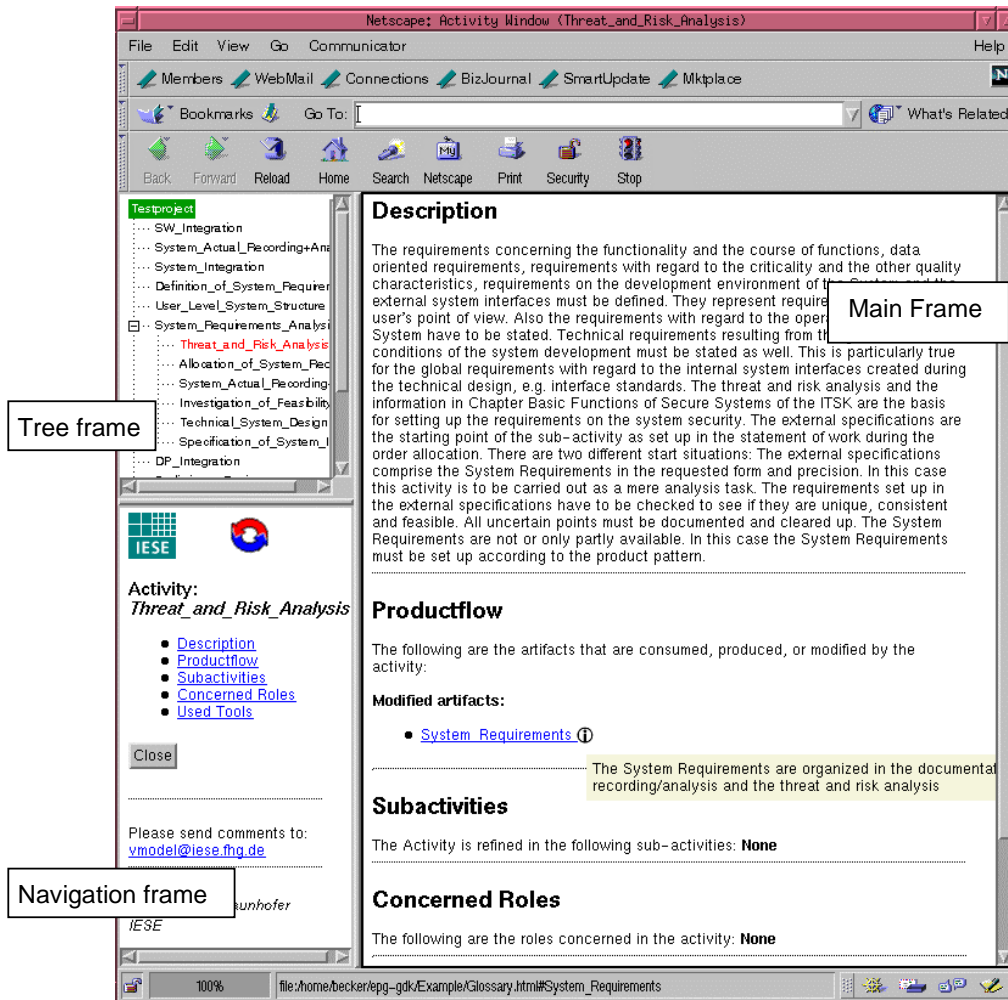


Figure 1: Example layout of an electronic process guide page.

Figure 1 shows an example of an EPG page in the recommended layout structure, consisting of three frames. The upper left frame shows the overall breakdown structure for the process, highlighting the currently displayed activity or artifact. This tree also serves for navigation. The lower left frame lists the information chunks displayed in the main frame on the right. Entries in the navigation frame are linked to information chunks in the main frame. Relationships to other parts of the process (such as artifacts modified by the activity) are expressed through html links, allowing to directly navigating to the corresponding entities.

Proprietary processes such as RUP and Mentor are now available only in electronic form. However, these processes are standardized and can only be tailored to a company's specific needs with a lot of extra effort, i.e., by manually changing the html code.

Until recently it has been harder for companies to get tailored process solutions in electronic guides. Tailoring existing process guides or developing html-based process guides from scratch requires a lot of effort both at creation time and after creation for maintenance.

Furthermore, manual creation and maintenance of process guides has shown to be tedious and error-prone [5].

Business process modeling tools such as ARIS or Adonis in their most current versions have plug-ins that allow the generation of html-based versions of their process models. The software process modeling tool Spearmint also allows the generation of electronic process handbooks from process models. Spearmint offers a fast and relatively inexpensive way for companies to produce electronic guides. In the Spearmint tool the process is modelled and tailored using a graphical editor with analysis and checking facilities especially designed for software process models. Spearmint can quickly and easily generate an html-based process guide. The structure of the guide is according to a predefined format. A specific template can further determine the layout of an individual guide. This mechanism allows the generation of different EPGs for a process model, for instance, focusing on different parts of the process model, or using different layouts. When generating an EPG from a Spearmint process model, relationships between process entities become html hyperlinks.

Not only is automatic generation of an EPG from a modelling tool fast but the resulting guide is of high quality with respect to structure and links that can be easily forgotten during hand coding. For this reason tools such as Spearmint have the potential to increase the penetration of electronic guides into companies who require tailored solutions to effect serious process improvement. The reduction in cost and effort to produce the guide (as well as the readily available proprietary guides) also make electronic process guides more attractive to small to medium enterprises that generally have less to invest in process improvement.

Despite the potential of this technology very little research has been done into the use of electronic process guides as tools for software process improvement. An instance of an electronic process guide has never been studied in practice and there is still no evidence that the format proposed supports the actual usage of electronic guides.

To best utilise electronic process guides and to improve them it is important to gain a basic understanding of how the electronic process guides are used. It is the purpose of this study to contribute to such basic knowledge by studying the use of one such guide in an industrial context.

A problem when studying potential benefits a process guide is that it is difficult to distinguish whether the benefits are caused by having a process in place, or whether the improvement is due to the specific structure and medium determined by the electronic process guide.

3. Research Method

The purpose of this study was to gain a better understanding of how the EPG was used in the context of software process improvement. To do this the EPG was installed to support the guidance phase of a software process improvement effort at Allette Systems, a

small Sydney-based company that focuses on web application development. The process improvement effort followed the IMPACT approach to SPI [19].

The IMPACT framework proposes a cyclic framework as shown in Figure 2. It is based on best practices and is designed to support continuous and highly focused improvement producing timely, cost-effective and tangible improvements in small to medium enterprises. The framework is presented in two distinct levels: the project level and the process level. At the project level the framework emphasises the importance of planning, managing and executing projects within SPI best practices. At the process level the framework offers a five step structure for managing SPI on an organisational level: Understand, Process Model, Improve, Process Guide and Measure.

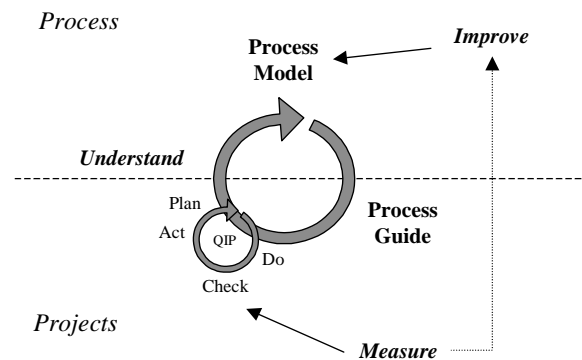


Figure 2: The IMPACT framework

Within IMPACT, the purpose of the understanding phase is to model the existing processes and to identify areas for improvement. This is done using process elicitation techniques and/or assessments. From the possible areas of improvement a set of achievable improvement goals is chosen. Then a process model is created that addresses the improvement goals. IMPACT itself does not prescribe any particular process, instead models are defined specifically to address the improvement goals by, for example, installing a proprietary process (such as RUP or Mentor), adopting a methodology (such as XP [3] for development), using a standard (ISO 12207 or IEEE 1233 [9]) or having a process engineer tailor a process specifically for the company. Improvements should always incorporate experience and feedback from previous projects where possible.

Once the improved process has been defined the process guide facilitates application of the process in projects. Without effective guidance improvements in the model cannot be realised in projects. Projects are then executed and monitored and feedback provided to effect further improvement.

The EPG was installed at Allette Systems to realise the process guidance stage of IMPACT. The EPG was linked to the PageSeeder tool [16] to support on-line discussion of the process and the EPG. An exploratory case study was carried out to determine how the EPG was being used. Exploratory case study was the chosen research strategy because, as

defined by Yin [23], this strategy allows researchers to investigate and acquire an in-depth understanding of a contemporary complex phenomenon within its real-life context. In this case, this is the use of an electronic process guide within a small organisation. Exploratory case studies are often opportunistic, that is, the opportunity exists to study a phenomena that has not been studied before but the researchers exercise little control over the context of the study. In an exploratory case study researchers observe the new situation with the goal of understanding more about that situation. The purpose of the understanding is to serve as the basis of further investigation rather than to provide absolute answers to specific questions.

A common criticism regarding case studies is the impossibility of generalising results obtained from a single case. However, according to Yin “case studies are generalisable to theoretical propositions and not to populations or universes” (pp. 10). That is to say, these results indicate the possible uses of the EPG and how features may be used, rather than the way it will be used by every person in every company. The results should be used to design further research into EPGs rather than interpreted as absolute answers. This exploratory case study should be considered, then, the very first step of scientific inquiry into the installation and use of EPGs to support software process improvement.

The revelatory nature of the investigation led to the choice of a single case design. The research questions formulated were:

Is the EPG used?

If the EPG is used, what is it used for?

If the EPG is used, what are the effects of using the EPG?

If the EPG is used, how is the EPG used?

How can the EPG be improved?

Data on the use of the EPG was systematically collected from multiple sources, in particular, surveys of users, EPG server hits (explained by interview) and PageSeeder discussion records.

A total of 4 surveys were performed at different stages of the study. Two survey instruments were used (Questionnaire 1 (Appendix A) and Questionnaire 2 (Appendix B)). Questionnaire 1 aimed to explore subjects' perception of the EPG, their views on benefits of the EPG, good/bad features of the EPG, most useful features, any lacking information, and any suggestions for improvements. This questionnaire was applied three times in the early stages of the investigation (weeks 2, 6 and 9). The purpose of repeat application was to see if people's views on the EPG and how they were using it changed over time.

Questionnaire 2 was applied once after the application of Questionnaire 1 (week 14). The purpose of Questionnaire 2 was to collect more detailed information about the benefits of the EPG technology as opposed to a paper-based guide.

The survey data was interpreted literally by one researcher and analysed using grounded theory [8] by another researcher. Grounded theory is a qualitative research technique that provides a systematic and verifiable way to analyse qualitative data. It is used as a method for the study of complex social behaviour from a sociological point of view. Grounded theory has also been used as a research strategy in many studies, within different disciplinary contexts [21]. The basis of grounded theory is that theory is developed inductively from the data, being therefore generated (or grounded) in a process of continual sampling and analysis of data [18]. In this study, grounded theory was used to explore the meanings, definitions, and interpretations made by the subjects of the study regarding their experience in using the EPG, thus providing deeper insights into the data. The use of two different analysis techniques by two different researchers also helps to validate the conclusions by providing multiple sources of evidence for resulting propositions.

The server logs from the EPG server were collected from the time the EPG was installed at Allette Systems. The logs record the date, time, identity of user and page accessed for all EPG use. Each time a page is accessed it is termed a "hit" on that page. Using the server data the following measures were defined:

1. total hits versus time – the total number of times the EPG was accessed versus time. This can be broken down into EPG information pages (i.e. activities, artifacts, roles and tools) and templates. Graphs of individual usage were also obtained (but are not reported here for privacy reasons).
2. coverage – the percentage of EPG pages (including templates) accessed at least once.
3. popularity – the percentage of total hits on any particular page or group of pages. This measure showed the pages and types of pages that were accessed most.

Users were interviewed to determine the reasons for their usage profiles. In particular, they were asked to explain high usage, declining or increasing usage and periods of non-usage in terms of what tasks they were using the EPG for and how they were using the EPG. This gives more insight into the EPG usage and is considered more reliable than the survey data alone because it is backed up by the actual server data. Individual usage explanations were combined to explain the overall usage patterns reported in this paper. Because the logs make little sense without the explanations of the profiles the EPG logs together with the explanations are considered one set of data called *EPG logs and interviews*.

The PageSeeder system records contained the date, time, identity of user and text of every comment or question discussed on-line through the PageSeeder system. The records were collected from the time the EPG was installed. From these records it was possible to determine usage in terms of number of comments entered versus time which was a reflection of the amount of discussion created by the installation of the EPG. The records were also analysed to determine the main topics of conversation, which gave some insight into the most discussed parts of the EPG.

Project data showing the main tasks of the users and their completion dates was also collected from the company.

During all analysis of the data careful attention was paid by the researchers to distinguishing between effects of the process (i.e. EPG content), the EPG layout and the electronic medium. Users were also instructed to answer the questions of Questionnaire 2 with only the EPG technology in mind, in an attempt to distinguish the different effects.

Triangulation was carried out throughout the analysis of the data. Triangulation is an important tool for validating conclusions in any study [20]. Triangulation combines the gathering of different types of evidence to support a proposition. In this study, triangulation is carried out among the multiple sources of evidence (data triangulation), the different evaluators (investigator triangulation), and by using different methods to analyse the data (analysis triangulation). In this study only conclusions that can be verified by at least two sources are reported.

4. Implementation

Allette Systems Australia is a small software development organisation based in Sydney, Australia with about 20 developers specialising in web application development for finance and business sectors¹. Before this intervention they followed an ad hoc development process but had installed and used a timesheet recording system that allowed them to allocate and track projects, tasks and development effort. They had never followed a defined development process.

The project timeline for the application of IMPACT at Allette Systems is shown in Figure 3.

¹ Only 8 of these developers participated in this study.

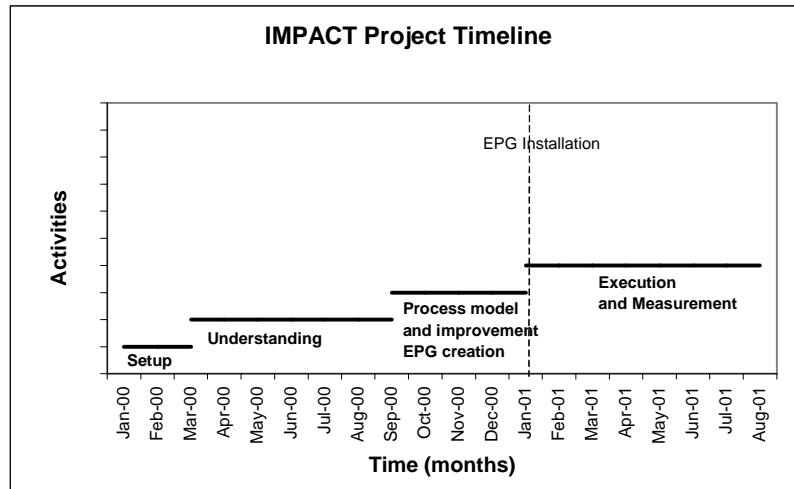


Figure 3: The project timeline showing when the different phases of improvement took place.

Project setup involved defining the goals of the project, employing staff and initiating the project.

The understanding phase was undertaken with a process elicitation approach. The existing processes were elicited and modeled using document and e-mail analysis and interviews. This was a labour intensive task which consumed a lot of time, but provided an understanding of how the company worked and where the best areas for improvement were.

The process model resulting from the understanding phase was a snapshot of a process from a particular project. Unfortunately, process participants felt that this process would be unlikely to be repeated to any extent in other projects. This implied a very ad hoc approach to development in the company and discouraged the use of the elicited model as a basis for a repeatable process model. The model did, however, identify many areas of possible improvement including requirements management, testing and evaluation, and documentation.

Through discussion with the company management, improving documentation was chosen as the improvement goal of the first cycle of IMPACT. Since the existing process was not a good basis for a process model the ISO 12207 standard was adopted to guide improvement. In keeping with the iterative approach, a very streamlined version of the ISO 12207 focusing only on key documentation was created as the process model. The rationale for this was not to overwhelm participants new to following a process with a huge, complex process.

The resulting process was modelled in SpearMint and described in terms of activities, artifacts, roles and tools and the product flow relationships between them. Activities and artifacts were also decomposed into more detailed descriptions.

The EPG of the streamlined ISO 12207 process was generated directly from the Spearmint tool. The EPG contained a process page and pages for each activity, artifact, role, and tool (entity pages). The process page contained a list and hyperlinks to all of the entity pages in the EPG, along with a description of the process and a navigation tree for accessing entity pages. The process page for the Allette EPG is shown in Figure 4.

Each entity page contained a general description and attributes associated with that kind of entity. For example, activity pages contained links to consumed and produced artifacts, sub-activities, the roles responsible for the activities and the tools that may be used.

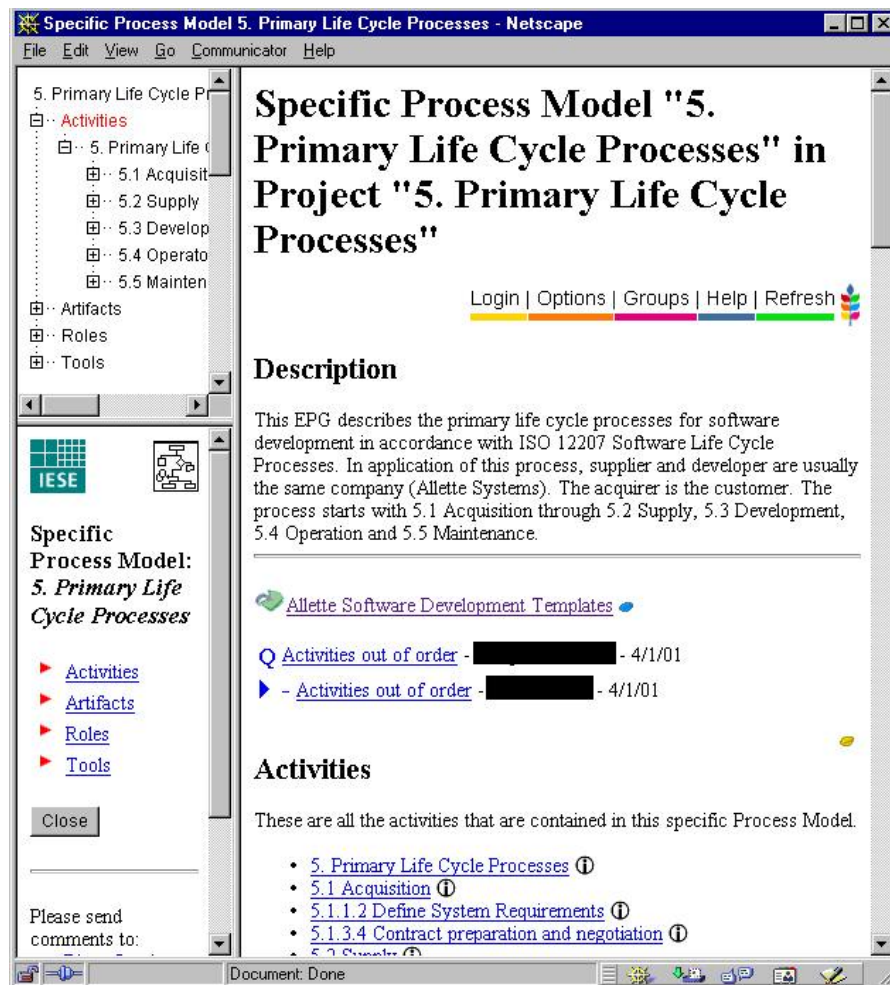


Figure 4: Part of the main Process page of the EPG.

Every page in the EPG had a navigation tree on the top left that allowed the user to navigate directly to any page (shown on the top left in Figure 4). The structure of the navigation tree reflected the hierarchical decomposition structures of the process model. On the bottom left of each page was a navigation pane that allowed the user to go to different sections of the page they were viewing. Each new page that was accessed appeared in a new window. Templates were linked to artifact pages and to a template index installed on the process page. In all, there were 142 pages describing the process.

Templates were created by Allette Systems staff using the ISO 12207 standard, RUP, Jacobson [11], Lowe [14], DOD-STD-2167A [6] and experience to guide their definition. All but one of the templates were created in both html format and word document format. An extract from the Software Requirements template is shown in Appendix C. Some of the templates (like the system requirements template) were linked to the EPG through the artifact page for that template. All templates were also accessible through a template index page linked to the main project page. In all, twelve templates were created. The first templates were installed around 21st January 2001. Including the templates and the template index page, the total number of pages in the EPG was 166.

The EPG (including the html versions of templates) was processed with the PageSeeder tool to support on-line discussion of the process and the EPG. To each section of each page was added a seed where users could insert comments or ask questions about the contents of that section. When a question or comment was added it was emailed to all of the users of the EPG and also appeared permanently on that EPG page. Other users could reply to questions or comments, thus forming discussion threads. An example of a seeded page is shown in Figure 4. The PageSeeder comments forming a thread on "Activities out of order" begin just under the link to the templates.

The seeded EPG was installed on the PageSeeder server on the 1st of January 2001. Eight users (who would participate in the case study) were nominated by the company and given accounts on the PageSeeder server. An account and password were required to access the EPG. Nominated users attended a presentation at the end of December about the EPG and the study. During the presentation they were shown the basic features of the EPG but were not instructed in the use of the actual process or templates. Approximately two weeks after the initial installation the first template pages were added. On the 18th January 2001 a new version of the EPG containing minor corrections to the existing pages and some new pages about later phases was installed. From then the intervention ceased and the observation of the use of the EPG began. During the project execution users also had access to a paper-based version of the ISO 12207 standard.

The EPG installation coincided with the start of the project that was intended to provide the context for the EPG use. This was a medium sized project (approximately 800 hours work). The project timeline is shown in Figure 5, showing stages during which components were worked on. The project followed a component-wise development pattern following elicitation of the requirements in January. The development of each component comprised a largely unstructured process of analysis, design, coding, testing and installation. Some development of components was done in parallel. Two of the components were completed and delivered to the customer during the study period, but the entire project was not completed (during the study). The EPG was available throughout the project. As it proved useful, however, it was used periodically in other projects with different users.

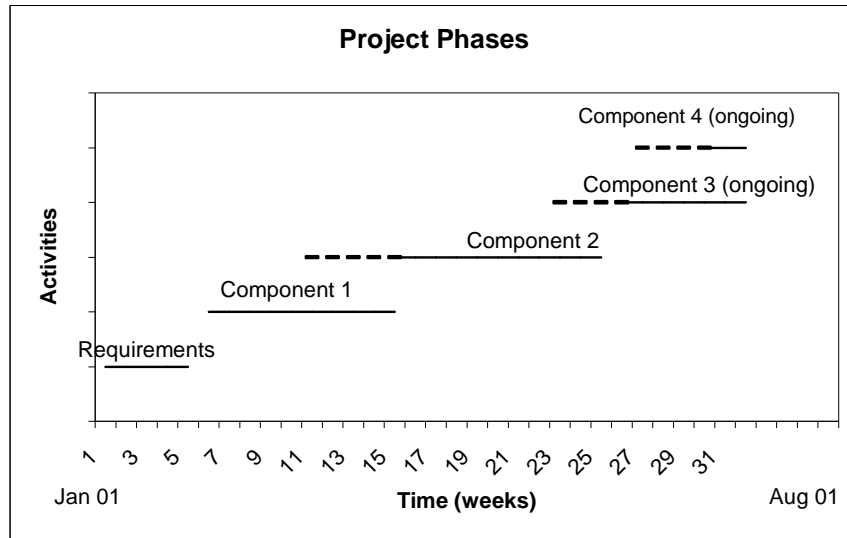


Figure 5: The timeline for the project in which the EPG was used.

5. Data collection

The timeline for the data collection for this case study is shown in Figure 6. Data was collected from the 1st Jan 01 to 13th Aug 01 (approximately 32 weeks, 8 months). The evaluation ended before the end of the development project due to funding constraints on the research project.

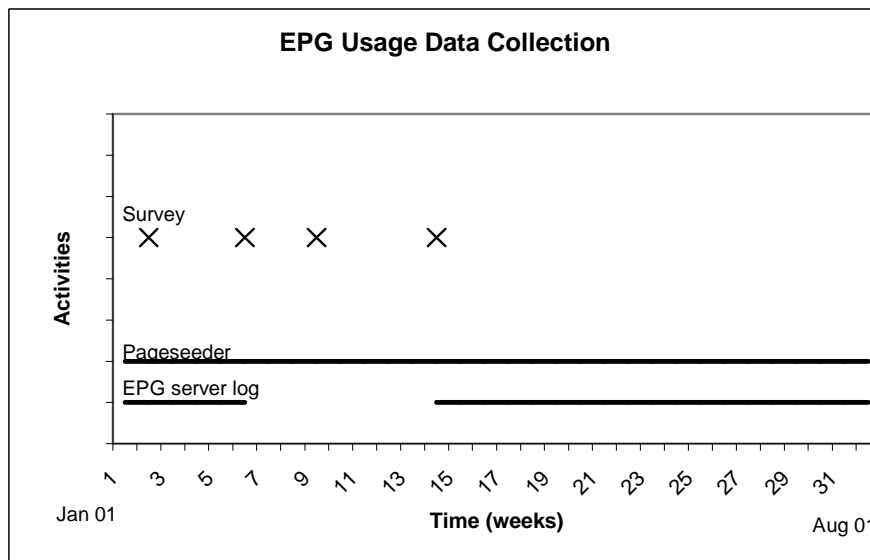


Figure 6: A timeline of the EPG usage data collection showing when the surveys were done and when PageSeeder and server log file data was collected.

Questionnaire 1 was applied on the 11th of January (week 2), the 6th of February (week 6) and the 27th of February (week 9). Questionnaire 2 was applied on the 3rd of April

(week 14). Table 1 gives a summary of the collection of questionnaire data. The company decided who would be involved in the evaluation. The participants included the development team from the project which provided the main context for the evaluation, as well as some managers who had been involved in realizing the process improvement effort. The difference in the number of responses to each application is because only people using the EPG were asked to respond and different people (and numbers of people) used the EPG at different times.

Date	11/1	6/2	27/2	3/4
Questionnaire	1	1	1	2
Total responses	2	3	3	5
Responders (individuals)	A, B	A, B, C	A, C, D	A, B, C, E, F

Table 1: A summary of the collection of questionnaire data.

Server logs of EPG usage were collected from the time it was installed. Unfortunately, logs from the 15th of February (week 7) to the 30th of March (week 13) were irretrievably corrupted during archiving and are not included in this data. The corrupted data constitutes 7 weeks out of 32 weeks of data (about 25%). While this affects some measures, all indications are that during this time the usage of the EPG was consistent with the usage before and after this time. Therefore, patterns that are observed over time are considered to be reliable.

For the purposes of the analysing the EPG server log data the EPG pages are broken into two categories, the EPG information pages describe the pages containing information and description of the process and the EPG template pages, containing the templates. It is important to note that the EPG had an administrator within Allette Systems who was responsible for installing and maintaining the EPG and templates. This person's data has been discarded from the analysis of template usage since much of their template usage would have been due to maintenance such as installation, changes and testing of the templates. The EPG information pages, on the other hand, required no maintenance and therefore it was possible to include data from the administrator in the analysis of these pages.

All comments and questions (passages) entered through the PageSeeder system were recorded for the entire period of the study.

6. Analysis and Results

Analysis from the three data collection methods and results with respect to the research questions are reported below.

6.1. Is the EPG used?

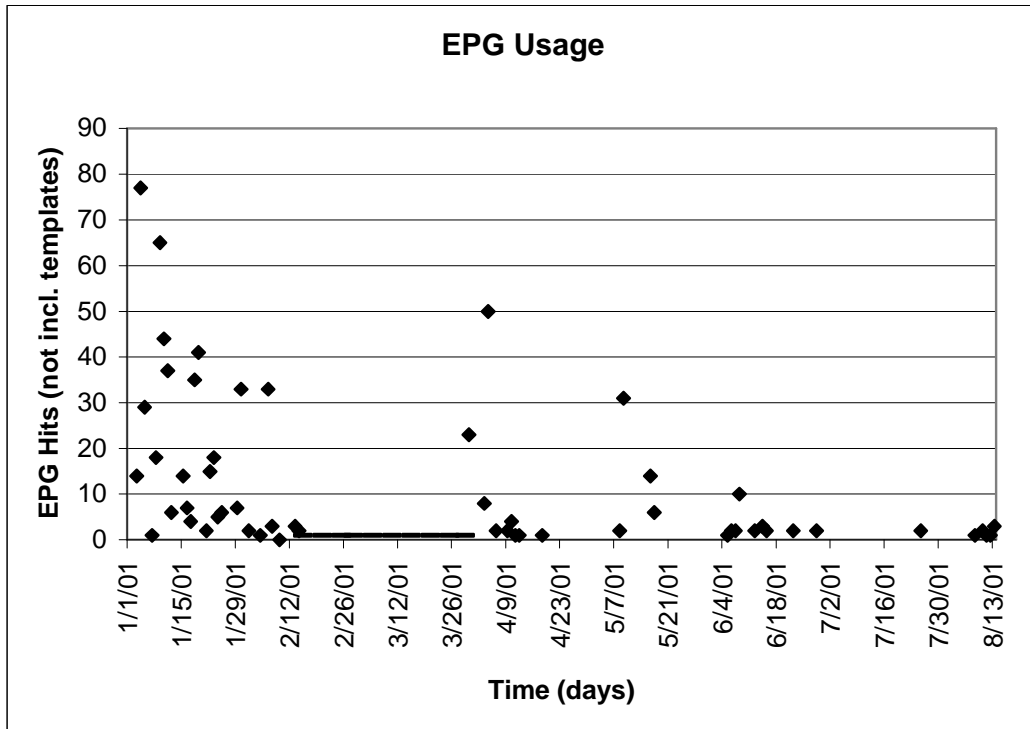


Figure 7: The total usage of the EPG information pages (number of hits vs time).

The total usage of the EPG information pages is shown in Figure 7. Over the course of the study the EPG pages were hit 813 times. During that time, 107 unique pages were hit, giving coverage of 64%. The graph shows high usage in January/February followed by a general decline in usage over 32 weeks. By the time the evaluation finished the usage had stabilised at almost nothing.

From this data we conclude that the EPG was used. The next sections will explore the usage patterns in more detail.

6.2. What is the EPG used for?

The data to answer the question of what the EPG was used for comes from the survey data, EPG server log interviews and PageSeeder data.

A literal interpretation of the data obtained from the three applications of Questionnaire 1 is shown in Table 2. Column 1 identifies the uses of the EPG reported in the questionnaire responses. The main reported uses were for creating documentation (using templates), for guiding the steps of software development, for planning and defining projects (including task list definition) for creating templates and as a forum for discussion. Repeated applications of the questionnaire showed that there was no significant changes in people's attitudes toward the EPG over time.

The EPG server log data and interviews support the reported uses of planning and defining projects and creating templates but fail to support the uses of creating documentation (using the templates) and guiding the steps of software development. Two of the main reasons given in interviews for the high usage of the EPG shown in January/February in Figure 7 were template definition and project planning. The figure shows a drop in usage after these two tasks have been completed. This data strongly supports the survey data. However, during interviews, no users associated high EPG usage with guiding the steps of software development. In fact, several users associated low usage with the overall unsuitability of the process for their projects.

The extensive use of templates from the EPG reported in the survey is not supported by the EPG server log data. The overall template usage is shown in Figure 8. The graph shows suspiciously low usage (only 12% of the total usage) and further investigation of actual template access reinforces the suspicions. For example, the logs show that the systems requirements template was accessed only three times over the eight months, but discussions suggested it was used many more times.

On investigation users admitted to obtaining the templates and using templates without accessing the EPG. The most common way to get templates was directly through the file server. The reason for this was that it was much quicker since it did not require logging onto the EPG server and navigating the EPG to get the template. Others admitted to saving templates on their hard disk for reuse or reusing documents from previous projects as templates. This indicates that the EPG was not the most convenient vehicle for accessing templates.

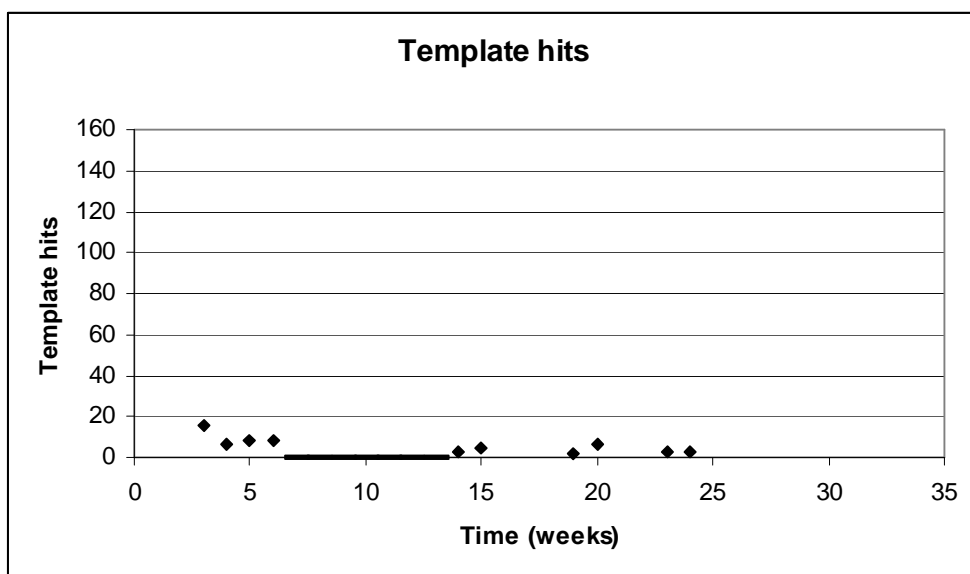


Figure 8: Template hits vs time

The PageSeeder log data, shown in Figure 9 supports the survey result that the EPG was used extensively as a discussion forum for understanding and improving the process. Analysis of the topics of discussion reveals that most (133 of 144 comments) were about templates. The graph shows regular discussion after the templates were installed for about three months. Once the template content stabilised discussion dropped off. The later spurts of discussion are new ideas for improving templates based on further usage.

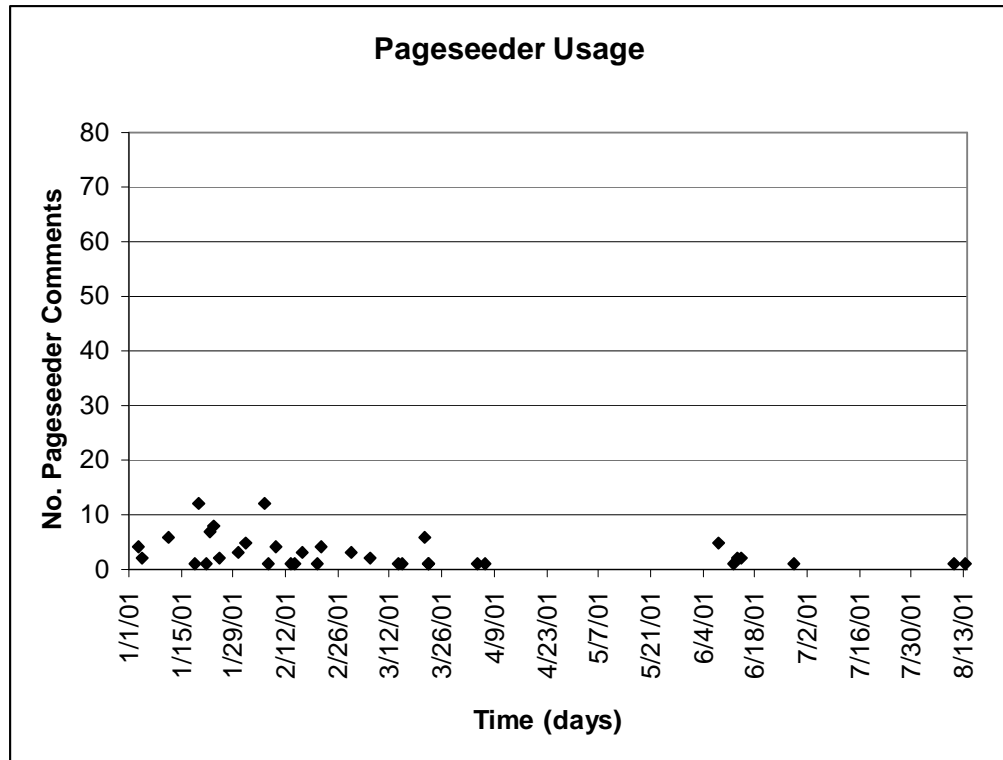


Figure 9: PageSeeder usage data.

Use	Supporting features	Outcomes	Possible improvements
Process Execution Tasks			
creating documentation	<ul style="list-style-type: none"> - activity and artifact descriptions - activity -> document links - templates - template index page 	<ul style="list-style-type: none"> - improved documentation 	<ul style="list-style-type: none"> - faster access to templates (from main project page) - examples of completed documents
guiding steps of software development	<ul style="list-style-type: none"> - structure (cross referencing) (order and relationships of activities and artifacts) - descriptions and recommendations 	<ul style="list-style-type: none"> - better understanding of process and tasks 	<ul style="list-style-type: none"> - better navigation tools - overview of process (stop getting lost in large process) - project specific tailoring/different processes for different types of projects - better layout/presentation - details on how to carry out tasks (e.g. methodologies)
planning and defining projects (incl. Task list)	<ul style="list-style-type: none"> - activity and artifact descriptions - structure 	<ul style="list-style-type: none"> - better project plans (task lists) - better project estimation - higher employee satisfaction - better customer relations 	<ul style="list-style-type: none"> - link to project management tool
Process Improvement Tasks			
forum for discussion	<ul style="list-style-type: none"> - PageSeeder 	<ul style="list-style-type: none"> - raised consciousness of process 	
creating templates	<ul style="list-style-type: none"> - activity and artifact descriptions - structure 	<ul style="list-style-type: none"> - improved documentation 	<ul style="list-style-type: none"> - better navigation - overview of process - better layout/presentation

Table 2: The results of the survey analysis.

6.3. What are the effects of using the EPG?

This question is answered through the literal interpretation and grounded theory analysis of the survey data.

Column 3 in Table 2 lists the outcomes of using the EPG as reported by the users. In particular, they reported improved documentation, a better understanding of process and tasks, better project plans, better project estimation, higher employee satisfaction and better customer relations.

Further analysis of the data from the questionnaires using grounded theory supports the literal interpretations above and reveals some interesting new insights. An example of the coding from the grounded theory analysis can be found in Appendix C. From the data several categories for analysis were identified. Firstly, a clear distinction emerged between results relating to process and results relating to the EPG technology. This was sometimes a difficult distinction to recognise and depended to some extent on the interpretation of the data. For example, the comment “it guides you when you don’t know what step is next ...” is obviously a comment on the process, but it also implies that the EPG has effectively presented and communicated that information, so it is also included as a comment on the EPG.

Secondly, a distinction emerged between comments on the *effects* of the process and the EPG and on the process and EPGs themselves. For example, the comment “we are more conscious about the process model we are following and how we can describe efficiently the work we do” is interpreted as an effect of installing the process and EPG, whereas the comment “I didn’t really like the tree structure on the left” is interpreted as a comment on the EPG technology itself.

Finally, the comments were categorised as either positive, negative or suggestions for improvement, for which there was little interpretation required.

The grounded theory analysis resulted in the classifications of data shown in Table 3.

The grounded theory analysis supports the major findings of the literal analysis in terms of outcomes (“positive effects” of process) and possible improvements. One important characteristic of the grounded theory analysis is the clear distinction it makes between process and EPG. The grounded theory analysis suggests that the major outcomes of the intervention can be attributed to the effective use of the process. The literal interpretation, by identifying uses and features of the EPG that were used most, shows how the EPG supported the implementation of the process. Together they suggest that the installation and following of a process had a positive effect on the company and the EPG tool was an important tool in the effective use of the process.

Process			EPG		
Positive effects	Negatives	Improvements	Positives	Negatives	Improvements
<ul style="list-style-type: none"> - better understanding /raised consciousness of work practices - better project definition, estimation and management - assists in project execution - stimulates discussion - assists in the creation of documentation - improves relationship with customers 	<ul style="list-style-type: none"> - too linear (not suited) - too generic (not suited) - redundant after development plan defined 	<ul style="list-style-type: none"> - project specific instances/tailoring - include examples - include task ordering 	<ul style="list-style-type: none"> - easier/faster access - on-line discussion forum - provides templates - easy to keep up-to-date 	<ul style="list-style-type: none"> - navigation/orientation not good - unsuitable interface - hard to read - confusing/complicated - no examples - can't be tailored - not enough details on method 	<ul style="list-style-type: none"> - provide better navigation and overview - improve general layout - integrate with project management tool - include examples/experience

Table 3: The results of the grounded theory analysis of the data.

6.4. How is the EPG used?

Data concerning the question of how the EPG is used comes from the survey, and EPG logs and interviews.

Column 2 of Table 2 shows the features that users reported using in the EPG to support their tasks. The most reported features were the descriptions, activity to document links, the templates, the template index page and the PageSeeder tool. The EPG logs cannot be used to verify the use of the descriptions and links since it is not that detailed, however, as discussed above in Section 6.2 it would suggest that although the templates were used, discussed and probably contributed greatly to the outcomes achieved, they were not extensively accessed through the EPG. The PageSeeder log to confirms the report that it was used extensively.

The EPG server logs give some interesting insights into the long-term usage patterns of the EPG. Consider again the logs shown in Figure 7. The interview data explains the high, declining and then low usage patterns observed in the usage graph.

The high usage at the start of the project is due not only to the high usage tasks of template definition and project planning but also due to curiosity about the EPG. Users admitted during interviews to logging on to the EPG just to “have a look” and see what it contained. The peak in usage on 4/4/01 is also due to curiosity from a new user.

The peak in usage on the 5/12/01 is due to a user searching for a template (which he was unable to find even after searching). This is the only incidence of high usage attributed to being lost or searching the EPG extensively.

Declining usage was generally attributed to four factors: learning effects, process irrelevance in later phases of the projects, overall process unsuitability, and the use of the task list to guide project execution rather than the EPG.

A learning effect associated with the process and resulting in declining usage was reported. This meant that pages that had been accessed and read did not need to be accessed continually (like a library or reference book).

Another reason for the steady decline in usage was a drop in relevance of the process as the projects moved to later phases. This is linked to the fact that the two tasks for which the EPG was used most (template definition and task list definition) occur early in the project (in January, see Figure 5).

A common pattern in individual usage profiles (6/8 profiles) was high usage followed by declining usage until there was no usage at all. This was attributed to curiosity followed by an assessment after initial exploration that the EPG was not relevant to the project (too complicated and formal), could not assist with the project or was too much trouble.

The final reason identified for declining usage was the use of the task list to guide process execution rather than the EPG. One reason for this was that the task list comprised a selected subset of activities from the process that was considered too big and complicated to be used in actual projects (even though the process itself was just a small subset of ISO 12207). This task list usage was probably an attempt to tailor the process to individual projects.

Low usage (1 or 2 hits/day) was mostly attributed to participation in PageSeeder discussions. Complete lack of usage (after initial usage or for long periods of time) was attributed to learning of the process, process irrelevance in later phases of the project and access of templates from other sources (for example, directly from the file server).

The coverage measure is an indication of how much of the EPG was used. A page contributes to the coverage count if it is hit at least once. Dividing by the total number of pages gives a coverage percentage. Unfortunately, this measure is strictly unreliable because of the missing data (a page could have been accessed during the time the data is missing), however still provides an approximate measure of how many of the pages were used. The absolute coverage during the entire study was just 64%, i.e. 36% of pages in the EPG were *never* accessed (note: this measure could be affected by the missing data). Analysis shows that it is the pages associated with later phases like operation and maintenance that were never accessed. This is consistent with the explanations given for declining overall usage that identified process unsuitability in later phases as a reason for decreasing usage.

The most popular EPG information pages during the study were the navigation pages “index” and “Primary Life Cycle Processes”. Together they accounted for 19% of EPG hits. This is not surprising since the index page was the default home page of the EPG. Of the actual process pages, those concerned with requirements were the most used. This is consistent with the overall usage data that shows high use early in the project lifecycle (January/February).

Another interesting figure is the popularity of the template index page (11%). This page was accessed from the main index page and the high usage of this page (almost the same as the index page) suggests that, contrary to the survey data, the process pages (i.e. associated activity and artifact descriptions) were not used to access the templates.

6.5. How can the EPG be improved?

Analysis of the survey data (Tables 2 and 3) shows clearly how users felt the EPG could be improved. Both the literal and grounded theory interpretations of the data agreed that the main areas for improvement are better navigation tools including a graphical overview of the process and easier access to templates, better layout/presentation, examples of documents and experiences about tasks, project specific tailoring and the possibility to link to a project management tool.

7. Discussion

In this section concrete conclusions regarding the use of the EPG in our study are drawn.

There is little doubt that the EPG was used as a reference source for defining the templates. This is reported in both the survey and backed up by the EPG server data interviews which identified this use as a source of high EPG usage.

The EPG was also used to define task lists for the initial project it was used in. This is reported in the survey and backed up by the EPG server data interviews. The EPG server data interviews do not, however, support the survey data which suggests the EPG was used to guide processes during execution. No users described this as a use when interviewed about their personal profiles. Instead the task list was used to guide the project rather than the EPG. Some users considered using the EPG for guidance and decided against it. One user cited irrelevance of process as the reason, another wanted a simple overview/explanation in order to decide whether to use the process or not.

One further important use of the EPG was as a forum for discussing the templates. This was reported in the survey and is backed up by the PageSeeder logs that show consistent use. Analysis of the PageSeeder comments show that templates were overwhelmingly the most popular topic of discussion. The survey data simply reports that the EPG stimulated discussion about the process which in turn improved the process and how people worked.

The EPG server/interview data does not support the survey that suggests that accessing templates was a major use of the EPG. When interviewed regarding the low hits of templates in the EPG server log most users admitted to accessing the templates directly through the file server or reusing already stored templates rather than downloading them from the EPG when required. Some users also admitted to using documents from previous projects as the basis of project documentation and just modifying the content. While survey and PageSeeder discussions show that template use was significant and that users considered the provision of the templates to be one of the major contributions of the EPG, the server log and interviews show that the EPG was not used as a tool to access the templates. Users were discouraged by the (relative to the file server) inaccessibility of the EPG which required a password for access and the difficulty of navigating the EPG and finding the templates. It was therefore easier to get the templates from the file server. Even those who did access templates through the server did so mostly through the template index page rather than through the EPG information pages as shown by the page "popularity" measure that shows the template index almost as popular as the main index page.

The importance of, discussion about and reported use of templates may be inflated in this study because of the software process improvement goal. Improving documentation was the goal, therefore templates were reported a lot and discussed a lot. If the improvement goal

had been, for example, to improve testing processes, the results may show quite different use of the EPG especially regarding templates.

There emerged from the study many possibilities for improving the EPG. Many were suggested directly by the users while some are proposed from the observed usage patterns.

Users complained in the survey extensively about the lack of a good overview of the process. They also cited lack of an overview as a reason for not using the EPG in the EPG server log interviews. This made navigation difficult, made it hard to understand the process and hard to find information. A graphical overview with hyperlinked navigation was sought. This would assist every observed use of the EPG.

In the survey users requested better navigation facilities in the EPG. This is supported by the extensive use of the template index page to access templates rather than navigating the EPG information pages. Navigation tools that provide easy access to the most used parts of the EPG (for example, the template pages) would greatly increase the ease of use of the EPG and may encourage more usage. It is especially important for things like templates that users are encouraged to access the templates from the EPG so that they can always get the most up-to-date version.

In the survey one user suggested that the ability to generate task lists from and record status of a project in the EPG would be a major improvement. The EPG server interview data supports the finding that a major use of the EGP was to define task lists for projects. An improvement would be if tasks selected from the EGP could be exported to a process management tool to automatically generate the task list for a project. Several users also commented on the inability to record or access the status of a project through the EPG. Providing such a link would encourage the use of the EPG to define task lists and encourage developers to refer to the EPG for guidance during process execution.

Many users commented in the survey about the lack of opportunity to tailor the EPG to specific projects and users. This is supported by the EPG server log interviews where users cited the "inappropriateness" of the process as a reason for not using the EPG. Users envisaged being able to select only the tasks required for particular projects and/or a smaller version of the process for smaller projects. In this study this was achieved by defining the task list as a subset of the activities in the EPG and then using that to guide the process. Probably the biggest improvement that could be made here would be to provide several versions of the process for different types of projects as it is unlikely that many project managers would have the skills required to fully tailor a process for a project.

One suggestion obtained from the survey was that the EPG should contain examples of documents as well as document templates. The examples could be used to help users fill out the templates. This is supported by the EPG server interview data where several users said they used documents from past projects as the basis of new documents rather than the raw templates. The data in the documents can not only be tailored to the new project but it

shows clearly what information is expected in what sections of the templates. This is very close to an experience factory style approach to process improvement, and one could envisage not only including examples of documents in the EPG but past experiences as well (including, for example, effort data for an activity from past projects). The context for the experience (i.e. the meta-model) would be the process, with experience and examples linked directly to the activities or artifacts in the EPG. Users believe this would be a great improvement to the EPG.

Unfortunately the outcomes reported in the survey cannot be verified with other data (no process measurement data for the company is available). It is true that documentation was produced where no documentation would have existed before, but the quality of this documentation was not assessed. The users were happy with the outcome of the SPI effort and will continue their process improvement efforts including using and improving the EPG. The managing director estimated the return on investment for the SPI effort at 2.5:1.

8. Limitations

One of the limitations imposed on this study in the close relationship between the use of the EPG and its content, i.e. the streamlined ISO process. During the study users expressed opinions on the process as well as the EPG technology. They reported that they found the process did not really suit the way they worked. It was described, for example, as “too heavy” and “too linear” and “not suited to later phases”. As a consequence, the results of this survey have been influenced by the content of the EPG. Some possible effects are that overall usage would have been higher if the process was better suited, especially in later phases, and that the EPG may have been used more as a guidance tool by developers. There also may not have been so many requests to provide tailoring facilities. One way to limit the effect of EPG content on a study of EPG technology would be to implement a process that is already in use via a paper-based guide in an electronic guide and study the effects.

One factor that could affect the results on PageSeeder is that one of the members of the users at Allette Systems was involved in development of the PageSeeder system. This particular user was noted to have used PageSeeder a lot, started many discussion threads with it and made many positive comments about it in the survey. Without his influence the use of PageSeeder may have been much lower. While the use and benefits of PageSeeder may have been inflated by his input, the data shows that other users found the use of the PageSeeder as a discussion forum within the EGP a valuable process and process improvement tool.

During the project the researchers worked closely with the participants and inevitably formed opinions about results from discussions with and observations of the users. One of the researchers also worked closely on the development of the Spearmint/EPG tool. Such opinions and experience may influence the interpretation of results, especially qualitative data such as the survey results. To limit this effect all results and interpretations were discussed

amongst the four researchers in an open atmosphere. Therefore, the interpretations reported here have been reviewed and agreed on by four individual researchers. The results of the study (including this paper) were also reviewed by representatives of the company to determine that the results reflect their experience in the study. In these ways researcher bias has been reduced as much as possible.

9. Conclusions and future work

The result of this study is a better understanding of how the EPG can be used to support SPI and how it can be improved. With respect to the research questions, the EPG log shows that the EPG was used, albeit with a general pattern of declining use over the period of the evaluation. The main uses of the EPG were to support process improvement and it contributed to the improvement outcomes by helping to define templates and task lists for projects and, significantly, by providing a discussion forum for improving the templates. Somewhat surprisingly EPG was not used to guide projects (mostly due to the unsuitability of the process and the lack of good overview and navigation tools) and users did not find it convenient or useful to access templates. In the study the provision of a process through the EPG did result in positive outcomes for the company including improvements in documentation, better project estimation, planning and management and improved relations with customers.

With respect to possible improvements, the evaluation shows that the EPG could contribute more support to process improvement with some simple modifications like improving overview and navigation tools, linking to project management tools, providing tailoring features and incorporating examples and experience . These improvements could result in higher and more diverse usage and make the EPG more effective.

Future work should address the improvement suggestions for the EPG and verify the resulting effects. The results of this study could also serve as the basis for more rigorous experiments into the use of EPGs.

Appendix A: Questionnaire 1

EPG Questionnaire

Please complete this questionnaire if you've used the EPG in the last two weeks.

Name: _____

Date: _____

(Your name is required for the evaluation study. All information you provide will be treated confidentially. Personal information will not be published or released to anyone outside the research team and will not be used for personal assessment.)

Did you find using the EPG benefited your work? Yes/no
If yes, how?.

What did you find good about the EPG?

What did you find bad about the EPG?

What features of the EPG did you use most?

For each feature you listed above, what tasks were you doing when you used this feature?

What was it like to access information via the EPG? (please mark the scale)
Very hard 5 _____ 3 _____ 0 very easy

What navigation features did you use? (please mark the scale)

Hyperlink from a particular page to an associated page	a lot	5 _____	3 _____	0 not at all
The project navigation tree (top left of each page)	a lot	5 _____	3 _____	0 not at all
Hyperlinks from the main project page	a lot	5 _____	3 _____	0 not at all
Previously established bookmarks	a lot	5 _____	3 _____	0 not at all
Other (please specify) _____				

Did the EPG lack any information you required? Yes/no
If yes, what information was lacking?

Did you download any templates or examples from the EPG? Yes/no
If yes, what were they and what did you use them for?

Did you ever refer to the paper version of the process (i.e. the ISO 12207 Standard)?
Yes/no
If yes, why and what for?

In your experience, what improvements could be made to the EPG?

Appendix B: Questionnaire 2

EPG Final Questionnaire

Please complete this questionnaire if you've used the EPG over the last 2 months.

Name: _____

Date: _____

(Your name is required for the evaluation study. All information you provide will be treated confidentially. Personal information will not be published or released to anyone outside the research team and will not be used for personal assessment.)

Please read before completing this questionnaire

The purpose of a process guide is to communicate process information. Regardless of the information it contains, a process guide can be presented using different media, usually either as an on-line electronic guide or as a paper-based process handbook. In this survey we are interested in your opinions about the on-line electronic form as a media for presenting process information. ***With this in mind***, please answer the following questions:

What did you find good about the on-line electronic presentation of the process guide?

What did you find bad about the on-line electronic presentation of the process guide?

What features of the on-line electronic process guide did you use most?

For each feature you listed above, what tasks were you doing when you used this feature?

Do you think there are benefits of having an on-line electronic process guide as opposed to a paper-based process handbook? Yes/No

If yes, what are those benefits?

Do you think there are drawbacks of having an on-line, electronic process guide as opposed to a paper-based process handbook? Yes/No

If yes, what are those drawbacks?

In your experience, what improvements could be made to the on-line electronic presentation of the process guide.

Appendix C: Examples of codes and passages from the grounded theory analysis.

Code	Suggestions for Improvement	Positive features	Negative features or missing features	Advantages of having a Process Guide
<p>Passages</p> <ul style="list-style-type: none"> - "An overview of the activities and artifacts and how they relate to each other. That is we have to go to a particular task to know what document has to be produced." (1) - "Some examples corresponding to some tasks, (technology, tool, practical example). (1) - "Perhaps more examples" (6) - "More examples and perhaps a one hour (or so) overview to show how everything fits together and how the documents relate to each other" (6) - "It would be good for us to have standard task lists which including different scenarios such as prototype development, multiple software items, iterative development, etc. so we can quickly put together tasks and time estimations for a project." (2) - "Integration with a project/time management system for easier planning, tailoring and keeping track of task allocation and progress" (2) - "It would make it easier to navigate through the different steps and more importantly to navigate to references easily." (4) 	<ul style="list-style-type: none"> - "...access to information is easier and faster since it is automated. We can then go from one section to another faster – without moving – We KNOW the information is available on line at anytime when required." (1) - "Various ways of finding the information" (1) - "...it makes it easy to uncover and keep track of dependencies without much thought". (5) - "Yes – presumably it's easier to recreate when it changes and it's certainly easier to get around." (5) - "As a guided practice tool, it facilitate quality analysis of projects with a minimum of training" (6) - "Accessibility – it was easy to find" (6) - "The electronic templates allow the process to be customized through the production of project specific documents, e.g. task lists, design systems requirements. Also having these documents in electronic form means that they can be kept up to date easily and the current version can be easily accessed by a team of people." (2) 	<ul style="list-style-type: none"> - "The navigation structure and paths". (1) - "...once the plan is done: the EPG becomes too generic to be really useful" (1) - "It's not always easy to read..." (1) - "It can be overly heavy in spots (disproportionate number of pages for small projects) and it requires some investment to understand the process (I wouldn't say that is bad, just an overhead that needs to be accounted for). However it seems to become significantly faster to use with experience" (6) - "In parts it was not easy to find examples or support for completing the documents." (6) - "Sometimes when constructing actual tasks in order you have to jump around a lot in the EPG to find the related EPG tasks. I think this is because the EPG is basically a waterfall model and Web development is highly iterative – I'm not sure how to make this any easier." (2) - "I found it annoying that the top right frame (project navigation tree) was so small and I had to keep scrolling it." (2) 	<ul style="list-style-type: none"> - "...while realizing the documents according to the EPG / ISO we are more conscious about the process model we are following and how we can describe efficiently the work we do." (1) - "It guides you when you don't know what step is next in your development process". (1) - "It has made it much easier to quantify, communicate and negotiate project fees". (6) - "It has also improved relationship with customers by helping them to understand the parameters of the projects and by providing improved certainly with deadlines" (6) - "Yes, the EPG provided significant guidance in scoping, costing and defining projects". (6) - "I used the EPG extensively when creating the task list for the Aspect project, to make sure I followed a logical structure and didn't miss anything." (2) - "It made my life so much easier when I had to create documentation on a project." (3) 	

- (1) Project Manager 1 (3) Developer 1 (5) Technical Manager
- (2) Project Manager 2 (4) Developer 2 (6) General Manager

Acknowledgements

We would like to thank Allette Systems (Australia) for providing the context for this case study, the Fraunhofer Institute for Experimental Software Engineering, Kaiserslautern, Germany for supplying the Spearmint/EPG tool and Weborganic Systems, Sydney, for supplying the PageSeeder tool. Funding for this project was provided through a collaborative SPIRT grant by the Australian Government (DETYA), AccessOnline Pty Ltd Sydney and Allette Systems (Australia).

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