Beyond the Process

Enriching Software Process Improvement with Knowledge Management

Hansen, Bo Hansen

COPENHAGEN BUSINESS SCHOOL
HANDELSHØJSKOLEN
SOLBJERG PLADS 3
DK-2000 FREDERIKSBERG
DANMARK

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Bo Hansen Hansen

LIMAC PhD School
Programme in Informatics

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Enriching Software Process Improvement with Knowledge Management

PhD Thesis

Bo Hansen Hansen
bo@2hansen.dk

LIMAC PhD School, Programme in Informatics
Copenhagen Business School, Department of Informatics
Howitzvej 60
DK-2000 Frederiksberg
Denmark

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Acknowledgements

To explicate something that has been a close and integrated part of my life for a period of more than three years has, to put it mildly, not been an easy task. However, I hope that the following text is not only understandable, but also interesting and inspiring for the reader. If my work contributes to the body of knowledge of SPI in the slightest way, my personal goal has been achieved.

This thesis has by no means been conducted by me alone: My partner Micha has provided me with support—and her patience has been almost infinite. Our children, Emily and Niklas, who happened to be born in the middle of it all—surely disturbing everything, but also teaching me something about relative importance, also have a large share in this work.

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Lastly, I would like to credit my supervisor, Karlheinz Kautz, for his care—without it, this would not have happened.

> "Experience is something I'd like to have without going through all the trouble of getting it." (DeLillo, 1971, p. 303)

Danish Summary

Formålet med denne afhandling er at belyse, hvorledes softwarevirksomheder kan forbedre deres udviklingspraksis ved at udnytte deres vidensressourcer bedre. Afhandlingen belyser dette ved at besvare følgende forskningspørgsmål:

- *Hvorledes kan en softwarevirksomheds videnstyringsstatus bestemmes med henblik på at kunne identificere vidensrelaterede forbedringsområder?*
- *Hvorledes kan forbedringer af sådanne områder planlægges via design og tilpasning af nye organisatoriske tiltag til styrkelse af organisationens læringsmuligheder?*
- *Hvorledes kan sådanne forbedringsinitiativer faciliteres og implementeres for at sikre accept og fortsat udvikling?*

Afhandlingen er en del af det nationale forskningsprojekt Softwareprocesser og Viden og er udarbejdet som et aktionsforskningsprojekt hos softwarevirksomheden Systematic Software Engineering i Århus.

Afhandlingen leverer, foruden forbedringer i den involverede organisation, teoretiske og metodiske bidrag til softwareprocesforbedringsfeltet ved at vise hvorledes teoretisk input fra vidensstyringsfeltet kan integreres i og styrke softwareprocesforbedringsfeltet, samt ved at vise hvorledes komplekse organisatoriske sammenhænge kan belyses ved at anvende en passende og fleksibel portefølje af analyse— og interventionsteknikker.

Derudover bidrager afhandlingen med udviklingen af en balanceret teori om vidensstyring i softwareprocesforbedring. Til dette formål introduceres begreberne eksemplarisk og situeret videnstype og normativ og reflektiv processforbedring.

Afhandlingen anskueliggør desuden, hvorledes et længerevarende samarbejdsbaseret studie har bidraget med resultater internt i case-organisationen ved at designe og tilpasse en ny projektevalueringsproces, der er baseret på et skifte mod en situeret vidensorganisation ved aktivt at involvere de eksisterende ekspertnetværk i organisationen.

Gennem designet af denne ny proces belyses, hvorledes Softwareprocesforbedringsfeltet på et teoretisk niveau styrkes igennem integration af teorier fra beslægtede felter. Afhandlingen viser, hvorledes kulturanalyse og videnskort kan anvendes som softwareprocesforbedringsteknikker. Derudover antyder afhandlingen en balanceret teori om vidensstyring i softwareprocesforbedring, der beskriver betydningen af at søge en ligevægt imellem den herskende organisatoriske videnstype (eksemplarisk vs. situeret) og softwareprocesforbedringsmetode (normativ vs. reflektiv).

Slutteligt viser denne afhandling, hvorledes et længerevarende forskningsprojekt, inspireret af aktionsforskning, kan styres og fokuseres igennem anvendelsen af Collaborative Practice Research.

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Chapter 1

Introduction

In post-industrial organisations the primary asset is no longer the physical equipment and production environment, but rather the know-how of the employed work force. Modern products and services are based on information technology which creates new opportunities for low marginal costs, low distribution costs, and global reach (Shapiro & Varian, 1999). At the same time the customers are seen to be growing in sophistication and are increasing their demands (Davenport & Prusak, 1998). This shift towards a knowledge society is in itself a change of environment that every modern organisation must deal with (Liebowitz & Beckman, 1998) and has led to the establishing of a knowledge management discipline (Swan *et al.*, 1999b).

The key asset for modern companies thus is their ability to develop and utilise the intellectual competences of their employees to create services of value for their customers (Quinn *et al.*, 1996). In this respect software developing companies are no exception, and they too, in their pursuit of greater professionalism, continuously have to improve their performance. The development of information systems is dependent upon knowledge of the application domain and development practices, which is why the knowledge management field continues to attract more and more attention in the software development community, both academically and in industry (Dingsøyr, 2001; Kautz & Thaysen, 2001). With this concern for improvement, the research into this area is rooted in the software process improvement (SPI) field.

This thesis is an independent part of the Software Processes and Knowledge (SPK) Project, a national Danish research project concerned with SPI and knowledge. It explores the practical sides of improving software development through knowledge management. The terms of reference for the SPK project are the following:

> "[How can] Danish companies, on an organisational level, base and strengthen the SPI activities through the establishment of a learning software organisation [. . .]" (Nielsen, 2003, my translation)

by

> "[. . .] strengthening and developing further the scientific basis for the work by the utilisation of experiences and terms from Knowledge Management" (ibid).

The researcher's motivation (viz., *my* motivation) for conducting this thesis arose not only from my previous academic interest, but also from practical experiences of working with development teams in the Danish banking and internet/telecom industries.

Through this work in Danish software developing companies, experience was gained how random re-use of previous experiences has resulted in the repetition of mistakes and the re-inventing of ideas, which has led me to consider whether important and relevant experiences could be shared among project participants and projects. This personal experience has shown that knowledge gained from running software development projects often is lost or scattered when the project concludes, and especially when participants move on to new projects. Too often it is totally dependant on the participants' initiative whether knowledge is pro-actively utilised when planning and conducting future projects. Here is considerable scope for reuse. Although every project is unique, it can be assumed that some aspects related to carrying out software development projects do not change dramatically from one project to another. Thus it seems unwise not to establish at least some routines to collect, process, and utilise such previous experiences.

Through previous empirical studies[1] I have shown how the application of development methods and methodologies seek to avoid these problems by standardising the development process. But the studies also show how these methods themselves do not have the intended effect on the practice in software projects, since they introduce other problems, e.g., posing a too fixed or too limited mindset onto the creative process of software development.

Further, if SPI related initiatives are to be successful, they will have to be adopted by the organisation's individuals. This means that the purpose of SPI eventually is to change the practice in an organisation. SPI focuses on the organisational processes and, as such, is often anchored towards analysing and optimising these processes rationally. However, as pointed out by several studies, e.g., (Brown & Duguid, 1991; Bansler & Bødker, 1993; Fitzgerald, 1998a; Madsen & Kautz, 2002; Kautz *et al.*, 2004), changing the process does not necessarily result in a change in the actual practice in the organisation, and thus the change is not impacting the organisational performance as intended. This gap between method (or process) and practice might even be cumulative in the situation where process creators rely on the process as the outset for further improvements—instead of actual practice. In these cases the designers analyse an idealised image of the organisational practice and, as such, propose improvement initiatives that are even more out of sync with the organisational reality. This might in the worst case scenario lead to two mutually independent organisational realities co-existing: one rational, coherent, with detailed documentation, but unfortunately imaginary, and one self-controlling and autonomous and random, but real.

> "An important aspect of my research is that it is important to focus on what 'people' actually do. Improving an (software) organisation is improving practice—not improving a vision, or an image of practice" (Scott Ambler, 2004 EuroSPI Conference, Trondheim, Norway).

To avoid these situations, the focus has to be on integrating the process and process improvement with the organisational practice. To signal this focus

[1] Especially my Master thesis (Hansen & Jacobsen, 2002)

and to emphasise that process and method descriptions are not automatically linked to actual practice, this thesis focuses on software *practice* improvement rather than software *process* improvement. This implies that effort has to be put into the transformation of ideas and concepts, and putting processes into practice—an effort that is reflected in the choice of the research approach.

Based on these experiences, the practical side of introducing knowledge management (KM) inspired ideas merge with the SPI effort in a software organisation, as well as the SPK project's intentions, this thesis' objectives are to conduct (and document) practical SPI-improvements achieved in the organisation by

- developing new techniques and combining existing techniques to improve the knowledge management capabilities in software organisations,
- establishing a means for facilitating these techniques into such organisations, and by
- providing empirical proof of concept for the applicability of the techniques.

To achieve these objectives, this thesis aims at answering the following research questions:

- *How can the knowledge management status of a software organisation be analysed in order to identify knowledge related improvement areas?*
- *How can improvements of such areas be planned by designing and aligning new organisational initiatives to strengthen the organisation's learning capabilities?*
- *How can such improvement initiatives be facilitated and implemented in order to secure acceptance and continuous evolution?*

These research questions are answered through a longitudinal collaborative based action research in a large Danish software organisation; the study thus contributes both to the SPI and the KM fields, providing valuable insights into how meaningful KM can be conducted in software organisations.

In the following paragraphs a brief summary of each of the chapters of the thesis is provided as a guide to the reader. The descriptions help the reader by *A*) elaborating the structure of thesis, and *B*) by supplying the necessary information to make it possible to understand the details of any section without having to read all prior chapters.

Chapter 2 presents a literature survey of the SPI field highlighting the state of the art of this field. In this survey the SPI contributions are categorised according to a classification scheme which spans from normative contributions to reflective contributions. The result of the classification shows that the SPI field is dominated by normative contributions, and that the field would benefit from more reflective and critical contributions. The survey suggests, such reflective contributions can be achieved by introducing theories from other disciplines into the SPI work. Although the literature survey is recognised as being an integral part of the research approach it is presented before the collective research approach in Chapter 4, since the survey to a large extent informs the research questions, and thus the research approach. Chapter 2 further introduces the KM discipline by defining knowledge, learning, and knowledge sharing. Doing so, two archetypal knowledge organisations, namely the exemplary and the situational types, are defined which represent two fundamentally different approaches to working with knowledge sharing. The chapter concludes by combining the findings from the SPI field with the organisation archetypes and this way suggests a correlation between SPI approach and archetype.

In Chapter 3 the host organisation, Systematic Software Engineering (SSE), is described with an elaboration of the structure of the company and its constituents. The section begins with a description of SSE's products, viz., which type of software is produced, and for which clients. This is followed by a description of the employees working in SSE and how they work. The development projects of the organisation are then introduced and detailed explanation of how projects are conducted and managed in SSE is given. Based on this introduction of the company, the description of the business development department in which the company's SPI efforts are based is provided. The SPI project, viz., the project that is in charge of the SPI initiatives and of the organisation's process framework, is explained, along with a description of the company's business manual. Further, the intellectual capital reports, which are an important means of communication and therefore a source of information regarding the official view of the organisation, are identified. Chapter 3 concludes with a description of the history of SSE focusing on the events leading up to this study and describes the challenges that SSE faced at that time.

Chapter 4 introduces the research method chosen for this study. The research objectives are presented and an explanation is given of how a collaborative practice research (Mathiassen, 2002) inspired approach is applied in a cyclic manner to achieve these. Three research cycles were planned and performed, each defining and addressing a specific research question operationalising the study's objectives. The section also describes conceptually the data gathering techniques applied and details are given as to how these techniques were integrated into the research outline. The research outline presents two supporting analysis techniques, a narrative and a cultural analysis, to complement the research cycles.

In Chapter 5 the story of the study is presented. This section describes the three successive research cycles as they were carried out during the study's duration. The section is narration based, viz., it describes verbally the flow of the study in each of the three cycles. This section provides the details regarding the application of the research method and techniques introduced in Chapter 4. The context of each of the three research cycles is chronologically explained and the application of the analysis techniques and the intervention approaches are documented and argued for.

Chapter 6 presents the results from the cultural analysis in which the values of SSE are identified. The analysis covers both the explicit values, viz., the official values as they are presented by the company itself, and the implicit values. Three distinct axes along which the organisational culture can be described are identified. It is shown how these are an integral part of the understanding of the organisation, and thus an important factor for designers of SPI related initiatives.

Chapters 7-9 present the results from each of the research cycles and provide detailed answers to the research questions. These chapters are of a descriptive character and focuses on presenting the outcome of the three research cycles. In Chapter 7 the first cycle is presented with a description of how the knowledge mapping technique was designed to provide the means for analysing the current knowledge status of the organisation. The technique relied on a collaborative intervention in which a knowledge map was drawn. This section provides the details regarding this mapping session, and shows how it helped the involved parties to identify and select an improvement candidate, namely the project evaluation process, which became the main focus of the rest of the study.

Chapter 8 describes how a new project evaluation concept was designed and tested. An analysis of the established practice in combination with the results from the cultural analysis provided the necessary background for designing the new concept. The new concept introduced ideas from the KM field and pro-actively involved the existing specialist networks of the organisation in the evaluation process. The new concept was tested through two pilot studies carried out by development projects. The results of these studies are also presented in Chapter 8.

Chapter 9 reports the transformation of the new evaluation concept into an organisational process; the results from the pilot studies were used to inform the finalisation of the process description. This section further describes how the process was aligned with the established way of documenting processes, and how the final suggestion was tested via two successive quality reviews. The action research study ended here before the actual roll-out of the process in the organisation.

Finally, in Chapter 10 the conclusions of the study are presented, as well as how this study contributes to the SPI field on three different levels. First, it answers the research questions by describing how empirically documented interventions in the organisation lead to expected practice improvements. Second, it contributes with the design of two SPI analysis methods; the cultural analysis and the knowledge mapping technique. Both are tools for SPI practitioners to analyse a specific SPI setting with regards to understanding and improving it. Further, it is shown how the combination and application of these techniques constitutes a theory of KM in SPI, which balances norm based and reflective approaches with the exemplary and situational knowledge organisation types. Lastly, this section provides an explanation of how the documentation of the research approach that was chosen for this study contributes to the body of knowledge within the SPI field and to knowledge about the application of action research in information systems and software engineering research in general.

Chapter 2

Theoretical Background

The theoretical of this thesis builds upon two fields: Software process improvement (SPI) and knowledge management (KM). Initially a literature survey of the SPI field was carried out (Hansen *et al.*, 2004a). The purpose of the survey was to present the state of the art of the SPI field. This survey identified relevant topics within the research area to which this thesis could contribute. In this chapter the results from the survey are presented. Further, this chapter includes an introduction of relevant theories from the KM field. These theories constitute the other theoretical basis upon which this thesis' findings are based. The chapter concludes by combining the categorisation scheme of SPI approaches with the theories from the KM discipline. This combination shows how different approaches to SPI and KM supplement each other.

2.1 Software Process Improvement

SPI is an applied field grounded in the software engineering and information systems disciplines. It deals primarily with the professional management of software firms, and the improvement of their practice, displaying a managerial focus rather than dealing directly with the techniques that are used to develop software. In terms of its theoretical heritage, SPI is equally indebted to the software engineering tradition and the total quality management (TQM) movement (Deming, 1982; Juran & Gryna, 1988). Classical SPI techniques such as those built upon the capability maturity model (CMM) (refer to Section 2.1.2.1) relate to software processes, standardisation, software metrics, and process improvement.

The scope for SPI research presented here is broad, as it includes approaches which do not only focus specifically on the process part of SPI, but instead on the purpose of SPI, namely to improve the software development practice in general. By adapting this view, I stress that a software development organisation needs to be understood as as a coherent system and further that it is this coherent system which the SPI field aims at improving. When trying to identify improvement areas, the whole system has to be taken into consideration and it is not possible to pre-define certain parts of this whole to be irrelevant or out of scope. Critics might claim that, by adapting a broad definition, I am not discussing the SPI field, but instead other related fields. However, to me the differences between these fields are insignificant when concerning software development companies, because in such companies the managerial tasks by definition *are* SPI tasks.

2.1.1 A SPI Literature Review

Webster & Watson (2002) suggest that literature reviews constitute an important part of the development of the IS field. Literature reviews offer the opportunity to synthesise and reflect on previous theoretical work, thus providing secure grounding for the advancement of knowledge. The authors suggest that the elements of a good literature review include a structured approach to identifying the source material and the use of a concept matrix or other analytical frameworks leading to

> "[...] a coherent conceptual structuring of the topic [...]" (Bem, 1995, p. 172)

2.1.1.1 Analysis Framework

To categorise the contributions an analysis framework was applied consisting of three categories. The first two categories were taken from Mintzberg's extensive survey of the strategy formation literature. He labels some of the strategy schools as prescriptive—viz.,

> "[...] more concerned with how the strategies should be formulated than with how they necessarily *do* form." (Mintzberg, 1990)

In SPI this category is often titled norm or model based (Aaen *et al.*, 2001) and for this reason I label the prescriptive contributions normative. Other kinds of schools Mintzberg labels descriptive—they are concerned

> "...less with prescribing ideal strategic behaviour than with describing how strategies do, in fact, get made." (ibid.)

These categories can easily be related to the SPI literature, which is concerned both with specifying how software processes could or should be improved, and with describing experiences of such improvement programs in software organisations.

Since neither of these literature types is primarily concerned with the theoretical analysis and reflection of theoretical knowledge, I supplement the framework with a third: reflective. Reflection in this context has an explicit theoretical focus, using theory for analysis, or generating new theories or theoretical understandings. Reflection, for example, is concerned with reviewing or categorising prescriptions and/or descriptions against some form of theoretical canvas, or with generating such a canvas against which contributions to the field could better be understood. It may also be concerned with exposing or challenging basic taken-for-granted assumptions (the dominant paradigm (Kuhn, 1962)). It may focus on what Schein (1973) calls the 'underlying discipline' or 'basic science' component upon which the engineering practice is based. Mintzberg's review of the strategy literature, for instance, would be classified as reflective in this academic context, in that it

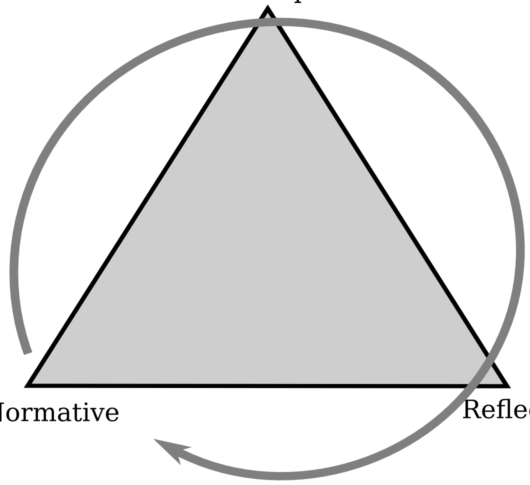

Figure 2.1: Categorisation framework

seeks to develop a framework (the ten strategy schools) against which many theoretical and practical experiences can be evaluated.

Using the terms normative, descriptive and reflective, the evolution of an applied academic field can be represented as a cycle, in which

1. norms/prescriptions about practice are carried out in work situations,
2. the resulting experiences are precisely described in order to generate better understandings, and
3. the resulting understandings are reflected in order to generalise them to theory, which could then form the basis for better normative models.

This is illustrated in Figure 2.1 on page 26.

So, in all, the literature contributions were categorised according to: *A*) whether their primary goal was normative, viz., to inform SPI practitioners about how to conduct SPI, *B*) descriptive, viz., to report from the conduction of SPI, or *C*) reflective, viz., analysing SPI theoretically.

2.1.1.2 Article selection

The article selection approach applied in the survey focused on identifying SPI related contributions from top IS journals, SPI journals, special issues on SPI, literature review articles from within the SPI field, key SPI contributors, SPI schools (e.g. the Software Engineering Institute (SEI) at Carnegie Mellon University), key authors, e-search tools, and finally identifying books written on SPI. Contributions that were included named software process improvement in the title, abstract or keywords and in addition had relevant content. The relevancy was decided by scanning the abstract and/or keywords. Academic conference proceedings were included, but non-academic sources such as practitioner journals and practitioner conferences were excluded. The approach was iterative, viz., new finds lead to further improvement of the search criteria. The resulting list contained 365 relevant contributions, with more than 150 contributions available in full text format, and enough additional information (in the form of abstracts, keywords, and notes) to categorise 279 entries.

2.1.2 Normative Contributions

Normative or norm based approaches to SPI display a common set of characteristics. They focus on software development processes at the organisational, project, team, or individual level, and are concerned with standardising and improving those processes. They prescribe norms for how individuals, teams or organisations should operate, and for how processes should be standardised and improved. They assume that processes can be measured, both as a baseline for improvement and to provide indications of subsequent improvements. They normally assume that well-understood software development processes exist that everyone agrees can be recommended in all situations. Organisational improvement is normally related to a maturity ideal: the mature organisation has articulated, standardised, measurable software development processes and measures them in order to learn how to improve them further. Maturity levels can be measured, using various questionnaire based techniques, and ‘immature’ organisations should normally follow a prescribed road-map to achieve the next maturity level.

Many of the major contributions to normative SPI originate from the SEI. This institute is industry-facing and supported by the American Department of Defence, whose principle interests are to identify competent software suppliers and ensure the delivery of high quality software.

2.1.2.1 The Capability Maturity Model

Originating from SEI, the CMM is probably the best known and most widely used approach to SPI. CMM is formally defined as

> "a description of stages through which software organisations evolve as they define, implement, measure, control and improve their software process" (Paulk *et al.*, 1995).

The development of the CMM model was based on Humphrey's definition of a software process maturity framework (Humphrey, 1988). The SEI worked with industry and government for four years to develop the CMM before it was published (Paulk *et al.*, 1993), and it is still evolving in response to feedback from the practitioners using it. The CMM principle has also been extended to other areas (Konrad *et al.*, 1996), including the: Software acquisition CMM, system engineering CMM, integrated product management CMM, and people CMM. In 1997 the proliferation of models led to an effort to integrate them into CMM Integrated (CMMI) (Ahern *et al.*, 2001; Reifer, 2002).

The CMM model describes how companies can mature according to specific stages. CMM and the derived CMMI describe five levels of maturity, 1: Initial, 2: Managed, 3: Defined, 4: Quantitatively Managed, and 5: Optimised, against which a software organisation can be assessed. Level 1 is the not-managed stage where ad hoc or non-deliberate actions define the orientation of the company and, as such, an assessment has no value, which is why the CMM model actually does not describe this initial level. Level 2 is the stage where the organisation manages its processes and its projects according to these processes. Level 3 is where the processes are defined and interlinked into a coherent process framework. Monitoring of tasks is implemented which project management can rely upon during the daily planning and managerial tasks. On level 4 the organisational processes are defined in detail, and the underlying cause-effect relations are known to a degree where quantitative monitoring can measure the improvement ratio directly, and further point to relevant candidate areas for further improvements. Level 5, the highest, and thus the most mature level, prescribes how the organisation engages in continuous learning and improvement. To achieve this level, an organisation must be able to manage its knowledge in a proper manner, which is also why software companies are becoming increasingly interested in the KM field (Dingsøyr, 2001; Kautz & Thaysen, 2001).

The CMM model describes the levels in details and focuses on which particular key process areas on each level are the most important to establish, monitor, and control. By controlling these key areas, the organisation can be assessed by external auditors, often from approved consultancy companies, as to whether they comply with the model on a specific level or not. These compliance statements are often crucial market openers, as many larger software customers require certification on a certain level of their suppliers.

The CMM model suggests two different approaches for companies to become mature, the staged and the continuous. The staged approach describes how a company implements all necessary requirements to achieve a certification on a certain level, and based on successive assessments climbs the CMM ladder one step at a time. The other approach allows for a more fluent ascent in which a company can focus on improving specific process areas even if these are defined on different levels in the CMM model. This latter approach is harder to base an assessment upon, as the model to a large extent relies on the inter-dependencies between process areas on each level. However, in principle, no fundamental problems hinder a company to be on one level in one process area, and on a higher or lower level in another process area.

The SEI has also developed other norm driven SPI approaches which are complementary to CMM. IDEAL is a practical approach to managing a software process improvement initiative. The activities (Initiating, Diagnosing, Establishing, Acting and Leveraging) function as a normative managerial superstructure for a SPI initiative. The Personal Software Process (PSP) (Humphrey, 1995) focuses on the individual discipline of software engineers, in relation to the organisation's progression to maturity via the CMM, by addressing the formal processes, measurements, documentation, statistical assessments, scheduling and assessment techniques. Since writing professional programs is normally a team effort, rather than an individual effort, Humphrey also developed the Team Software Process (TSP) (Humphrey, 1997, 1998, 2002). PSP and TSP can be seen as responses to early criticism that the CMM was too process orientated and ignored the human factor, namely the contribution of professional software developers.

Normative SPI approaches have been developed outside the SEI also. The BOOTSTRAP methodology (Kuvaja & Bicego, 1994; Kuvaja *et al.*, 1994) was initially developed in an ESPRIT[1] project and is now the responsibility of the BOOTSTRAP Institute. Version 3.0 was released in September 1997 (Kuvaja, 1999). It combines elements of CMM with the relevant ISO, Department of Defense and European Space Agency software standards, in order to provide tools, essentially a detailed questionnaire, for carrying out maturity assessments and thereafter making appropriate action plans. In TAPISTRY—a software process improvement approach tailored for small enterprises (Kuvaja *et al.*, 1999) the authors address the European market situation, which is characterised by many small and medium size enterprises that either cannot afford, or are not culturally suited to the full-scale assessment methods. The SPICE Project (Software Process Improvement and Capability dEtermination)[2] is the name commonly used for a project with the purpose of developing a working draft for a standard for software process assessment, conducting industry trials on this, and promoting the software process assessment to industry. The work originated from the existing assessment models and tried to develop a common base, on which the standard should rest. The SPICE standard does not in itself specify an assessment model or method, but defines a set of requirements that a model or method needs to meet to comply with the standard.

[1] http://cordis.europa.eu/esprit/home.html
[2] http://www.isospice.com/spice/spiceproject.htm

The above mentioned approaches all have relied on models describing how software is developed the 'optimal' way, and thus describing paths to help organisations adopt these models. Another type of normative approaches focuses on solving organisation-specific problems. These problem driven approaches to SPI (Cusumano, 1989; Aaen *et al.*, 1998) share some of the characteristics of the model based approaches, but are distinguished by focusing on ways to identify and solve specific problems in a software organisation, instead of prescribing a desirable model for developing software. They do not, therefore, normally incorporate assessments. As in the model driven approaches, software development is considered a repeatable process, consisting of sub-processes and procedures, which can be described to a certain level of detail. Systematisation and standardisation are the main coordination and formalisation mechanisms, and the focus is on long-term, integrated, organisation-wide efforts which are centrally planned and managed.

The industrialised software organisation or Japanese software factory approach is not a formally defined approach, but a practice evolved in large Japanese corporations. One example is Toshiba (Matsumoto, 1981, 1987) which operates a three phase model: designing physical surroundings to support the development process, constructing integrated software support for the development process, and establishing a monitor and control system for the development process. By applying these steps simple and repeatable work routines are created, which aim at heightening product quality without jeopardising the productive momentum.

The application of metrics in industry (AMI) method is the result of an ESPRIT funded project with the purpose of filling the gap between software process assessments and actual planning actions. The resulting method, described in an AMI handbook (Pulford *et al.*, 1995), is a pragmatic, incremental, quantitative approach applicable in any software business because of its claimed flexibility and adaptability to any organisation structure or team size.

The generic software factory or the Eureka software factory project (Weber, 1997) was set up with the purpose of providing a generic architecture, a framework, and to some extent a technological infrastructure for developing software factories, making it both easier for companies to build their own software factory, and for companies to design tools supporting them in that.

The experience factory (Basili *et al.*, 1994a; Basili & Caldiera, 1995a) describes an approach to problem driven SPI where the authors put forward an infrastructure outlining a two-tier organisational structure: the development organisation and the experience factory. The first develops and delivers software and while doing so it also provides information to the latter. Based on this information, the experience factory actively supports development projects, and provides goals and models based on previous experiences. A methodological support device, the Quality Improvement Paradigm, is provided, consisting of a six step cycle (understanding the process and product, definition of the process and product qualities, evaluation of successes and failures, information for project control, learning from experience, reusing of experience). By following these steps, the company can continuously learn from experience on two levels, the individual projects (the development organisation), and on the corporate level (the experience factory). Another important tool in the experience factory is the goal/question/metric paradigm (GQM) (Basili *et al.*, 1994b) which supports the goal setting and measurement process.

2.1.3 Descriptive Contributions

Descriptive contributions are those which take as their principal focus the reporting of actual SPI initiatives in companies. Much of the descriptive work relates to experiences with the CMM. A distinct subcategory of descriptive contributions—success stories—are reports of successful projects written by people heavily involved in the projects, such as CMM consultants and SPI project managers.

A strong element in the SPI literature concerns the narration of success stories. Examples are: NASA's Goddard Space Flight Centre (Basili *et al.*, 1994b; Basili & Caldiera, 1995b), Hughes Aircraft (Humphrey *et al.*, 1991), Raytheon (Dion, 1992, 1993; Haley, 1996), PRC (Hollenbach *et al.*, 1997), Motorola (Diaz & Sligo, 1997), Oerlikon Aerospace (Laporte & Papicco, 1998), Shlumberger (Wohlwend & Rosenbaum, 1994). These are representative of the core American experience, principally with CMM, but also with IDEAL and the experience factory approach. Success stories tend to present a generally positive tone about the SPI initiative described, and the narration of the success is combined with presentation of problems encountered, lessons learnt, and advice for practitioners, which are, however, not generalised to theory. The problems described do not challenge the underlying paradigm, but relate more to the operationalisation of the prescribed approach in the given context. Many of the well-reported success stories refer to relatively large, expensive projects in larger software firms connected to the American defence and aerospace industry.

A different approach to establish the benefit of SPI initiatives is found in a category labelled statistical surveys. These contribute to the SPI field by investigating very different subjects: CMM in small businesses (Brodman & Johnson, 1994; Bilotta & McGrew, 1998), the results and benefits of maturing (Goldenson & Herbsleb, 1995; Johnson & Brodman, 1996), the difficulty of examining return on investment through CMM (Johnson & Brodman, 1995, 1996), and what are the success factors of CMM (El-Emam *et al.*, 2001). These surveys have drawn on data from between 10 and 200 companies. The SEI has made a fairly substantial effort to provide a more general, statistically based evaluation of their CMM experience (Herbsleb *et al.*, 1994a,b; Herbsleb & Goldenson, 1996). Part of this effort was a questionnaire sent to 167 CMM organisations. The respondents (83% of the sample) reported some statistically significant correlation between performance indicators (such as keeping deadlines and budgets, and staff morale) and CMM level. Performance indicators reflect the perceptions of the (SPI connected) respondents. However, few of the companies had achieved a high CMM level; according to the (un-assessed) informal judgement of the respondents themselves, 63% were at level 1 (the 'stuck in first'-phenomenon (Johnson & Brodman, 1996)) and only 11% at level three or above. All the higher level organisations were 'government contractors'. When derived from the companies' (earlier) formal assessments these figures were 83% (level 1) and 7% (level 3 or higher), respectively. Another study (Herbsleb *et al.*, 1994a) showed substantial gains in productivity, defect detection and reduction, time to market and business value (set against considerable investment).

Also a number of more independent research oriented studies of SPI initiatives exist, namely case studies. Researchers have carried out a number of such case studies using a form of theoretical framework. Many of the SPI programs involved were inspired by CMM. A metrics program in a large Danish company has been reported and reflected upon in a series of contributions (Iversen, 2000; Frederiksen & Mathiassen, 2002; Frederiksen & Rose, 2003; Iversen & Mathiassen, 2003). Other research has focused on knowledge management and organisational learning (Arent & Nørbjerg, 2000; Kautz & Thaysen, 2001), on SPI in small companies (Kautz *et al.*, 2000, 2002), on the personal software process (Abrahamsson & Kautz, 2002a,b), on commitment (Abrahamsson, 2001) and on a reflective usage of the IDEAL model (Börjesson & Mathiassen, 2003). These themes also figure in other case studies: metrics (Bhandari *et al.*, 1993; Herbsleb & Grinter, 1998), knowledge management and learning (Gasston & Halloran, 1999; Conradi & Dingsøyr, 2000; Larsson & Kolb, 2002), small organisations (Kelly & Culleton, 1999). Other case studies touch on subjects such as quality and SPI (Edgar-Nevill, 1994), managing diversity (Deck, 2001) and SPI in web time (Wiegers, 1999).

2.1.4 Reflective Contributions

The reflective literature is sparse and differs much in style and purpose. Topics of discussion range from the core assumptions of CMM to the building of theoretical frameworks. The earlier contributions are focused on CMM itself, while the later tend to have a broader view of the SPI field. A couple of early articles take a critical look at CMM (Bach, 1994) and CMM assessments (Bollinger & McGowan, 1991; Bach, 1994). The main criticisms are that CMM has no formal theoretical basis, and little empirical support, that it ignores people, reverses the institutionalisation of process for its own sake, and that it introduces an artificial goal (achieving a higher CMM level) in place of the goal of writing better software. The SEI (Curtis, 1994; Campbell, 1995) replies that the misconceptions are due to ignorance of the CMM, it points to CMM's reliance on the principles of total quality management, and suggests that the focus on process is justified by software development and thus it demands a shared effort. Weaknesses in the grading templates and sparse data analysis are discussed; it is proposed that the grading system be abandoned and these themes continue to be discussed for some years (Bach, 1995; Fayad & Laitnen, 1997). Other strands of the reflective literature compare CMM and other approaches (Kohutek, 1996; Lyytinen *et al.*, 1998) or analyse and discuss CMM from a theoretical standpoint. Ngwenyama & Nielsen (2003), for example, investigate the underlying values of CMM, revealing contradictory assumptions about organisational culture. Some later reflective contributions try to build frameworks of SPI either to characterise and define the field (Aaen *et al.*, 2001) or to provide a tool for evaluation of different software process models (Saiedian & Chennupati, 1999). Aaen *et al.* (2001) build a conceptual map based on an extensive survey of the SPI literature and experience from SPI practice, in which characteristic features (management, approach and perspective) of SPI are described. The distinction between model driven and problem driven SPI approaches previously applied in this study, is another reflective contribution. Model driven approaches (Arent, 2000; Aaen *et al.*, 2001) are based on an underlying normative model of software process improvement (which usually includes an explicit or implied normative model of software development—the processes to be improved); the main purpose for a SPI initiative is to align the software firm with this underlying model. By contrast, problem driven approaches (Iversen *et al.*, 1999) prescribe how a software organisation can improve its problem identification and solving activities, and thus become better at identifying which parts of the development process need to be improved, and how to address this task. Hossein and Chennupati's (1999) evaluation framework focuses on goals of the model, structure, management role, use of metrics, benefits, underlying models, rating process, organisational impact and scope/domain.

2.1.5 Survey Results and Discussion

The contributions were categorised against the normative, descriptive, reflective framework, and the number of contributions in each was counted. It was understood that most of the contributions contain a mixture of these components, so the aim was to determine the primary purpose of the contri-

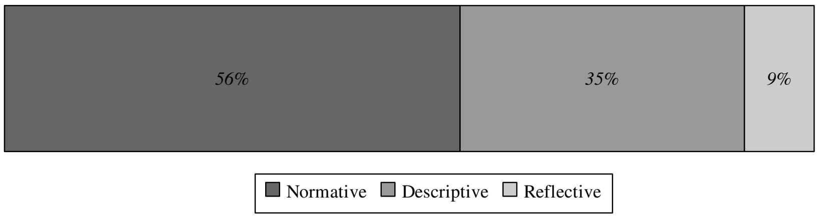

Figure 2.2: The shape of the SPI literature

bution, and record it accordingly. There were 279 items in the database with enough information to categorise; they distribute as represented in Figure 2.2 on page 36.

Many different SPI approaches exist in many different variations, but according to the result from this survey, the scientific description of these approaches has, until now, mainly been of a normative character. The fact that almost one third of the original contributions mentioned the CMM in the title, abstract, or keywords suggests that the CMM is established as a de facto standard or rather as a reference model within the SPI field. A further finding is that the majority of the literature concerning the CMM approaches is of a normative nature, presenting a guide to how to conduct CMM based SPI.

The characterisation shows that the SPI field is overly normative in its character and lacking reflective contributions. The comparative lack of critical scrutiny, rigorous descriptive research carried out by trained neutral researchers, and the theoretical influence from other related fields, together with the focus on applied techniques rather than the building of defensible theory, has meant that credible alternative ways of improving the making of software in software firms have either not yet emerged, or not been able to compete. The lack of serious reflective challenges may have stifled the development of a more multi-faceted range of approaches suited to fit in a variety of settings. Such a multi-faceted range of approaches could well be beneficial in the wide range of cultural and situationally different circumstances under which the software is built.

In order to build on the existing reflective work in SPI, this analysis points toward the need for the following types of SPI research: *A*) Descriptive studies of SPI initiatives carried out by trained independent researchers, *B*) the building of theoretical accounts of improvements in software construction based on relevant theories, and/or independently researched descriptions of actual projects, *C*) theoretical analysis of such descriptions using theories from related disciplines, and *D*) reflective cumulative accounts of any trends. Such forms of research may redress the balance and ensure a better balance between theory and practice in the future.

Further analysis suggests that descriptive contributions should include contributions other than success stories. Although the success stories provide interesting reading and serve to illustrate many of the practical hurdles to achieving SPI success, they lack 'representativeness' (Herbsleb & Goldenson, 1996). That is, they in themselves do not illustrate any general picture; especially where it is well known that many SPI initiatives are problematic or fail (Abrahamsson, 2002; Mathiassen *et al.*, 2002). The failures, however, are never or rarely reported.

All SPI approaches, including the CMM presented here, to a certain extent recognise the importance of knowledge in modern organisations and therefore refer to collecting and utilising organisational knowledge.

The objective of SPI is to provide improvement to the practice of software development companies. Software development companies are knowledge intensive companies and, as such, their practice relies on how well they manage their intellectual capabilities. The focus on managing knowledge in software companies suggests that the SPI field has much in common with the KM field.

This similarity in objectives is also recognised in several previously conducted studies. Kautz & Nielsen (2004) describe how SPI innovations proliferated when SPI was combined with KM and organisational learning initiatives. In Baskerville & Pries-Heje (1998) an attempt to directly incorporate KM terms into the CMM model is described. These authors suggest how it is possible to control and measure KM key process areas and, as such, describe assessable measures to an organisation's KM capabilities. Mathiassen & Pourkomeylian (2003) describe how KM and the choice of KM strategy is an important factor when planning SPI initiatives and show how it is beneficial to continuously balance KM strategies with relation to the organisation's maturity and the actual SPI effort.

This emphasis on knowledge in SPI underlines how KM efforts conducted in a software organisation *is* SPI. This similarity is recognised in most SPI approaches which address the processes of establishing organisational learning. For example, the top level of CMM is labelled 'optimised' and focuses on the continuous task of experience based improvement (Paulk *et al.*, 1993, 1995, 1996). A level 5 organisation by definition is a learning organisation, and the focus of the SPI initiatives in such an organisation is to facilitate learning activities by establishing measurement and feedback mechanisms, qualitatively and quantitatively.

This means that KM is a requirement for SPI and KM is the subject of the next section.

2.2 Knowledge Management

This section introduces theories from the KM field relevant to this thesis. The SPK project's goal was to examine in details how SPI practice can be aided by introducing concepts from the organisational learning and KM fields towards forming a learning software organisation (Nielsen, 2003). KM by definition has a managerial focus and for this reason the organisation plays a central role in the following descriptions.

Organisational design has moved toward a specific focus on knowledge and the management of intellectual capital. This shift is rooted in the fact that for post-industrial organisations the primary asset is no longer the physical equipment and production environment, but rather the know-how and intellectual capabilities of the employed work force (Quinn *et al.*, 1996). Modern products and services are based on information technology which creates new opportunities for low marginal costs, low distribution costs, and global reach

(Shapiro & Varian, 1999). This strengthens the competition and introduces rapid changes to the organisation's environment. At the same time, the customers grow in sophistication and increase their demands (Davenport & Prusak, 1998). This shift towards a knowledge society is a change of environment that every modern organisation must handle (Liebowitz & Beckman, 1998). This among others has led to the establishing of a knowledge management discipline (Swan *et al.*, 1999b).

A major challenge in the KM field is how to facilitate identification, creation, and sharing of valuable knowledge in an organisation. KM plays a prominent role in modern, knowledge intensive organisations such as software development companies. In these KM is introduced, often as part of larger organisational change processes that aim at improving their software development process (Kautz & Nielsen, 2004).

In this thesis I understand KM as any process or practice of creating, acquiring, capturing, sharing and using knowledge wherever it resides to enhance learning and performance in organisations including the creation of environments in which learning and knowledge exchange can take place (Quinitas *et al.*, 1997). So in the following I use KM when referring to both the managerial (strategic and tactic) and practical (operational) levels of improving the learning capabilities in the organisation.

2.2.1 Knowledge

Knowledge has been defined frequently and differently by many authors (Cook & Brown, 1999; Kautz & Thaysen, 2001). The latest contributions suggest that knowledge exists both on an individual level and on a group level and that knowledge generation requires some form of action (Cook & Brown, 1999).

Individual knowledge is held by an individual and is applied in the individual's actions. Group knowledge exists in the shared actions when individuals act in group (Brown & Gray, 1995).

Further, knowledge exists both on an explicit and on a tacit level (Polanyi, 1966). Explicit knowledge is explicable—or codifiable through speech or writing. Tacit knowledge is not immediately codifiable as it relies on actions and complex language. Tacit knowledge is

> "[...] the capacity to do something without necessarily being able to explain it" (Brown & Gray, 1995, p. 2).

Another important element that influences KM, is how knowledge is maintained in the organisation. Walsh & Ungson (1991) describe how knowledge is stored in six 'bins': *A*) In the organisation's individuals—viz., in their belief structures, their memory stores, and in their personal records and files, *B*) in the organisational culture—viz., in the way employees are 'taught' by the organisation to perceive, think, and feel, *C*) in the transformations in the organisation—viz., in the actual transformation processes carried out in the organisation, e.g., in standardising operating procedures, *D*) in the organisational structure—viz., in the roles and rules constituting the organisation, *E*) in the ecology—viz., in the physical layout of the organisation, and finally *F*) in so called external archives—viz., e.g., governmental regulations, former employees, &c.

Wenger (1998) alternatively suggests in his description of communities of practice (COP) that it is our belonging to several practice based communities that constitutes our worldview and thereby our capabilities to understand the environment we see. The author refers to the communities as the containers of competences. These competences evolve inside the communities, but are also exchanged in the boundaries between various communities and thus affect the knowledge available inside a community.

Taken together these propositions suggest that the corporate culture (Hofstede, 1981) plays a significant role in relation to an organisation's KM capabilities.

2.2.2 Learning

A crucial element of KM is the ability to learn since learning is defined as the

> "... act, process, or experience of gaining knowledge or skill."[3]

Learning occurs in the interplay between competence and experience (Wenger, 2000), and often leads to a change in the repertoire of future behaviour (Walsh & Ungson, 1991). Experiences gained affect the cause-effect relations in the memory. This changes the repertoire of competences for future actions which—when applied—lead to new experiences &c. This interplay is also referred to as the learning cycle (Hedberg, 1981).

Walsh & Ungson (1991) further distinguish between automatic and controlled retrieval of knowledge in decision situations—automatic relying on standard operation procedures in situations where the context is known and thus predictable. The controlled retrieval is applied in more complex situations in which the parameters are foreign to the decision apparatus, and as such need more analytic effort to be understood. This distinction represents a managerial view upon what Hedberg (1981) calls unlearning which to a certain extend builds upon the distinction between single loop learning and double loop learning. Single loop refers to the situation where error detection and correction (response and action) does not change the underlying norms and fundamental competencies, and double loop learning describes the situation where responses require a search for error corrections deeper in the theories in use (e.g., institutionalised via standard operating procedures) in the organisation (Argyris & Schön, 1974).

Incomplete learning cycles may seriously jeopardise learning. Hedberg (1981) describes how learning cycles can be incomplete and distinguishes four situations in this context: *A*) role constrained learning where the link between individuals' beliefs and their actions is not aligned because of constraining formal roles or rules; *B*) audience learning where individual action does not directly affect the organisational action, as the individuals do not have enough capacities to change the organisation in a desired direction; *C*) superstitious learning where due to a misalignment between the organisational action and the environmental responses, responses are wrongly assumed as resulting from organisational actions; *D*) learning under ambiguity where the

[3] http://dictionary.reference.com/search?q=learning (May 2007)

environmental responses can be the cause of different interpretations amongst the individuals in the organisation.

2.2.3 Knowledge Sharing

Making an organisation a learning entity or actively knowledge sharing is by no means a simple task, and many problems lure on the way; the four examples of the learning cycle disorders (Hedberg, 1981) need to be overcome. On the other hand, also complete learning cycles might be problematic for organisations, as the distinction between exploitation and exploration shows (March, 1991; Levinthal & March, 1993).

Experience exploitation describes a reactive approach in which the current practices are improved by carefully studying and analysing these and their results with the purpose of extracting information of how to adjust and (fine) tune future practices to become better at achieving the organisational goals. Thus, the identification of 'best' practices and the generation of means to spread these best practices among relevant organisational units are the main tasks for an exploiting organisation. The advantages of this approach are that the organisation will become expert in its field because it continuously will be able to learn from both successes and failures. On the other hand it will be exposed to the danger of becoming skillfully incompetent i.e., so specialised that it can not react (fast enough) to changed conditions, e.g., changes in the market (Argyris, 1993; Holmqvist, 2003) or disruptive innovations (Christensen *et al.*, 2002; Charitou & Markides, 2003).

The alternative approach, the experience exploration approach, is a proactive approach in which innovation and experimentation are used to change future practices by trying out radically new concepts or approaches. This leads to more revolutionary potentially disruptive changes, which can be used to achieve competitive advantages. This approach can prevent an organisation from becoming skillfully incompetent, but is itself no silver bullet as its exploratory nature makes returns

> "[...] less certain, more remote in time, and organisationally

> more distant from the locus of action and adaption" (March, 1991, p. 73).

Organisations, software developing and others, looking for an effective knowledge management strategy, are often caught between two competing approaches: on one hand storing codified knowledge in databases or other repositories and on the other hand using (and developing) the employees' personal networks for knowledge creation and sharing (Hansen *et al.*, 1999; Swan *et al.*, 1999a). Hansen *et al.* (1999) suggest that companies concentrate their efforts on either a codification strategy based on explicated knowledge in generally available repositories; e.g., handbooks or databases, or a personalisation strategy based on face-to-face contacts between organisational members. These authors recommend that an organisation chooses one of these as its main strategy, based on the characteristics of its product portfolio, and the nature of the employees' problem solving activities.

Codification in this respect means that the organisation's knowledge management relies primarily on repositories of explicated information. In the terms of Walsh & Ungson (1991), the retrieval of information is controlled and the organisational memory is largely dependent on the organisation's members' interpretations and experiences. Hansen *et al.* (1999) describe how information technologies can contribute to this strategy by providing the means for storing and sharing the knowledge objects in databases and allowing for many people to retrieve these objects without having to get in touch with the original creator. With this people-to-document strategy, learning is highly dependent on the organisation's ability to codify and store the correct knowledge via interchangeable 'knowledge objects' and on its members' abilities to locate and use these objects. The steps from individual beliefs to organisational action in the learning cycle (Hedberg, 1981) thus are highly dependent on rules or formalised procedures, which both opens

> "[...] up possibility of achieving scale in knowledge reuse and thus of growing the business" (Hansen *et al.*, 1999, p. 108)

but at the same time exposes the organisation to experience the negative effects of role constrained and audience-learning which potentially might be

> "[...] contributing to organisational inertia in that it delays the transformation of knowledge into actions" (Hedberg, 1981, p. 11).

The personalisation strategy, on the other hand, relies on person-to-person contact to allow for sharing experiences and knowledge directly between the organisation's members. This strategy facilitates a controlled approach to information retrieval by letting the employees

> "[...] collectively arrive at deeper insights by going back and forth on problems they need to solve" (Hansen *et al.*, 1999, p. 108).

Following this strategy, the organisational memory is based on the individuals, and information technology is used primarily as a means to locate knowledgeable people and enable direct communication. By adopting the personalisation strategy, organisations are able to think out-of-the-box and to invent new or specialised ways of doing things for themselves or their customers. The main drawbacks of this strategy are the following: *A*) it is not very effective in situations where specialised solutions are not needed, *B*) it does not scale as well as the codification strategy—e.g., key members of the organisation easily become bottlenecks (Hansen & Kautz, 2005a), and *C*) the nature of the strategy makes it vulnerable to superstitious learning (Hedberg, 1981; Levitt & March, 1988).

When Hansen *et al.* (1999) recommend that organisations choose either one of these strategies as their primary approach to knowledge management and sharing they explain that this choice should be based on

> "[...] the way the company serves its clients, the economies of its business, and the people it hires. Emphasising the wrong strategy or trying to pursue both at the same time can, as some consulting firms have found, quickly undermine a business."
>
> (Hansen *et al.*, 1999, p. 107).

Thus, managers need to take into consideration whether the company should offer standardised or customised products, whether the products are mature or innovative, and whether the employees rely on explicit or tacit knowledge when solving problems. Simply put, an organisation producing a standardised and mature product which relies primarily on explicit knowledge should choose a codification strategy over a personalisation strategy since the benefits from knowledge sharing through codified knowledge objects will better suit this type of organisation.

2.3 Conclusion

In the following I will describe how the designers of a knowledge based SPI initiative need to consider what kind of approach they want to follow when combining KM with SPI.

2.3.1 SPI Approach

In the literature survey in Section 2.1.1 three categories were used to distinguish whether the contributions had a primarily normative, descriptive, or reflective perspective. If these categories are viewed as a continuum instead of distinctive separate categories they form an axis that spans from normative to reflective. The characteristics of a specific SPI approach can then be used to position it on this axis. The axis then represents an extension of the distinction between model based and problem based SPI approaches as introduced in Section 2.1.2. Instead of including only normative approaches in the distinction the scope is broadened to include approaches that do not prescribe a specific norm for the improvement, viz. those that are reflective in character.

E.g. a SPI approach that relies strictly on prescriptions formulated in rules and norms would be placed on the normative end on the axis. Similarly an approach that seeks fundamentally new solutions targeted directly to the specific context in an organisation would be placed towards the reflective end on the axis. Most SPI approaches include a mix of the two approaches and thus will position themselves somewhere between these on the axis. The same approach might be positioned differently depending on how it is used in a specific situation. E.g. the different stages of the CMM can be positioned differently on the axis even if they are from the same base approach. Although the CMM fundamentally is a normative approach introducing a specific set of rules, it can be argued that the higher levels (4 and 5) in the model, even if still prescriptive of nature, include a more reflective approach.

2.3.2 Knowledge Organisation Archetypes

The KM literature covered by this thesis describes two archetypal knowledge organisations which can be labelled as the exemplary and the situational knowledge organisation. Theses archetypes are distinguished by their fundamental differences concerning the following characteristics: *A*) Knowledge type, *B*) approach to knowledge creation, *C*) learning type, *D*) knowledge retrieval type, and *D*) knowledge management strategy.

2.3.2.1 Knowledge Characteristics

The primary knowledge type in an organisation might be explicit or tacit (Polanyi, 1966). The organisation's capabilities to recognise one or the other of these knowledge types affects the organisational settings and thus the prevailing organisational routines for acquiring and sharing knowledge. If the primary knowledge type in an organisation is explicit the organisation's knowledge management and knowledge sharing routines will focus on explicating the organisation's member's knowledge. Often this will involve strong document recording, classification, searching, and distributing capabilities (Hansen *et al.*, 1999). On the other hand, if the prevailing knowledge type is the tacit form, the organisational routines established to secure knowledge transfer and diffusion will largely be executed by the staff of the organisation. The primary routines will target the abilities for employees to locate each other, and each other's expertise, and further the routines will provide means for close collaboration and education (Hansen *et al.*, 1999).

The knowledge creation approach can either be based on knowledge exploitation or on knowledge exploration (March, 1991; Levinthal & March, 1993). In an organisation which bases its knowledge creation on knowledge exploitation the ability to analyse and fully understand the already established practises is important. Fine tuning these and continuous optimising of the known settings will constitute the process development. Thus, the parts of the organisational routines that are concerned with knowledge creation will be established by expert systems in which a detailed model of the company's business area will be maintained. Feedback routines will secure that experiences from practise will further optimise this model. In an organisation which bases itself upon knowledge exploration the purpose of the knowledge routines will be to question the established model of the business area in question, and thus to seek fundamentally new approaches or meanings within the business domain. Such routines will be dependant of the ability to cross examine and interrelate knowledge of any type, and focus on establishing the right personal relations between experts in various fields.

The prevailing learning type is either single loop learning or double loop learning (Argyris & Schön, 1974). Organisations practising single loop learning are striving for expertise based on fast and robust feedback mechanisms. The strengths of the single loop paradigm is the quick way of reviving experiences and utilise them to gain more knowledge concerning well defined and scoped areas of interest. This way it is possible to make relatively quick decisions based on experiences and complete learning cycles (Hedberg, 1981). Organisational decisions based on rule systems and detailed process descriptions fit well with this learning type. Double loop learning involves more thorough analyses and requires the questioning of the underlying assumptions upon which the existing knowledge has been build. Organisations in which this is demanded must secure these skills e.g. by hiring highly educated experts and by establishing routines that facilitate innovation &c. (Christensen *et al.*, 2002; Charitou & Markides, 2003).

The knowledge retrieval type applied in an organisation can also have two forms: It can be automatic or controlled (Walsh & Ungson, 1991). The automatic knowledge retrieval is characterised by relying on "well-established or habitual sequences of action" (Walsh & Ungson, 1991, p. 69), and thus utilises the already present decision mechanisms. In an organisation relying on this type of knowledge retrieval standard operating procedures and heuristics can facilitate a quick and effortless decision making. The organisation's decision making apparatus will have pre-interpreted earlier experiences and will have condensed these into routines and guidelines. The task thus is to maintain the model and constantly adjust it. The controlled knowledge retrieval is characterised by thorough analysis of a present situation. In this way fundamentally new explanation models are constructed to fulfil new requirements and provide new and specialised answers. In this situation the organisational settings will be optimised towards the ability to conduct such deep analyses. This could be by facilitating cooperation e.g. in expert teams consisting of experts from different knowledge areas or with different skills.

The last attribute is the chosen knowledge management strategy which can be either a codification or a personalisation strategy (Hansen *et al.*, 1999). The codification strategy relies on knowledge being codified in various forms to be easily shared among employees in the organisation. This suggests that the organisational routines for storing and retrieving data concentrate on procedures for explicating and characterising the experiences, e.g. into databases or document repositories. The personalisation strategy on the other hand relies on people as bearers of knowledge and at the same time people as the pivot around which the organisation shares its knowledge. In such an organisation the routines should facilitate easy location of experts and their knowledge as well as collaborative means for sharing this knowledge.

2.3.2.2 Exemplary Knowledge Organisations

The exemplary organisation is characterised by conforming to an ultimate form of perfection. In this organisation the primary knowledge asset is explicit knowledge (Polanyi, 1966). This knowledge is acquired through continuous knowledge exploitation (March, 1991; Levinthal & March, 1993) through which the organisation refines its knowledge concerning its business domain to a level where automatic retrieval (Walsh & Ungson, 1991) can be exercised in an efficient way. All relevant processes are known and given a specific scenario the organisation can prescribe a best practice to achieve its goals. Its complex rule-set is maintained by optimising the underlying model via single loop learning (Argyris & Schön, 1974) and the organisation is practising a codification strategy to share knowledge (Hansen *et al.*, 1999).

In this type of organisation the focus is on understanding the business domain to an extent that every parameter is known and described including how it correlates to every other relevant parameter in the domain. The model of the business domain becomes the centre of the business. Creating business processes which support this model is the crucial task of the organisation. This type of organisation is very efficient as long as the model is correct and as long as the domain stays unchanged or only changes in small increments (Hansen *et al.*, 1999).

2.3.2.3 Situational Knowledge Organisations

The other archetype is the situational knowledge organisation. Situational here refers to the organisation acknowledging its position in relation to its surroundings. This means that in a situational knowledge organisation these surroundings are factors that act on an individual or organisational level to condition behavioural patterns. Therefore in this type of organisation the specific context in a given scenario is also the key element to the organisational acting. The primary asset is the ability to understand any given situation by utilising the employees' capabilities and as such the tacit knowledge (Polanyi, 1966) is the organisation's key asset. This knowledge is acquired in the process of solving tasks in the business domain and therefore is anchored in the practice of the organisation; it is by definition not easily codifiable. The ability to explore (March, 1991; Levinthal & March, 1993) this knowledge in different scenarios is the primary means of transferring knowledge between members of the organisation. The preferred strategy is that of personalisation (Hansen *et al.*, 1999) and the processes of the organisation focus on matching the employees to the specific tasks and on facilitating the employees' ability to retrieve the organisational knowledge in a controlled way (Walsh & Ungson, 1991) which allows for and supports double loop learning(Argyris & Schön, 1974) by continuously challenging the underlying paradigm.

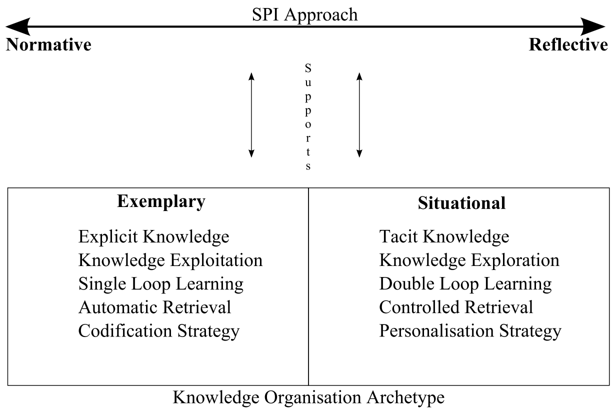

Figure 2.3: SPI approaches in relation to KM theory

This type of organisation is most efficient when the challenges are hard to categorise and require specialised solutions.

It is important to notice that both the exemplary and situational types are archetypes. In practise the discussed elements are not as clear cut and are most intertwined in a complex way. The thus position the specific organisation somewhere in between the two end points of the scale.

2.3.3 Combining Approach and Archetype

In this context, I suggest that that there is a strong correlation between the SPI approach and the knowledge organisation archetype. As depicted in Figure 2.3 on page 50 facilitating learning through the introduction of SPI initiatives thus relates to these initiatives' position on the normative/reflective axis. This means that theories from the KM literature can be applied as a way to determine which type of SPI approach will fit in a specific organisation—or a specific scenario. Or alternatively—the characteristics of an applied SPI approach can tell which KM approach(es) will constitute a best fit for the paradigm already present.

As a consequence, to choose or adjust to a specific SPI approach requires to take the knowledge organisation archetype into consideration. A strict normative SPI approach will be harder to apply in a software organisation which primary business is to deliver new and conceptually different highly customised solutions. Likewise, a very adaptable SPI approach might be ineffecient in an exemplary knowledge organisation since a norm based 'standard' solution might be applicable with only minor adjustments—and most likely also better supporting the business.

Chapter 3

The Host Organisation

This study relies heavily on the specific setting in Systematic Software Engineering (SSE) because it is practice oriented and collaboration based. This chapter focuses on presenting the case organisation at the outset of the interaction, viz., Spring 2003, as viewed by the researcher. The settings in the organisation, of course, have changed during this longitudinal study, but to fully comprehend the later decisions taken regarding the research approach, research design, actual interventions, and analysis results, a detailed understanding of the initial situation in the host organisation is required. Therefore, this chapter focuses on the situation at the outset of the study, thus leaving the description of the major events which occurred during the project to Chapter 5 in which the course of the study is laid out.

The chapter is organised as follows: First a general introduction of the case company is given, followed by detailed descriptions focusing on relevant sub units and projects. Finally, a brief summary of the organisation's achievements until 2003 is presented, leading to a description of the challenges facing the organisation at the beginning of this study, and as such to the areas of interest which constitute the research question of this study.

This chapter relies primarily on observations conducted during visits in the company, but is also informed from the first interview round(s), and from artifact studies conducted during the first months of the study. A detailed description of the background and use of data collection techniques is provided in Section 4.4.

3.1 Organisation

SSE is a Danish software development company, in which the primary business segments consist of information systems development for the defence and health care industries, with NATO and the Danish Defence being among its largest clients.

With more than 250 staff employed SSE is by Danish standards a large software company, and the largest privately owned. The major shareholders are the managers, a fact claimed by these managers as providing the company with a high manoeuvrability and direct control.

The company is located in the outskirts of the second largest city of Denmark, Århus, and was relocated at the very beginning of this study into its own newly constructed facilities. This relocation came as a visible result of the company's growth and as a signal of SSE's significance to the business in the area, the mayor of the city was present and spoke at the inauguration of the new buildings.

3.1.1 The Products

The portfolio of products developed by SSE is concentrated around mission critical systems, viz., information and communications systems with extreme requirements for stability and robustness.

The systems are often operated in stress filled environments, and important and critical decisions are dependent on their reliability and ease of use. Examples are control and communication systems for the Danish Air Defence and Electronic Patient Records for the Danish Regional Health Care.

The typical product is developed in close and long lasting co-operation with the customer, and SSE's development resources are primarily spent on the continuous development of new versions of existing products adding functionality based on supplements to or renewal of existing contracts. In this respect, much of the product portfolio is financed by a small set of sponsors; customers who, by and large, control the future trajectory of the(ir) products. This close collaboration is necessary not only because only a few customers exist for these highly specialised niche products, but also because parts of the systems are security classified due to their connection with the defence industry.

Another part of SSE's development resources is involved with developing and maintaining a set of off-the-shelf products that are licensed to customers. They are often spin offs from customer sponsored products, but they are licensed on an as-is basis, though often bundled with consultancy to tailor the product to the buyers' needs—providing SSE with valuable feedback concerning the future development of the product. However, these products are also highly specialised and of interest only to a very specific group of customers.

A smaller part of SSE's development effort is concerned with ad hoc systems development for short term customers, but due to the main competencies of the company, the number of these one-time customers is limited.

Apart from the development activities, there is also a growing market for providing what is termed as professional services. This area includes consulting customers about how to partake in larger development processes, e.g., as independent advisory between customer and (another) development company.

In 2002/03 some 28% of the revenue was based on licensing existing products and less than 10% on consulting, leaving the remaining part to the sponsored products and ad hoc projects, with the former being the largest. In 2001/02 SSE's client portfolio consisted of 36 active customers each generating an average yearly revenue of €360.000, but these figures cover an uneven distribution among customers, as the largest five account for 48% of the revenue (figures from (SSE, 2004a)).

3.1.2 The Employees

Employees in SSE are considered as talents instead of human resources to underpin that the company recognises each employee as some*one* to invest in instead of some*thing* to exploit. human resources management thus is an (officially) unknown discipline in SSE, and instead, talents management is practiced. In their own words:

> "We have Human Talent Management—not Human Resource Management. To consider employees as resources belongs to the past. Our future is built on and by talents" (SSE, 2002, p. 25)

The typical SSE talent can be described as follows. He (the vast majority of the work force is male) is well educated with a Masters in engineering or computer engineering (60% of the work force have a Masters or PhD). He is in his mid thirties (avg. 33 years), and originates from the western part of Denmark. He has been working for SSE for some years and finds that the company is an exciting and demanding place to work.

The company educates its talents according to the motto: "Better train people and risk they leave—than do nothing and risk they stay" (SSE, 2002, p. 30), and has formally established a training board to coordinate and facilitate a set of programmes to secure that the employees are trained and certified according to business demands and the overall strategy of SSE. The training board also decides which employee education should be internally conducted, and which should be outsourced to professional educational suppliers. Many training courses are developed and conducted internally, e.g., an introductory course for all new employees. Also, educational courses aimed at the specific Project Management skills, practices, and support tools needed in SSE are organised by internal departments. Specific courses exist for the following roles in SSE: Project manager (PM), team leader (TL), quality responsible (PQR), configurations manager, test manager, review manager, developer, educator/teacher, customer and supplier relations. The most relevant of these will be described in more detail in Section 3.2. These roles are all parts of an overall programme of formal career paths, which is offered to the employees. The employees can use the programme to design whichever career they want to build, while working for SSE, e.g., along the manager path or specialised into one of several professional engineering paths.

A sum approximating 10% of the total wages is invested in educational initiatives, and the employees spend an average of 11.5 days/year on training. This high level of education is also an expressed expectation among the employees who, in general, see SSE as a place to build and maintain a professional working career.

The typical employee expects to work normal hours, except on rare occasions when an extra effort is needed, e.g., to finalise a delivery. A 'pizza index' is maintained as a non-scientific (and humorous) measure to show how (preferably) few nights the employees are required to stay behind and work after hours. The index states how many pizzas each employee (on average) has bought and eaten during working nights. In 2001/2 this figure was 6, and the year after it was 7, indicating a quite stable work week without the need for working overtime or at odd hours. Both management and employees see this ability to keep projects on time within the normal working hours as an important factor regarding their project management skills, and thus regarding their professionalism.

The satisfaction (regarding working conditions and working at SSE in general) among the employees is a critical parameter for the management in the organisation, and yearly employee satisfaction surveys are carried out, the results of which are not only published, but also taken very seriously and analysed with great care. The generally outspoken opinion among the employees is that they see themselves working for SSE in the coming years. No one explicitly talks about alternative job opportunities or career options unless they, for other reasons, plan to leave the geographical region. The high focus on job satisfaction, combined with the extensive use of close and stable team work, results in making the employees less prone to leaving the organisation. Nevertheless, if some leave, they risk being considered quitters and quite bad team players.

By staying loyal to the organisation the employees are rewarded by not only the opportunities for a high level of training, but also high job security, since

SSE until 2003 only very rarely dismissed personnel (or talents). In 2002 only 24 (less than 10%) of staff left the organisation, which by Danish standards is a low rate of personnel turnover for that specific time period[1].

3.1.3 The Projects

All parts of SSE are organised in projects, and officially no static departments exist. That is, all projects belong to a business unit (BU) which resemble the overall product composition in a set of four-plus-one major business areas: Defence, health care, key accounts (i.e., not defence or health care), products (licensing), and the more internally oriented business development (BD), (refer to Figure 3.1 on page 59); the latter will be further described in Section 3.2.

The development projects, also known as customer projects, to distinguish them from internal support projects, are the actual production units of the organisation; some 20-25 that are performed simultaneously. In 2001/02 55% of the projects were larger than 10,000 man-hours, and 78% larger than 5,000 man-hours, signifying that the project portfolio consists of large and long lasting involvements with few customers, which is why only five customers account for half of the revenue. The projects differ in size with respect to staff, with the largest employing more than 50 and the smallest having less than one full time employee attached to it. The project teams are quite stable, in the sense that most employees only work on one project at a time, and often with the same group of people.

A typical project has a PM, who is responsible for the day-to-day operation of the project; however, for large projects he would be assisted by TLs who refer to the business unit director (BUD) of the particular BU (e.g., defence) to which the project belongs. The PM can rely on a PQR to secure the project's quality, i.e., making certain that the project is managed according to the formal quality specifications of SSE. Similarly, formally defined roles

[1] According to statistics from The Confederation of Danish Employers (DA) the national figure was 24.5% for 2002 (http://www.da.dk/SuperShowDoc.asp?pid=20030811113257CDH)

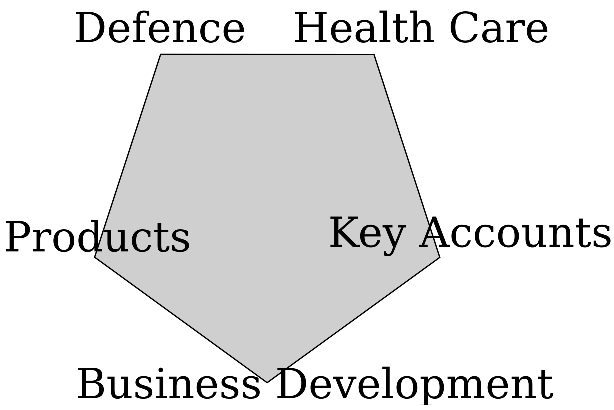

Figure 3.1: The four-plus-one business units

exist together with detailed descriptions of how the project ideally should be carried out according to the formal specifications[2].

The typical development project follows a traditional iterative life cycle consisting of the steps presented in Figure 3.2 on page 60. A project can be initiated by several events: a new customer might require a new software tool, an existing customer might request new features in an existing sponsored product, or an off-the-shelf product needs to be upgraded to a new version with added features, &c. Whatever the reason, a project charter has to be developed, stating the idea, viz., the scope and expected results of the project. Preliminary estimates as to the costs and duration of the project are important attributes at this initial stage. The start-up phase includes the formal initiation of the project: planning, allocation of resources and talents, and preparing the project management tools as required by SSE's internal specifications.

The following four phases are to be iterated a number of times depending on the size and scope of the project and on how much information is available at the outset. The general idea is that each phase can either finalise a specific part of the project or be used for focusing and detailing the project (a spiral based process model (Hughes & Cotterell, 2006)), where each iteration digs

[2]The formal process framework and quality assurance programme will be the focus of the following Section 3.2, and will only briefly be mentioned here to establish a basic understanding of the surroundings of the typical SSE project.

Idea
$\triangledown$
Start-up
$\triangledown$
Analysis
$\triangledown$
Design
$\triangledown$
Coding
$\triangledown$
Test
$\triangledown$
Deployment
$\triangledown$
Operation

Figure 3.2: The development project life cycle, (SSE, 2002, p. 16)

deeper into the problem matter, and produces more final or refined outputs. The four repeatable phases, analysis, design, coding, and test, in themselves compose a traditional process model for systems development, but depending on how they are actually implemented, the practice can differ. In SSE three different strategies are formally acknowledged: *A*) The waterfall strategy with only one iteration, and all requirements initially defined, *B*) the incremental strategy with multiple iterations and in some cases interim software deployed, and *C*) the iterative strategy with multiple iterations and directly based on the deployment of interim software.

This layout and the strategies are a direct derivative from a US Department of Defense military (certification) standard (the MIL-STD-498) (Wright, 1999), and are therefore required to be followed for SSE to be in compliance with this standard.

Aside from this development process every project undergoes an evaluation process. This is an internally developed two level process which prescribes that any project must conduct one or several milestone reviews (MR) during its life span, and a project follow up (PFU) when closed. The following descriptions are based on an idealised image of the processes based on how they are intended to be conducted—their espoused layout. For a more realistic and detailed description (the layout in use) see Section 8.1.

The MR describes an internally oriented review process that enables the project to sum up its achievements after reaching each of its milestones. The process involves every project member to participate in a collective project meeting in which the just concluded project phase is discussed and evaluated. There are several outcomes.

First, when the development phase is formally concluded, the MR marks that a milestone has been reached and thus a goal achieved. This signal value is an important factor for showing progress both internally among the project and externally to the rest of the organisation.

Second, the open nature of the evaluation is intended to provide an effective means for 'clearing the air' before the next phase is initiated. The team members during the review can focus on discussing possible identified issues in a sand boxed environment, viz., in a controlled environment detached from the normal project development task, and thus presenting challenges, tasks, and deadlines. This is regarded by the project members as an important therapeutic instrument to improve the working climate within the project. Typical misunderstandings and opposing opinions can be cleared or aligned during the MR, more easily than during the active project work, because of the formal meeting setup and agenda, which requires the participants to focus on the just concluded phase, thus steering clear of current tasks and problems. In this way, the possibilities for at fruitful dialogue between project members and/or project management is strengthened since the focus is on understanding and learning rather than pointing fingers or placing responsibility. At this stage the project outcome (the milestone) is already achieved.

Third, the lessons learnt that are identified during the MR have proved (according to employees) to be effective means for planning the future project phases by avoiding unwanted situations but still repeating well working procedures or situations.

Fourth, the MR reports are handed to a special project (the SPI project, further information in Section 3.2.1) responsible for designing SSE's process descriptions with the intentions of letting the lessons learnt affect the future formal process descriptions, thus allowing the direct experience from the development projects to inform the future process definitions, and thereby creating the ideal future practice.

The PFU process in many ways resembles the MR, but the scope is broader since the PFU focuses on the whole of a project's duration. The PFU is conducted as the project is closed and, as such, poses an important signal value. But since the scope of the PFU spans very broadly, it is not intended as an in depth analysis of all the phases conducted; this task is already covered by the previous held MR(s). The PFU is conducted by the PM, and for larger projects the project management (viz., including TLs and PQR), and not as the MR by the whole project team. Instead, the PFU focuses on summing up the overall lessons learnt (potentially including issues from the MRs) and condensing them into a written report. The PFU report sums up the project by including relevant information about the following four areas: *A)* Lessons learnt and future business, which includes descriptions of the experiences gained throughout the project, with a special focus on lessons that are thought to be of use to other or future projects. The future business section is intended to suggest how future sales can be derived from the project and/or client, and includes a mandatory customer satisfaction analysis. *B)* Project data includes detailed project specific data, such as duration, staffing, development strategy, risks, resources spent, and defects recorded in each of the project's phases. These data should be collected, compared with the project plan, and commented upon by the PM. *C)* Financial information is collected and presented to be able to analyse whether the project achieved its financial goals. The data are presented in a SSE specific format which makes it easy to compare projects on specific measures. The data should be commented upon by the PM to provide necessary information regarding whether certain figures deviate from the norm. *D)* Process information provides feedback about how the project has incorporated and utilised the process framework during its life span and consists mainly of the PM commenting on the different processes applied in the project, including a usefulness-score of each. This feedback is intended at evaluating the process framework and provides ideas and necessary changes for future revisions.

The PFU report presents the details from each of these interest areas in detail, and requires for a PM to also consider the most important issues for the concluded project to be included in an executive summary. In this summary the PM has the possibility of recommending future actions or changes to the process framework based on the project's experience. To supplement the readers' background information, a section in the PFU is included to present general information about the project, which can be used to classify the project type, size, scope, &c., with respect to cross-analysing and comparing several PFU reports—a task that is carried out by the special SPI project. The PFU report must be formally approved by the BUD to which the project belongs to ensure that the data submitted are of an adequate quality; that is, the project cannot be formally closed without this approval. Both the MR and the PFU processes will be presented and analysed more thoroughly in Chapter 8 and Chapter 9.

As a result of the composition of the project portfolio in SSE, some projects continue for a long period, e.g., the projects that develop the major products of SSE. These projects are never closed as such, but are staffed up and down to meet actual needs and ensuring that any problem that occurs with the product is taken care of, even if no current development on that specific product takes place. For the larger products, the continuous development requires a large staffing, which makes the settings surrounding these projects quite stable and much more like a production unit or a product department, with relatively fixed location, fixed staff, &c. For these types of projects, the PFU is conducted on a regular basis when the PM or BUD finds it beneficial.

A collective maintenance and operations project exists which is responsible for maintenance and fixing minor bugs for a whole range of products. If one particular problem exceeds the scope of this maintenance, a new project might be instantiated to deal with that particular project/problem. This maintenance project is normally quite small, and evaluations are carried out on a more ad hoc basis.

As every part of SSE is organised in projects, this also covers the non-development parts of the organisation, like the canteen and the support functions. These projects, however, are run more or less as parallel departments and do not follow the same development project layout. Another example of a special and continuing project is the SPI project, which is the project responsible for the process framework, and for developing and maintaining the production facilities in SSE. This project will be the focus of Section 3.2.1.

3.2 Business Development

Of particular importance to SSE is its ability to continuously secure and document the high quality of its development capabilities and of its products. Their 'world class' quality is a trademark of the organisation, and much effort and many resources are spent keeping up the high standard. In SSE the BD unit is responsible for managing the extensive quality and training programme and is, as such, a focal point for this study. The BD BU's tasks are laid out by a management steering group (MSG), an advisory board consisting of the top management, the management from the BD BU, and a selection of PMs from development projects. The MSG meets regularly to discuss and plan initiatives relevant to the process framework and quality assurance, including training.

In SSE the focus on achieving world class quality translates into adopting and deploying specific standardisation schemes and development frameworks. There are several reasons for this.

First, the extreme requirements concerning stability, up-time and correctness of the produced systems demand, according to management, a rigid and thorough quality control and elaborate tests. Some guidelines for achieving this are considered useful, and standardisation schemes or models are two examples. A crucial point regarding quality is to be able to proactively convince the (potential) clients that the organisation is able to deliver on time, within the budget, and with the promised quality; as such, a certification or compliment statement might act as a common and easily obtainable (for the client) unit of comparison (between competing suppliers), and thus as a sales parameter or even a necessity to generate future sales.

> "Our ambition is to create a production process that will enable our customers to rely on Systematic to deliver to time, budget and quality.
>
> We have made a determined effort to obtain certification against the internationally recognised software Capability Maturity Model." (SSE, 2004b)

Second, the fact that several essential customers explicitly require that SSE be assessed according to different standards and schemes makes the adoption of such standards compulsory. For example, when working with the NATO SSE is met with requirements of compliance with various military standards (for a non-comprehensive list refer to Figure 3.5 on page 75), and some projects, like the Joint Strike Fighter[3], require specifically that potential suppliers be certified on a certain CMM level (in this case level 3), and further that it can be documented that specific plans for achieving compliance with even higher stages are under serious consideration. In these cases, just to be able to participate in certain tenders, SSE is met by clearly defined standardisation and certification requirements.

Third, in many of the projects in which SSE participates, their role is not as principal supplier, but instead as subcontractor. In such projects with many participants in a large web of suppliers it is necessary to have some coordination activities, and in practice this coordination is often dependent on all the subcontractors following a specific guide, framework, or standard in their work. To be considered as a supplier in these cases, it is often easier, if not a necessity, to be able to prove up front that the development organisation is capable of handling a large and complicated development project—proof that often translates into standardisation and certification requirements.

The focus on certification and standardisation schemes has led SSE to invest a major effort into achieving these various certificates. Previous studies (e.g., (Hansen *et al.*, 2003a)) have shown that a difference between practice and (documented) process might exist, which can diminish the effect of such programmes. However, in SSE the management (especially the management of

[3] http://www.jsf.mil/

the BD) has been very focused on actually gaining advantages from adopting certification frameworks like CMM. So, even if the requirements have been triggered from outside, the incentive for the organisation to actually work with and benefit from the programmes is strong.

The quality programme in SSE is built around a Business Manual (BM) which is a catalogue describing the modus operandi for SSE. This catalogue is the backbone of the process of the organisation, and contains descriptions on various levels of all (relevant) major tasks conducted in SSE, including meta-tasks, viz., tasks for rethinking and improving the operational tasks. To maintain, update, and deploy the BM, a special development project, the SPI project, has been established. This project is the sole project of the BD, and will be presented in the following section. The BM itself is the focus of Section 3.2.1.1.

3.2.1 The SPI Project

The SPI project, is in charge of the design, tailoring, diffusion, and adoption of the improvement initiatives in the organisation. As mentioned, SSE is highly involved in actively developing its abilities to produce software and has adopted CMM (Humphrey, 1989) as their basis for conducting SPI related activities. At the beginning of the study the organisation had recently been certified as CMM level 3 compliant, the culmination of a long period of a concentrated SPI effort.[4].

This achievement has had attention from management, as it is considered a key strategic effort; the successful implementation as well as the certification as one of the first Scandinavian companies is considered to be a very important and tangible break-through for the SPI project, resulting in this project and the BD BU establishing themselves as key players in the organisation.

The SPI project employs on average 15 full time staff and handles, apart from the maintenance of the BM, the development of internal systems and

[4]Parts of this previous SPI work are documented comprehensively by Mathiassen *et al.* (2002).

tools to support the management of development projects, repositories, documents, time, &c. As of September 2003, the SPI project consisted of 1 PM, 7[5] developers devoted to the development of internal applications/tools, 3 employees working on the current and next version of the BM, 2½ project controllers[6] (PC) and 2½ responsible for (formal) quality assurance.

The members of the SPI project are 'ordinary' staff, i.e., developers, who for a period of maximum two years are recruited to be part of this special project. This maximum period is maintained to avoid creating a gap between the SPI project and the daily project work. The idea is, that if an employee is away from development project activities for too long, s/he will lose parts of the hands-on feeling that is required to fully understand the relevant processes, and thus lose the ability to pin-point and specify these processes in a way that can be utilised in the organisation. The rotation principle is also feasible because the employees, when 'returning' to the development projects, should not have been away from practice for too long. If so, their ability to be able to quickly commence in the daily development might be reduced. Also, the 'returning' employees act as facilitators of the BM since they have been working very closely with this material.

Apart from the maintaining of the BM, the SPI project is responsible for the internal education of staff with regard to the improvement programme, which means that courses and educational material also are products originating from this project.

The SPI project maintains a large measurement system, which automatically collects data from various sources, stores them, and provides tools for recalling them for later analysis. The measurement system consists of a set of software robots or data-collector applications, which every night scan through the code base and documentation base of all the projects to collect and calculate key figures such as the number of code lines, the status of the projects (which phases are concluded), the duration of the projects, the staffing, the size of the documentation, the size of project reports, &c. This

[5] 3 real staff, 4 on shorter specific contracts.

[6] The project controller role is intended as being responsible for helping the development projects to comply with the BM and, as such, the PC is the projects' contact person in the SPI project.

data warehousing tool is used to collect and analyse the projects' performance in many respects—and a necessary tool to be able to follow a quantitative project management agenda, as required by the higher stages of the CMM model. Not all the collected data were used in 2003, but to make certain to be able to collect as much relevant data as possible, the collection programme is established based on an inclusive strategy basis, viz., it is better to collect a little too much now, rather than to find out later that more historical data was needed.

An application programming interface for recalling and using the data is maintained as well which makes certain key figures available, both for the SPI project, management, and for the projects. These key figures are continuously analysed to create a picture of the projects' status, and at the same time new ideas for key figures are constantly suggested both by the SPI project and by the project managers. These suggestions often arise directly from an observed need to understand a certain situation, but also suggestions based on knowledge from research are found. The normal way of approaching the stored data is to extract them into spreadsheets which are a common reporting tool used in the organisation.

The measurement system is developed by the SPI project, and was initiated years before this study was conducted, giving SSE a long historical track record for many of the organisational key figures. The initiation of the measurement system was one of the original initiatives in the organisation towards implementing the CMM model. The measurement system keeps track of many project specific data of crucial importance, it calculates output on the basis of the content of a task managing system in which every project (including the SPI project) keeps track of all the tasks that are currently planned or under completion.

Apart from the measurement system, the SPI project maintains the company's intranet, including the web front-end of the BM and several small applications and routines which are used by the projects, e.g., a knowledge sharing tool, a bulletin board, report templates, and report generators.

Another responsibility of the SPI project is following up on the projects' usage of the process framework. This includes collecting and analysing all the evaluation reports that the projects produce, viz., the MR and PFU reports, with respect to extracting relevant lessons learnt or other project related or organisational learning. In many respects the SPI project resembles an experience factory tier (Basili *et al.*, 1994a; Basili & Caldiera, 1995a) (refer to Section 2.1.2) within SSE. It collects and analyses the process data from the development organisation, with the purpose of understanding the development process more and more thoroughly, and using this understanding proactively by feeding ready-made processes back to the development organisation.

3.2.1.1 The Business Manual Hierarchy

As a means for documentation and control, the company has developed a catalogue of their processes, the BM, which is implemented as an intranet based portal consisting of the standard process, viz., process overviews, detailed process descriptions, templates, and best practices (termed assets); all are organised in a three-by-three matrix representing on one axis (vertical) the company's organisational levels, and on the other (horizontal) the processes' support purpose (i.e., which management task they are supporting). The middle section of Figure 3.3 on page 70 depicts the contents of this. To supplement the standard process, the BM further consists of some help and guides (BM essentials, top of figure) and some extra material (supporting material, bottom).

Since SSE has reached CMM level 3, the BM is highly inspired by the CMM model and, as such, makes up the SSE implementation of CMM level 3. The label of level 3 is 'defined' (for details on the CMM model refer to Section 2.1.2.1) which translates into focusing on constructing the complete procedure and managing it, preferably quantitatively—to prepare for the next stage.

The BM is the atlas of the organisation defining and describing any process that is considered—by management—to be relevant with regard to the

Business Manual Essentials

Introducing the Business Manual	Contents of the Business Manual	Applying the Business Manual
Purpose, scope, objectives, and policy Organisation Authorities and responsibility	Reader's guide Overview of process areas and processes Terms and definitions	Introduction Development strategies Modification strategies Tailoring

SSE Standard Process

Business Management	Project Management	Project Support
Business process Purchasing and acquisition Proposing and contracting	Project initiation Project planning Project control Project closing	Change management Configurations management Stakeholder management Supplier agreement management

Process Improvement	Quality and Process Management	Process Support
Organisation process improvement Piloting and deploying Process assets Auditing	Quality and process planning Quality and process control	Review Structured decision making Casual analysis and resolution

Employee Development and Resource Management	Life-cycle Management	Software practices
Employee appraisal Employee and resource allocation Organisational employee development	Solution planning Solution control	Requirements establishment and technical solution Design Implementation Integration Test Acceptance and delivery Operations and support

Supporting Material

Project Information	Assessments	Education
Introduction Software process related documentation	Introduction Wall of fame	Introduction Article Courses

Figure 3.3: The business manual

company's ability to achieve its goals. The CMM approach chosen in the company is the staged approach, meaning that the organisation is developing its maturity in steps, and that assessments are carried out one for each level in the CMM.

The BM, being the process library in the organisation, therefore undergoes major revisions and updates, with a new version representing each step on the CMM ladder. At the outset of the study a version 3.2 was effective, but already planned was the next version to be deployed during the Autumn of 2003. As of 28. November 2003 all (including the reception desk and the canteen) projects were supposed to comply with this new version (ver. 4.1) to allow for an institutionalisation period of 3-5 months before the assessment for level 4, scheduled for 4th April 2004 (For a detailed description of the actual events occurring during the study refer to Chapter 5).

The CMM level 3 focuses on having the processes defined, and the BM at this stage consists of 32 processes, divided into activities, sub-divided into some 900 tasks (SSE, 2004b). The main agenda in the BM in version 3.x are within the project management area. The BM is not a blueprint or stand-alone document intended as a template, but is instead a collection of requirements that must be met by the projects' processes. Every project is different with respect to size, contents, purpose, &c., and a one-size-fits-all approach is considered too restrictive. The BM in itself constitutes the base of the formal description of the organisational processes on a meta-level. Therefore, these descriptions are often on a rather high level, and not easy to facilitate in the daily work in development (or other) projects. For this reason[7] a project during its initial phases develops its own version of a *project's defined process* (PDP), which constitutes a set of documents describing the formal surroundings of the project (scope, duration, goals, &c.), and at the same time defining how the project expects to implement the SSE process framework to achieve its goals. The explicit and tangible part of the PDP is a collection of templates of reports which the PM or

[7]The other reason being that the project is required to explain how it will implement and comply with the BM, both for internal (to the project) purposes, and for allowing external assessors to examine whether the project complies with *A*) the BM, and *B*) with its own explanation.

(often) the PQR fills with project specific data.

Because of the quite high number of tasks in the BM, a set of standard interpretations, or standard PDPs, is maintained by the SPI project, to ease the tailoring task for the project's management. This collection of standard PDPs is known as PDP common.

Before initiating a project its PDP is assessed as being in compliance with the BM, and during the project's life span an internal auditor conducts several audits to ensure that the project complies with its PDP. The overall lay-out of the BM hierarchy is illustrated in Figure 3.4 on page 73.

3.2.1.2 The Intellectual Capital Reports

The SPI project is responsible for maintaining and the publishing of SSE's much renowned intellectual capital reports. Studying these reports is a main source of information regarding the organisation. The reports, which are published with a frequency of one per year, are an important means of communication from SSE to interested parties, viz., customers, business partners, regulating authorities, potential employees, &c. To a certain extent, the reports are viewed as marketing material, since they deal with SSE's merits, which are very positive. However, the reports are a good means to study the organisation as they present how the organisation wants itself to appear.

The reports are laid out as a general capital report, with an introduction to the company. But instead of key financial figures (which are included in a summarised form) the reports describe how SSE is organised. The company's values (for a detailed analysis of these see Section 6.2) and mission are explained, followed by a description of what SSE does, which kind of projects are conducted, and how SSE conducts these projects. A large section of the reports is devoted to a description of CMM and how SSE has achieved to implement this model into their own unique process framework and practices.

Many non-financial indices and facts are presented in the reports to help the reader understand what kind of an organisation SSE is. For example, the bicycle index (how large a percentage of the employees rides bikes to and from the office), the already mentioned pizza index, and the carrot index

Business Manual

The BM contains high level process specifications focused at supplying business information about how SSE conducts its business. These specifications are the constitution of SSE and, generally speaking, every action conducted must comply. The daily use is somewhat limited due to the quite general specifications, as a result of the broad scope.

▽

Project's Defined Process Common

The SPI project produces translations of the most used parts of the BM to help the projects tailor the requirements of the BM into operational procedures and practices. The PDP common consists mostly of pre-configured templates and guidelines. At the outset of the study one PDP common existed, but more were planned in order to meet the requirements of different types of projects (size, duration, &c.)

▽

Project's Defined Process

Every project must describe and document how it plans to comply with the BM in its own unique defined process (PDP), which is a comprehensive set of descriptions of every process that the project intends to follow. The PDP is audited regularly (internally) and must comply with the BM. The descriptions are, to a large extent, similar to the one already pre-tailored from the version found in the PDP common, viz., inherited from there without change. This is especially true for projects which bear much resemblance with the common or normal SSE project type.

Figure 3.4: The process hierarchy

(how many kgs of carrots have been eaten per employee) are each not in themselves very vital to the organisation, but nevertheless illustrate how indices can be used to describe aspects of an organisation. Along with these indices are found more common non-financial figures concerning the employee satisfaction, customer satisfaction, level of employee education, deviates between estimates and actual hours spent, &c, all the figures a potential customer/employee can use to evaluate the organisation. Apart from the evaluation that the numbers themselves give rise to, the fact that the numbers are actually available is an important characteristic, since it signals that SSE is able to compute these figures, some of which might be quite hard to collect, calculate and present unless a large set of routines are working properly—so the ability to present these kinds of figures in itself shows that SSE has achieved a high maturity level concerning its internal practices.

The reports, in spite of their marketing purposes, are formally audited by the same auditor who audits the financial reports, and as such are intended to be more than just a marketing flyer. The reports are of a very high quality, and have been nominated for the award ‘Best Danish Intellectual Capital Report’ several times, and won this award in 2001. All the reports are publicly available and can be downloaded from the company’s website[8].

3.3 A Brief History of SSE

The above description covers SSE as it presented itself in the first half of 2003. The events leading up to this year however provide insights as to what has shaped the organisation. In the following a brief historical summary of SSE is given from its foundation in 1985 until 2003. A tabular presentation of the main events is given in Figure 3.5 on page 75[9].

SSE was founded in 1985 by the two owners and managers, Alex Holm Jensen and Michael Holm. Practically speaking, SSE has from then and up to 2003

[8] http://systematic.dk/UK/About+Us/Intellectual+Capital+Reports.htm
[9] http://systematic.dk/UK/About+Us/Quick+Facts/Milestones.htm

Year	Key Events	T*	TR†	P‡	PR§
2002/03	250 employees CMM 3 certification	31.6	25.9	3.1	34.8
2001/02	200 employees ISO 9001:2000 certification	25.1	40.2	2.3	53.3
2000/01	Opening of Copenhagen office, awarded Best Danish Intellectual Capital Report	17.9	29.7	1.5	87.5
1999/00	Nominated as 'Gazelle' company (borsen.dk, 2006)	13.8	16.0	0.8	300.0
1998/99	150 employees	11.9	43.4	0.2	-50.0
1996/97	100 employees	8.3		0.4	
1995/96	Establish. of Systematic Inc., USA				
1992/93	ISO 9001 and AQAP certifications				
1985/86	Establish. of SSE				

*Turnover (€1m.)
†Turnover Ratio (% of previous year)
‡Profit (€1m.)
§Profit Ratio (% of previous year)

Figure 3.5: Key events in SSE prior to study initiation

been a success, both financially and product wise. Financially, the company has since the late 90's experienced a steady high growth, despite the dot-com bubble which greatly impacted many software companies, both on their turnover and revenue. In the period from 1998/99 to 2002/03 SSE maintained an average growth-ratio of 28% in turnover, and (just as important) a staggering 119% in revenue. These figures signal that the management and employees together have achieved something extraordinary, and this is also the general feeling when talking with representatives from the organisation. The company has branches in three countries and product wise it has achieved being one of the two or three leading (Danish) providers to the Defence-industry with several highly acclaimed products selling world wide.

Internally, the company has, despite of the growth-ratios, been able to continuously align and trim its organisational practices to cope with 200 more employees since its inception (80% increase) apparently without harming the necessary drive required to be successful. SSE has in the said period achieved to implement a full scale CMM organisation, with process descriptions covering most aspects of the development organisation, and is certified as CMM level 3 compliant. Apart from the company being nominated as a 'Gazelle'-company, viz., strong growing company[10], it has earned acclaim for its intellectual capital reports.

Thus, the business situation in SSE in the Spring 2003 can be summed up in a single word: Success! Almost every aspect of the company has proved to be successful; in the cases of reduced success, proper actions have been taken to avoid a larger negative impact, both financially and organisationally. Because of this success, the employees and managers are very proud of themselves, seem not to be afraid of anything—and thus are very open to spend resources on projects that are believed to contribute to the future growth. The road-map for the future organisational development has been sketched out: the CMM model will continue to constitute the base of the SPI effort, and CMMI level 4 compliance is expected in April 2004, and the further Level 5 in May 2005 (The actual events are described in Chapter 5). The management

[10]For more details, refer to http://dbdenmark.dnb.com/English/default.htm?Loc=/-English/Gazelle/Gazelle.htm

of the BD BU is convinced that continuous evolution of the organisational practices is a necessity to keep the high growth, and to secure the future of the company. This means that the company not in any way rests on its laurels, but keeps up the high investment in the future.

3.4 Challenges Facing SSE and Constraints for Research

The success of a collaboration based study depends on several factors (Avison *et al.*, 1999); one important of these is the relevance of the expected outcome for the host organisation. Therefore, challenges facing the organisation provide a good starting point when looking for relevant research topics. In this section the major challenges—as they were expressed by the management of the BD BU—are presented.

The immanent challenge facing SSE is to achieve its own strategically defined goal, which is to continue the climb up the CMM ladder. This means that the organisation in 2003 and onwards must implement and deploy a quantitatively based management of the projects, and further prepare for the enabling of (automatic) feedback cycles from the projects to continuously optimise the organisation.

Prior to entering the SPK project, the management in SSE had considered what they expected to gain from participation in this project; their ideas were then translated into the following list, which was discussed at an initial meeting.

- Achieving higher maturity levels.
- Broaden the scope of the BM to include other disciplines than project management.
- Strengthening the experience based learning—closing the feedback cycle.

This list consisted of what the SPI project would work with regardless of the SPK project, and if there were any research proposals that could contribute SSE was open to collaboration[11]. These initiatives fitted well with the overall research agenda for the SPK project, but added, of course, some constraints which were necessary to consider when the specific research question for this study was defined. The choice of strategy was not up for discussion, as the CMM model is the base upon which the future SPI related work in SSE rests. New initiatives and suggestions thus had to comply with the requirements from CMM or at least not conflict with them. However, this constraint was not any great hindrance since the nature of the CMM paradigm is inclusive in settings where the model is not treated as a cook book recipe, but is tailored extensively to fit with the current organisational settings. But, of course, this constraint could and should not prevent the researcher from pointing out alternative suggestions and/or disadvantages of the chosen path.

[11]For further information refer to Appendix A which lists the topics that was listed during the initials meetings with SSE.

Chapter 4

Research Approach

In this chapter I present the research approach which I adopted for the study. Initially a presentation of the research objectives is given which is followed by a presentation of the chosen research method. Following this, the detailed research design is presented, including presentations of the data gathering techniques applied during the study.

4.1 Research Objectives

The Software Processes and Knowledge project (SPK), which this study is a part of, is an action research project which intends to improve practice through intervention while contributing to scientific knowledge (Nielsen, 2003). The setting of the SPK project defines the context of this study: First, three companies participate in the SPK project. Given this relatively small sample highly detailed studies are carried out in each company. My study takes place in one of these companies and adapts a deep study approach. Second, the SPK project's predecessor, also researching software process improvement (SPI) from a learning perspective (refer to, e.g., (Mathiassen *et al.*, 2002)) relied heavily on close collaborations between researchers and a limited number of organisations—and mostly on qualitative approaches. The SPK project and my study take place within this tradition and thus favour these approaches.

Given this, the overall goals defined by the SPK project presented in Chapter 1, and the host organisation's interests and needs presented in Section 3.4 the overall objectives for this study can be summarised as to examine how the concepts of knowledge and learning are handled in software organisations and, based on this understanding—and by applying ideas from the theoretical field of knowledge management (KM)—to suggest how practice can be improved.

Therefore, this study's objectives are to conduct (and document) practical SPI improvements achieved in the organisation by

- developing new techniques and combining existing techniques to improve the knowledge management capabilities in software organisations,
- establishing a means for facilitating these techniques into such organisations, and
- providing empirical proof of concept for the applicability of the techniques.

4.2 Collaborative Practice Research

With these research objectives in mind, I have chosen a research method inspired by collaborative practice research (CPR) to guide this study. CPR fits the objectives since

> "it combines action research, experiments, and conventional practice studies to strike a useful balance between relevance and rigour." (Mathiassen, 2002, p. 322)

and as Mathiassen (2002) points out, applying a portfolio of research methods in different parts of an collaboration based research project is a way to achieve results both with regard to action and to research. He describes three research goals that are of interest in practice oriented research: to understand, to support, and to improve practice. Mathiassen suggests:

> "The three goals are distinct and can be pursued in isolation. But that would seriously reduce the opportunities to learn about practice." (Mathiassen, 2002, p. 327)

Based on the experiences gained from conducting a large research project[1], he describes how a research method actually emerged from pursuing these three targets. He termed it CPR. CPR thus describes how three basic phases each with different research activities addressing different knowledge types are relevant when conducting practice related research.

> "[...] the involved activities presuppose and support each other: we reach a deeper understanding of practice as we attempt to change it; we need to understand practice to design useful propositions; and, the propositions and our interpretations of practice are ultimately tested through attempts to improve practice." (Mathiassen, 2002, pp. 327-328)

Viz., the understanding of the subject area is achieved through collection and interpretation of data about practice. Based on understanding the area of interest, normative propositions and artifacts to support practice can be designed, and through intervention the propositions and artifacts can improve practice.

CPR suggests that full learning cycles comprising all three phases are implemented and I find it beneficial to think of the framework as describing three successive steps, each based on the outcome of the former (refer to Figure 4.1 on page 82). This cyclic implementation of the framework allows it to be used as a controlling structure for a collaboration based research project; a guide describing three phases each focusing on targeting a specific sub-goal. Further, the cyclical notion can be extended to involve several cycles, each based on the other—so the outcome of the improvement effort in one research cycle can be used as a means for the understanding in the next, and so forth, which I term a recursive cyclic approach.

Checkland & Holwell (1998) describe how

[1] The project Mathiassen reported from was the predecessor to the SPK project.

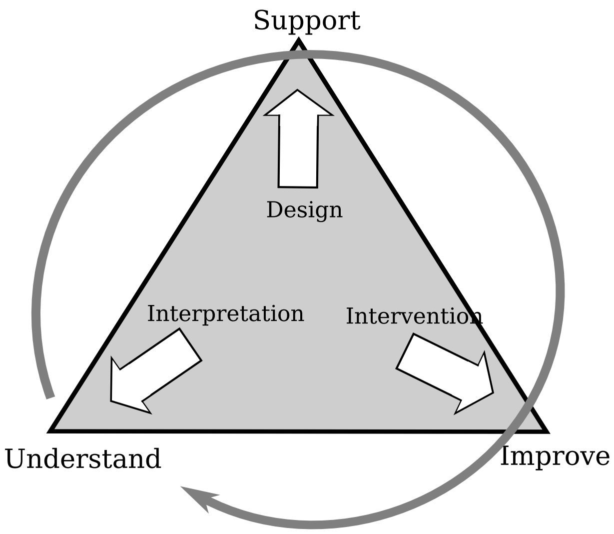

Figure 4.1: Cyclic application of the CPR framework—Inspired by Mathiassen (2002)

> "Particular linked ideas F [theoretical frameworks] are used in a methodology M to investigate an area of interest A. Using the methodology may then teach us not only about A but also about the adequacy of F and M." (Checkland & Holwell, 1998, p. 13)

which in combination with Avison et al's (1999) statement

> "Each iteration of the action research process adds to the theory [...] so it is more likely to be appropriate for a variety of situations." (Avison *et al.*, 1999, p. 95).

means that adapting a cyclic approach to the CPR framework leads to conclusions not only about the actual interventions in the collaborating company, but also about the theoretical framework upon which the interventions are based, and at the same time about the application of CPR itself.

4.2.1 Research Organisation

The CPR approach as described in Mathiassen (2002) is based on a number of SPI research studies which were jointly performed in a Danish national research project from 1997-1999. The descriptions given by Mathiassen are from a national project's perspective, viz. emphasising on the coordination of the individual projects.

In my study the ability to interact with other researchers and other research projects of course is beneficial, but not vital. The core activities of this study are concerned with a single research project, and therefore the research design is a local adoption of the CPR approach.

The SPK project is mimicking the set up of the preceding research project (refer to (Mathiassen, 2002, pp. 324-324)) and my study therefore is one of three local research projects (one in each of the participating companies) interconnected via a researchers' forum and a SPK project plenary consisting of all involved researchers. This structure is illustrated in Figure 4.2 on page 84.

The local research groups are established in each of the companies as collaborative research units. It is in these local research groups that the individual research studies, such as mine, are anchored. These organise their interventions via a local steering committee. Further, the local research groups, including directly involved staff from the host organisations, participate in SPK plenary sessions (called workshops) in which findings from within each of the organisations are presented and discussed. These workshops facilitate the exchange and sharing of local findings and this way provide the researchers and staff with a wider empirical foundation. All researchers from the SPK project meet regularly in a researchers' forum (aka SPK-research project meeting). In this forum the course of the SPK project is discussed, as are local research progress, publications and outlet suggestions, suggestions for new research initiatives, research implications, and other coordination needs.

Locally the research study is organised as follows. A formal control structure, the steering committee manages and controls the research activities. Its primary task is to support the research initiatives in the organisation, and to facilitate that their objectives are accomplished. The steering committee also formally defines and designates the authority and the level of formalisation in the project. The steering committee consists of representa-

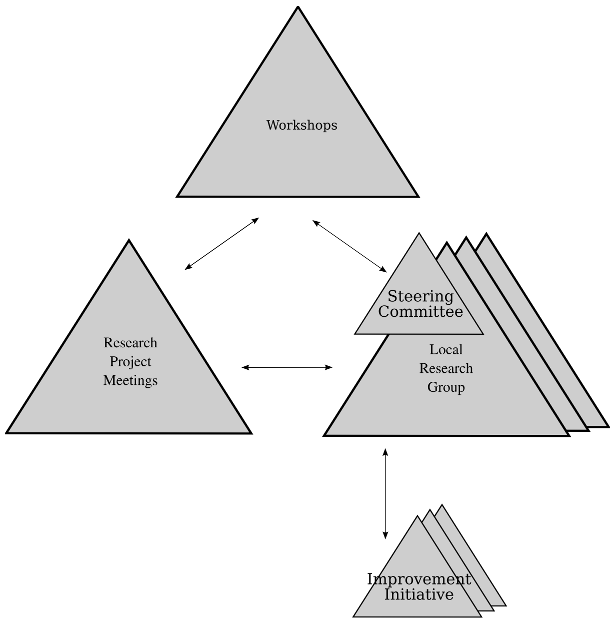

Figure 4.2: Research layout—Inspired by Mathiassen (2002)

tives from the organisation and of researchers. The steering committee has 8 members: the line manager (BUD) responsible for the SPI project, the project manager (PM) from the SPI project, one professor, three associate professors, and two PhD students. By having both the line manager and the SPI project manager as members of the steering committee, the level of formal authority is high leaving only the CEOs of the company more senior. This warrants that the steering committee possesses adequate formal power for decisions made to be carried through. At the same time, having all the involved researchers represented provides an opportunity for exploiting synergies between the research initiatives in the organisation, as well as with other SPK project related activities. The steering committee meets approximately bimonthly and functions both as a co-ordinating and planning forum. Research initiatives are discussed and their plans, intentions and results debated. Also, more critical decisions, e.g., renegotiation and/or cancellation regarding research initiatives in progress are taken by the steering committee, whereas normal day-to-day decisions are left to the involved parties of the different activities, often a researcher and staff from the organisation.

4.3 Detailed Research Design

In the following section a description is given of how the actual CPR research cycles were designed and which research methods and techniques were applied. This section has been compiled in retrospect because of the study's gradual emergence. Three research cycles were conducted each following an Action Research (AR) inspired approach.

4.3.1 Action Research

Action research fits well as a method for implementing the CPR approach since

> "Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework." (Rapoport, 1970, p. 499)

Snyder & Cummings (1998) argue that action research is required to study the results of knowledge related interventions

> "Action research is needed to explore the effects of interventions intended to treat specific OLDs [Organisational Learning Disorders]" (Snyder & Cummings, 1998, p. 890).

And further Avison *et al.* (1999) stress the possibility to achieve close connectedness to practice

> "[in] action research, the researcher wants to try out a theory with practitioners in real situations, gain feedback from this experience, modify the theory as a result of this feedback, and try it again" (Avison *et al.*, 1999, p. 95).

A formal contract between the participants of the SPK project describes how the various parts are expected to act, and the level of resources and engagement that is required. Also, the topic of the research is described in the project charter, and it is out of this interest that the participating parties have signed an agreement. This secures that the different parties, i.e., the researchers and practitioners share the same goals. If not conflicts may arise jeopardising the outcome of the study:

> "Successful action research is unlikely where there is a conflict between researchers and practitioners or among practitioners themselves." (Avison *et al.*, 1999, p. 96).

4.3.2 Research Outline

According to Avison *et al.* (2001) three important aspects need to be taken into consideration when performing an action research project to overcome the so-called double challenge of combining both action and research, namely; the initiation, the determination of authority, and the degree of formalisation of the project. For an action research study to be more than consulting, it is a requirement that a research method which academically guides the study's focus is applied and followed:

> "If researchers are not explicit in following the tenets of action research when working in real life situations, their work might be better described as consulting." (Avison *et al.*, 1999, p. 96).

This study adopts a recursive cyclic CPR inspired approach, and three cycles are carried out supported by two supplemental analysis techniques. The outcome from each cycle acts as the input for the following cycle, thus narrowing and focusing the field of investigation.

At the outset of this study it was not possible to describe in detail the activities in the later cycles, as these depend on input from the former. Yet to be able to plan the study in advance the following research questions were developed on the basis of the research objectives given in Section 4.1:

- *How can the knowledge management status of a software organisation be analysed in order to identify knowledge related improvement areas?*

- *How can improvements of such areas be planned by designing and aligning new organisational initiatives to strengthen the organisation's learning capabilities?*
- *How can such improvement initiatives be facilitated and implemented in order to secure acceptance and continuous evolution?*

Each question is answered in a full CPR research cycle. Each of the cycles is planned accordingly and a detailed research method is established that fits the objectives of the cycle. Hence the study emerges in a controlled way, following relevant topics—both from the viewpoint of the host organisation and the researcher—and provides a balanced action and research effort to secure both the research and practice objectives.

In the first cycle this approach was applied as a means to developing and testing a technique to identify and prioritise knowledge related improvement areas in the host organisation. In the second cycle an action research inspired approach involving two successive pilot studies was adopted to develop and test a first draft of a project evaluation technique, and, finally, in the third cycle the action research approach was adopted utilising quality reviews to adjust and test the evaluation technique in the specific organisational settings in the host organisation.

In the following I present the outline of each of the cycles—the detailed implementation is later presented in Chapter 5. A graphical illustration of the outline is found in Figure 4.3 on page 88.

4.3.2.1 First Research Cycle

The objective of the first cycle was to analyse the knowledge situation and to identify relevant improvement areas in the organisation. The first cycle focused on developing a technique suitable for this analysis. Further the application of this technique would provide a list of knowledge related improvements grounded in the company's current situation.

The research cycle consisted of a data collection phase divided into an observation track and an interview round (which together constituted the 'understand'-

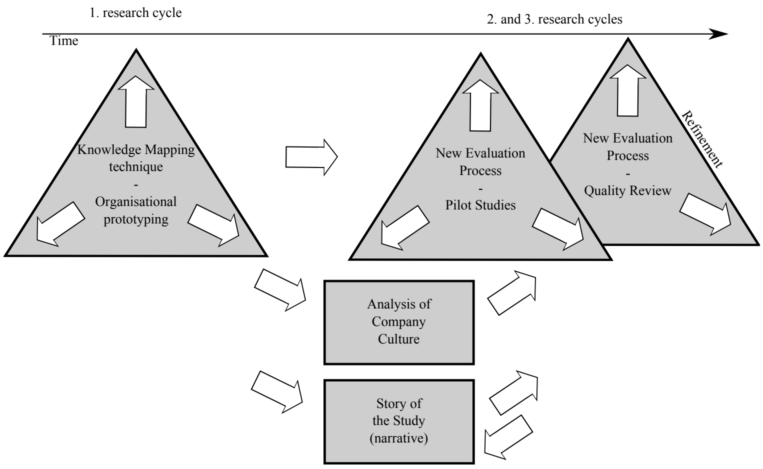

Figure 4.3: Research outline

phase of the first CPR-cycle) followed by the development of an analysis technique (‘support’-phase), and finally an intervention in which the analysis technique was implemented and applied in the organisation (‘improve’-phase).

The observations were conducted as ‘being present’ in the organisation to collect basic information regarding the structure, daily life, culture, practice, &c. of the organisation. A detailed description of this data gathering technique can be found in Section 4.4.1.

To gain in-depth information regarding specific topics that could inform the design of the analysis technique a set of qualitative interviews was conducted. These followed the layout presented in Section 4.4.5. Based hereupon a new analysis technique was developed. This technique later was implemented in the organisation to test it and to provide results regarding its feasibility.

After applying the developed technique in the organisation the research cycle was terminated by evaluating the outcome of the technique—both regarding the applicability of the technique itself and regarding its results. The evaluation of the technique itself was conducted through a debriefing session following immediately after its application. The evaluation of the effectiveness, i.e. to which degree did the technique identify relevant organisational improvement areas, was conducted during the following research cycles.

4.3.2.2 Second Research Cycle

The second cycle was targeted towards planning, designing, and aligning new organisational initiatives directed at strengthening the organisation's learning capabilities. Subject of study was the project evaluation process, which in the first research cycle was identified as a candidate for improvement.

The second research cycle consisted of a data collection phase which, like in the first cycle, was divided into an observation track and an interview round ('understand'). This was followed by a 'support'-phase which was conducted as an in-house organisational development project in close collaboration with the SPI project. Two successive pilot studies (Whitman & Woszczynski, 2003) concluded the cycle and this way evaluated the new project evaluation concept ('improve').

The data collection phase extended the data collected during the first research cycle. It was based on observations which provided an immediate understanding of the project evaluation process. This understanding was further enhanced by the conduction of a second interview round consisting of 9 semi structured interviews with employees with different roles and from different development projects.

Based on this I worked closely together with a representative from the organisation in designing a new concept to use in the development project evaluation phase. This work was conducted as an internal development project similar to how the organisation itself designs new organisational improvements. Following this it was possible to *A*) design an applicable concept by adopting internal processes, and *B*) while doing so to collect empirical data concerning the knowledge constituents in a high maturity software organisation.

The project evaluation concept that was developed introduced a number of improvements to the already practiced process. Two successive pilot studies were conducted to test these improvements in real settings. Both pilot studies were conducted with project staff from within the organisation. The pilot studies were closed with a debriefing in which the participants discussed and evaluated the outcome and applicability of the evaluation concept. The pilot study technique applied is described in Section 4.4.4.

4.3.2.3 Third Research Cycle

The third research cycle's objective was to examine how it is possible to facilitate new techniques and how they can be implemented in a way that secures both the acceptance among the organisational members and a continuous evolution. The subject of study in this research cycle was the project evaluation concept developed and piloted during the second cycle. The 'understanding'-phase consisted of an analysis of the results from the pilot studies. The results—in combination with the results of an cultural analysis (refer to Chapter 6)—were used to adjust the evaluation concept into a more practice oriented process description—ready for organisational deployment ('support'). Finally, the quality and applicability of the evaluation process was secured through two successive quality reviews ('improve').

The data collection in this research cycle was focusing *A*) on analysing the outcome of the pilot studies to identify improvements for the concept, and *B*) on understanding how process descriptions and tools were designed and deployed in the organisation. This analysis was based on an artifact study which is described in Section 4.4.2.

On the basis of this understanding the new project evaluation was transformed from a conceptual idea into a final deployable process. This transformation was conducted by a small project team with two members. Most work at this stage regarded the production and adjustments of descriptions and templates and similar practical oriented tasks and was conducted individually by the team members, who met regularly to coordinate the effort.

The final process descriptions were tested during two quality reviews—one external and one internal. These reviews secured the quality of the new process both regarding its applicability, but also regarding its ability to collect and define actions that can help the organisation to continuously learn from its experiences. The applied quality review technique is detailed in Section 4.4.5.

4.3.2.4 Supporting analyses

To guide my understanding of the organisation, the following supportive analysis techniques were applied.

First, a narrative, describing the study's layout or the 'story of the study' was produced as a means to create a detailed, coherent, and chronological recording of the complex nexus of events and decisions endured during the course of the study. This story of the study secures the collection of empirical evidence and this way documents the foundation upon which this study has been conducted.

A narrative is a textual and chronological description of occurrence or course of events—in this case the events that constituted this study. Used as a means of scientific interpretation a narrative can contribute with a coherent description, which links together the individual parts of the study. This 'first story' provides the ground upon which insights and theories are explained and built while climbing the 'ladder of abstraction' (Miles & Huberman, 1994, p. 91).

Choosing a less rigid form of expression provides the possibility of including relevant context which makes it possible for the reader to re-create the course of the study, and thus follow the chain of decisions and events which finally constituted the study. At the same time a detailed description contributes with empirical data regarding the practice in a high level SPI organisation. This is further detailed in Chapter 5.

According to Rapoport (1970) a collaborative study produces results that should fit into current practices and therefore an understanding of these and the climate in which they reside is necessary. To obtain this a grounded theory (Glaser & Strauss, 1967) inspired cultural analysis was conducted.

It focused on establishing an understanding of the values of the organisation—to make it possible to align suggested improvements accordingly (Bødker & Pedersen, 1991). Applying an open approach enabled me to look for relevant interrelations within the organisation and helped me pinpoint properties affecting the adoptability of improvements. In other words, results from this analysis were 'grounded' directly in the observed data instead of being produced e.g. by deduction or other ‘intellectual experiments’. The detailed description of this technique is presented in Chapter 6.

4.4 Data Gathering Techniques

To conduct research within the SPI field is to conduct research into organisational practice, change, and development (refer to Section 2.1). This means that SPI research intends to improve practice in real life organisations developing real software for real customers. Therefore, research within this field needs to be highly interconnected with the software organisation’s daily practice. This practice dependency poses some challenges to the research and the researcher: it might be difficult for an outside observer to fully comprehend the highly specialised setting or system of which any organisation consists, and further it might be problematic to acquire relevant and correct data about these practices (Bødker & Pedersen, 1991).

Practice does not merely follow predefined plans. Therefore examining project plans and educational material might provide an idealised picture of a given organisational reality (Brown & Duguid, 1991). The same challenge must—to a certain degree—be overcome when collecting information directly from the respondents. Humans—when asked directly—tend to rationalise or idealise their own situation (Argyris & Schön, 1974)—partly because they want to appear knowledgeable and smart, and partly because it is necessary to sum up and aggregate the complex daily life in order to tell others about it—this is also true within the IS domain (refer to, e.g., (Kautz *et al.*, 2004)).

Further, practice often is very context dependant, meaning that practice will differ from situation to situation, even if the overall process is described as one. Within the software development field this means that developers when adapting process schemes or methods instantiate their own version of the process from situation to situation (Fitzgerald, 1998b; Madsen & Kautz, 2002; Kautz *et al.*, 2004).

Therefore, when the intention is to improve a current organisational setting it is important to improve the actual setting—not some idealised image.

This stresses the importance of grounding the research in practice. So a key requirement for this research was to secure that the SPI achievements were grounded in the organisational reality. This further suggests that to produce valuable SPI research it was necessary to reveal the real practice and not the documented practice. To do this this research had to rely on a thorough understanding of the specific organisational setting, e.g., the organisational culture—and as such adapt suitable techniques to obtain this understanding. In the following the applied data gathering techniques are presented in detail.

4.4.1 Observation

I was present in the organisation as often as possible—at times once a week—participating in the activities conducted at the time. Presence in the organisation was important since it provided me with detailed insight into many 'taken-for-granted' situations, which often are not explicated during formal interviews or conversations (Bødker & Pedersen, 1991). This way I participated in a number of meetings and employee courses both in an active as well as an observing role. The ability to ask "What happened just there?" in or just after the occurrence of an interesting incident made it possible to collect and describe non-formal communications and practices, and further it provided me with a broad view of the organisation allowing for a more detailed understanding—and thus a better ability to conduct valid analysis of data. The information gathered from the many visits was documented in a diary and in a dictionary explaining the many different organisational constructs and concepts. The diary and dictionary were recorded as electronic texts to make it possible to hyper link to relevant (electronic) documents and other sources, e.g., electronically recorded and stored interviews. The cultural analysis (refer to Chapter 6) was to a large extent based on observations and direct participation, information that could not have been derived in other ways.

The ability to be physically present in the organisation granted me access to many resources as relationships on a more personal level were gained. The trust that these relationships were based upon was important with respect to the accessibility of both resources and data, especially when taking into account the relative high level of security in the organisation. Shortly after commencing the study I was equipped with a personal access card which made it possible for me to access the premises as a normal member of the organisation's SPI project.

4.4.2 Artifact Studies

The study was extensively informed by studying organisational artifacts and their use. Artifacts concerned report templates, manuals, organisational process descriptions, course material, computer based tools used in the development projects, &c. Reports were carefully read and their templates studied to extract information regarding their use, information needs, effectiveness, and intended users. Manuals, primarily the business manual (BM) (refer to Section 3.2.1.1), were studied to gain insight into the intended practice, which later would let me compare this with my observations of the actual practice. Further the artifact studies let me learn about the SSE jargon (refer to Section 6.5.3) used in the formal documentation. To use this jargon or verbal symbols (Bødker & Pedersen, 1991) would enhance the ability to design applicable procedures for the organisation. Most of the formal documentation in SSE are made available via IT tools, and the structure of these tools were also studied.

4.4.3 Qualitative Interviews

To gain more in-depth information about specific practices or situations 17 qualitative semi-structured interviews were conducted. In these participated representatives from every level of the organisation. The interviews were all guided by interview guides.

The interview guides were used as a means to structure the interviews—not to rigorously control them. The interviews were kept in an open-ended manner allowing the interviewer to follow up on (new and) interesting topics. The questions formulated in the interview guides also were articulated in an open-ended manner to avoid simple binary answers and to allow the interviewees to respond with their own words. Correspondingly, the structure and content of the interview guides were revised by the interviewer after each interview to make adjustments with respect to what was found to be interesting or potentially could be of relevance for further research.

The specific content of the interview guides implemented during each of the interview rounds is explained in more detail in Sections 5.3.1.2 and 5.4.2.1. The interview guides all begin with more general questions about the interviewee personally and her/his background and role in the organisation. This soft start serves a dual purpose: first, the gentle nature of these questions helps the respondent to relax, and second, it provides the interviewer with knowledge about the organisational background and in this way the study with insights about the organisation (Andersen, 1990).

All interviews were recorded and expansive resumes were written afterwards for later consultation and analysis. These analyses did not require full search capabilities or direct quoting, thus the interviews were documented via resumes, viz., not fully transcribed.

Every respondent was (of course) asked for permission to record the interview under the assumption that—because of the partly sensible nature of the interviews—the recordings and resumes were kept confidential. None of the interviewees declined this request.

Recording interviews can pose the threat that the interviewee feels inhibited to speak about sensible matters and generally acts more closed than if the interview is not recorded (Andersen, 1990). To avoid this influence, the interviews, as mentioned, started with straightforward questions to make the respondent feel more relaxed. Another precaution taken was to rely on computerised equipment instead of traditional tape recording devices, thereby avoiding visually signalling the fact that the conversation was being recorded. No tape recorder was present, and no tapes needed turning—nothing but a small laptop computer was visible.

The respondents were selected by the PM of the SPI project. I asked for a number of interviews, and stated which roles were needed, and a representative from the SPI project booked the actual meetings with employees.

In one of the interviews two respondents from the same project participated. This approach was suggested by the interviewees themselves because they felt they could help each other in reconstructing some of the events from their project.

The interviews were conducted in two interview rounds: one during the first research cycle (April 2003, six interviews and June 2003, two interviews), and one during the second cycle (February 2004, nine interviews).

4.4.4 Pilot Studies

Pilot studies are defined as brief preliminary surveys often using a small convenience sample (Whitman & Woszczynski, 2003). In my study pilot studies were utilised to test the applicability of suggested improvements of the process descriptions and practices in the organisation. These test consisted of applying the process to be tested in daily settings, but under careful observation and facilitation.

This approach served several goals. First, the pilot studies made it possible to test the new concepts in the settings in which the processes were intended to be used. Second, pilot studies made it possible to achieve a quick first time success, which could act as an organisational ice breaker for the new concept. Third, pilot studies were a well established practice in the organisation, and therefore the members of the organisation were used to it. This made the preparation and introduction easier.

The pilot studies provided feedback to the project team regarding the applicability of the tested process. Therefore, the pilot studies were based on draft material. This, however, did not present problems, as the participants were familiar with pilot studies and therefore did not expect completely final process material. Further, the inventors of the new concepts were present during the pilot studies (to record the activities), and could resolve any problems related to imprecise descriptions. A detailed description of the setup and application of the pilot studies is included in Chapter 8.

This is a team method for checking a document's quality through a review process. The purpose of a quality review is to inspect a product for errors in a planned, independent, controlled and documented manner and to ensure that any errors found are fixed. This method is a process with defined roles and activities. The roles involved in a quality review are:
The producer is the author of the product being reviewed. This role has to ensure that the Reviewers have all the required information in order to perform their job.
The chairman is responsible for ensuring that the quality review is properly organised and that it runs smoothly during all its phases.
The reviewer is a person who has either a vested interest in the quality of the product or who has the skills and experience necessary to assess the quality of the product.
The scribe is someone to take notes of the actions identified at the review meeting.

Figure 4.4: The quality review technique

4.4.5 Quality Reviews

The quality review technique concluding the third research cycle was based on an already established practice in the organisation. This followed the project management method PRINCE2 (Hughes & Cotterell, 2006). This method prescribes a meeting to be held in which the suggested process is 'walked through'. All material concerning the process was reviewed to examine its quality (completeness, applicability and estimated usefulness). A formal description of the technique is reproduced in Figure 4.4 on page 97.

The quality review method was chosen because the organisation consider this method to be a guarantee that the reviewed material is ready to be deployed. A description of the detailed application of the quality reviews is included in Section 9.2.

4.5 Summary of the Research Approach

In summary to improve practise and provide scientific theoretical contributions about the role of knowledge management and sharing, I applied a collaborative practice research approach which combines action research with experiments and conventional practice studies.

My research was supported by a defined management structure consisting of a steering committee, a local research group, research project meetings and research workshops. On this basis I went through three research cycles to understand, support, and improve practice while gaining scientific knowledge. As a supplement to the three research cycles I constructed a narrative of the study and supported the study as a whole through a cultural analysis. Data was gathered utilising observations, artifact studies, qualitative interviews, pilot studies, and quality reviews. The latter two approaches were also used to validate my research results.

Chapter 5

The Story of the Study

In this chapter the course of the study is laid out. The presentation of the study is based on a narrative which describes in detail the contents of each of the research cycles. This detailed description presents the research and its context in a coherent and chronological way to describe the challenges faced and achievements made by the study. By telling the story first rather than presenting the results, it is possible to provide insights as to how the results were actually achieved. The reporting of the results will be presented and discussed separately in Chapters 7—9. As the study consisted of three action research cycles, the overall flow of the narrative follows these three cycles. The internal and external events informing the narrative are presented in tabular form in Appendices B and C respectively.

5.1 The Narrative

The narrative represents two intertwined and inseparable stories: a story of how SSE managed to climb from CMM level 3 to CMMI level 5 in a fluctuating environment, and a story of how SPI related initiatives were conducted as a part of my research study. With respect to the first story, my role was limited to that of an outside observer, since the market situation, the general strategy of the company, the ability to hire skilled staff, &c., were factors that my research and its interventions had no significant influence on. The other story, however, concerns the events that occurred as a result of the research, and this story follows my interventions in the organisation. The first story might have had a dramatic effect on the second whereas the second story only in a limited measure affected the first—and for good reasons. My research was focused and dealt with specific parts of the overall course of SSE, and only these specific parts were influenced by the study's interactions. SSE is actively managed, that is, management navigates SSE's business and is continuously presented with new challenges in the environment. These events and the managerial and organisational reactions of course impact the research initiatives. But the risk (or opportunity, depending on one's world-view) of being affected by such external events can be viewed as an integral part of conducting collaborative research, and thus it is a necessary evil. On the other hand, conducting collaborative research requires that the research story affects the company's story at least to some extent.

The primary data source for the narrative was my diary (refer to Section 4.4.1) in which resumes of visits, meetings, and other observations were recorded in a chronological manner. To create an overview of all events that occurred during the study, an event list (Miles & Huberman, 1994, p. 111) was created. An event list is a graphical representation of the events which are included in the narrative. The events in the event list were organised chronologically and further categorised as to which part of the story they belonged, the internal or the external, viz., whether they occurred as a consequence of this study or not. Because of the chronological order of the events in the list, I chose to term it the timeline of the study.

The timeline was constructed electronically as a web-based application. This made it possible to represent all the events from the study in one place because the application allowed the data to be scrolled horizontally. The full version of the timeline including all recorded events is available on-line[1]—an excerpt of the timeline is found in Figure 5.1 on page 102.

The events in the timeline were colour coded to make the timeline a suitable tool for gaining an overview of the many events. The colours for the internal

[1] http://2hansen.dk/timeline/thesis_timeline.html—(Please note that the software used for producing the timeline is maintained and generously made available by the Simile project, http://simile.mit.edu/)

events were: Green for meetings/observations, blue for organising events, viz., steering committee meetings and research co-ordinating activities (SPK research meetings), and red for formal interviews. The external events were not colour coded.

As can be seen from the excerpt the events were represented in three vertical bands; the lowest represents the internal events—those that were directly related to the research interventions. The middle band contains the external events—those which occurred independent of the research study. And at the top of the timeline a summary band is included. This band has a larger time scale and pictures an overview over the complete time period at one time. This makes it easier to locate a specific time period and scroll to it using the scrolling capabilities of the dynamic timeline. In this navigation band all events are condensed into categories, e.g., first interview round or third research cycle.

The timeline was used as a means for supporting my memory when I compiled the story of the study. I would consult the timeline to navigate between the many events and to make certain that the narrative included the events in their correct order. The timeline and the diary supplemented each other such that the timeline provided an overview which the diary could not, and the diary provided the details that the timeline did not. The complete list of events in the timeline are represented in Appendix B (internal) and C (external).

5.2 Research Initiation

At the initial kick-off meeting of initiating the SPK project, the formal agreement and an initial plan for the SPK project in SSE were developed. This meeting was the first time I met with SSE and its representatives. SSE had participated in the previous SPI related research project (the forerunner to the SPK project, reported in (Mathiassen *et al.*, 2002)), and both the representatives from the company and the senior researchers already knew each

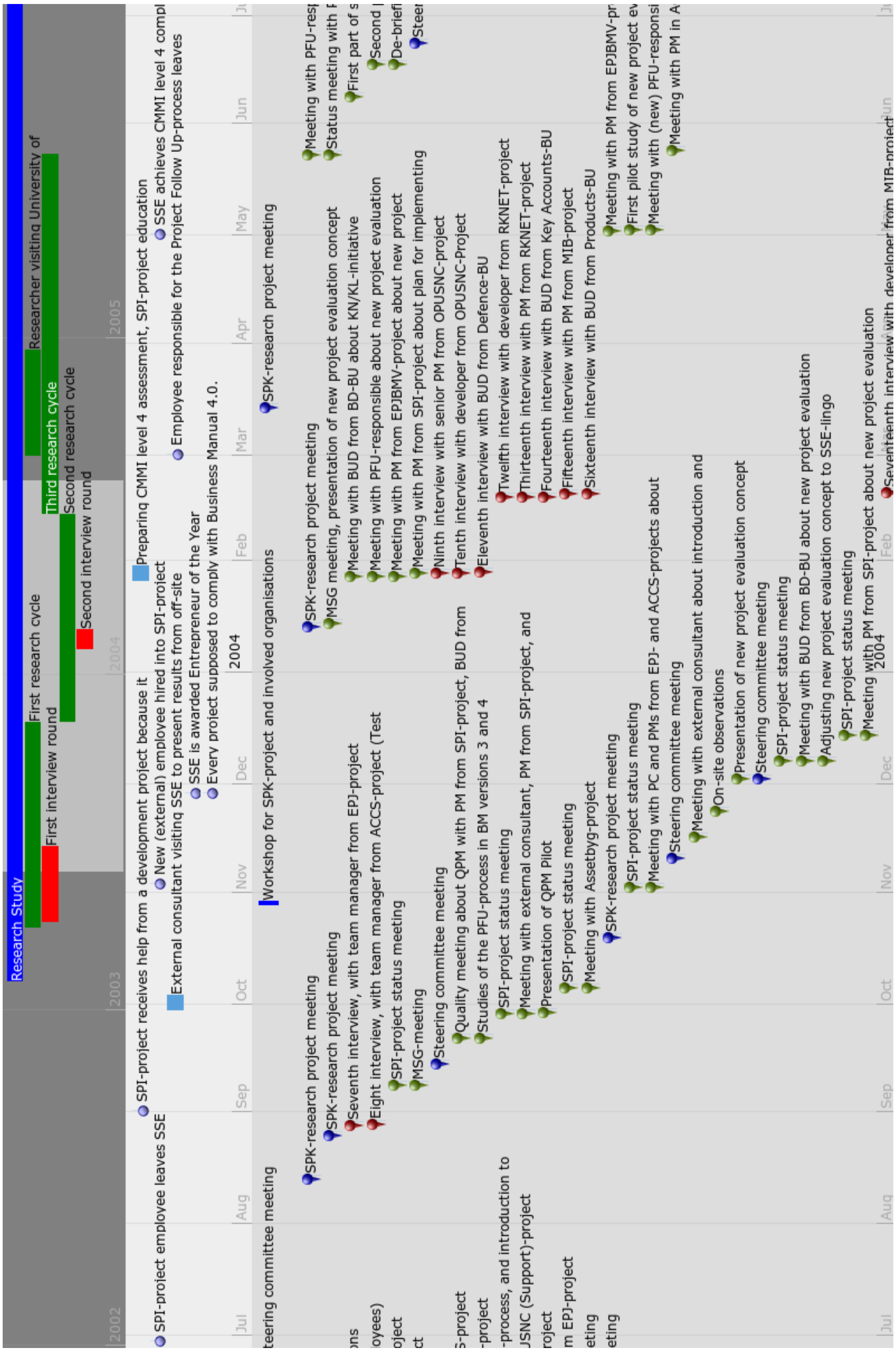

Figure 5.1: Excerpt from the timeline

other and much of the agenda had, because of this, been agreed upon beforehand. This acquaintance between the organisation and the researchers acted as an icebreaker for me, and proved to ease the process of establishing co-operation, since both parties already knew what to expect (and what not to). As such, the discussion quickly could be directed towards more practical matters. Since more than one independent SPK related research study was to be conducted simultaneously in SSE, the participants of the meeting appointed themselves as a steering committee (refer to Section 4.3) for these studies, with the responsibility for coordinating the activities among these.

At the meeting the representatives from SSE presented their ideas as to which imminent projects or initiatives they saw SSE facing. A list of these subjects can be found in Appendix A. This list provided an overview as to where the SPI project (the representatives from SSE were members of this project) saw interesting topics to be studied further. After this presentation the researchers each presented their research agendas and ideas for research activities in SSE. The initial meeting was not intended to come up with final research topics, but instead to establish a common framework as control structure for the joint effort.

On the basis of the results from the first meeting, the time until the next steering committee meeting was used to transform my research agenda into: *A*) a set of clearer research objectives, which were compatible with the goals of the organisation, and based on this *B*) a research approach describing how these objectives were to be achieved.

A literature survey (refer to Chapter 2) was conducted to inform the researcher about the state of the art of the relevant scientific fields to suggest specific relevant research topics for the study. Taking into consideration the early stage of the research, the proposed research objectives (refer to Section 4.1) were inclusive in their nature, stating that an initial goal of the research was to identify improvement areas within the organisation. A more detailed objective was to be based on the result of this initial analysis. Further, the initial analysis would be based on observation and participation supplemented by open, but informed, semi-structured interviews with a wide selection of employees.

5.3 First Research Cycle

The objective of the initial cycle was to develop an approach to analyse the knowledge management status of the organisation with the purpose of identifying relevant improvement areas in the organisation. A secondary goal for this cycle was to provide a thorough overall understanding of the organisation and its settings.

The research question for this cycle was the following:

- *How can the knowledge management status of a software organisation be analysed in order to identify knowledge related improvement areas?*

This cycle was conducted from Feb. 2003 to Nov. 2003, in co-operation between the author, the line manager (BUD), and the project manager from the SPI project. The results from this cycle were documented in an internal report as well as in two scientific papers (Hansen & Kautz, 2004a, 2005a) and are presented in Chapter 7.

5.3.1 Getting to Know SSE

The initial cycle opened the organisation, i.e., let the researcher gain a thorough understanding of the organisation, its employees, practices, culture, business domain &c. At the initiation if this cycle a survey of relevant knowledge management (KM) and learning literature was conducted (refer to Section 2.2) to provide the necessary input to design the data collection, to analyse the data gathered, and to suggest a way to pin-point relevant improvement areas.

5.3.1.1 Participation and Observation

Initially, observation and participation were conducted to gain a bird's-eye view of the organisation. I participated (as a fly on the wall) in a wide selection of meetings to learn about the SPI project, and also in a formal 'introductory course' intended for new employees. Apart from this, an extensive study of the business manual (BM), at that time in version 3, and of the existing process for conducting project evaluations, including extensive studies of several existing PFU reports, was conducted to gain an initial understanding of the formal procedures of knowledge and experience sharing in the organisation.

Of key interest was observing the employees from the SPI project who were working with the development of the BM. The project controllers (PCs)[2] were of major interest, since the PCs were responsible for facilitating the BM among the development projects and tailoring it into project's defined processes (PDPs). The PDPs should, on the one hand, be of use to the projects and thus of value with regards to securing the progress and quality, but on the other hand, they could not be tailored too much, since they had to comply with the requirements specified by the BM. The PCs therefore were the direct link between the SPI project and the development projects. I was to discover that the PCs would be a pivot point in the analysis of how the organisation transferred formal knowledge (in the form of BM) from the SPI project (management) into the projects.

Focusing on the PC role also gave me the opportunity to investigate how well the process descriptions were understood by the development project members and to what extent the PDPs were actually considered useful—viz., whether the PDPs were used in the daily project work or whether the PDPs simply were artifacts justifying compliance with the organisational requirements. These topics would be known by the PCs who were the only SPI project members meeting the development projects 'in the trenches'.

To strengthen the observation effort and my visibility in the organisation, I was equipped with my own desk, and I set up a schedule for my planned visits to the organisation. The visits were limited to app. one every week due to the fact that SSE is located 300 kms from were I live. But to make it easier to coordinate my activities in the organisation, my visits were placed on a fixed weekday. This heightened the chances of being present when relevant meetings and activities took place. The weekday chosen also was the day of

[2] For an in depth explanation of the roles refer to Section 3.1.2

the bi-weekly SPI project status meetings which made it possible for me to participate in these meetings, and in this way be informed about the latest news from inside this project. Whenever necessary, other meetings and visits were scheduled as relevant activities approached.

The observation effort, thus, initially concentrated on following the SPI project and especially the PCs, as well as on participation in related meetings. As mentioned participating in the BM maintenance and development was of high priority, and several meetings were held with the employees responsible for these activities.

It quickly turned out that the single most important source of knowledge concerning the organisational practice was the projects' evaluation process. As described in Section 3.1.3, this process relied primarily on the use of milestone reviews (MR) and project follow ups (PFU) which is why these processes and their constituents were established as the primary targets for the initial understanding of the knowledge and learning capabilities of the organisation.

5.3.1.2 First Interview Round

The purpose of the first interview round was to provide me with a thorough understanding of the organisational constructs in SSE. A series of semi-structured interviews were performed following the outline described in Section 4.4.3. These interviews would inform me how the respondents interacted with other members of the organisation. Further, the interviews clarified how the different employees coordinated and organised a typical working day, as well as which tools and other means of communication were used. The intention was to extract general information about the company, the SPI initiatives, and, thereby about actual and potential knowledge management related problems and possibilities.

The respondent selection process aimed at covering as many roles as possible, and at the same time covering a wide selection of project sizes and types. Eight semi-structured qualitative interviews were conducted with one of the PCs and seven representatives from different parts and levels of the organisation (one developer, one PQR, four PMs, one senior PM). A set of two interview guides was used, depending on the interviewee's role in the organisation: one for development project members, and one for the PC (refer to Appendices D.1 and D.2 respectively).

The interview guides were developed on the basis of observations and participation as described in Section 4.4.3, and further inspired by the literature survey presented in Chapter 2. The main difference between the two sets was that the one intended for the PC role, contained questions directly related to this role and the project staff version included questions related to conducting project work. The structure of the interview guides related to the following:

- the interviewee's background and role,
- the project(s) (projects in SSE, organisation, type, size),
- BM, PDP, project's status report (intended and actual use),
- knowledge and experience gathering (how this is done, opportunities), and
- the SPI project (co-operation, services).

Before the interviews I acquired project specific information, e.g., a PFU report of the latest project in which the interviewee had participated. This provided me with insights into the specific settings of the project which not only made it easier for me to understand the responses, but also guided the interview towards specific experiences documented in these. These reports were present during the interviews so they could be referred to. During the interview with the PC samples of PFU reports were likewise present to provide some concrete material to discuss. The ability to have real PFU reports and the PFU template (viz., real project experiences) available during the interviews proved helpful when discussing the pros and cons concerning the expected and actual outcome of conducting the MR and PFU processes.

5.3.2 Analysing for Relevant Improvement Areas

On the basis of the thorough understanding obtained during the first interview round, the next step was to combine these newly acquired insights with theory, to design a mechanism for analysing the organisation with respect to its current knowledge sharing abilities, and to pin-point and prioritise relevant focus areas for future initiatives, viz., detailed research objectives.

In this part of the study the focus was on detailing the research question, focusing the study towards an implementable agenda fitting the overall research objectives, and at the same time fitting the interests of the SPK project and SSE together. The work in this step of the research primarily consisted of designing and planning an analysis technique. The major task was to identify and explore existing techniques for querying, analysing and communicating complex information, and then transforming these into an operational approach to analysis. For these reasons, the data gathering for this phase was focused on searching literature and reading background materials, studying the notes from the interviews as well as notes from the artifact studies.

While this was conducted the research did not produce any direct results for the organisation, and a feeling of impatience became noticeable among the representatives from the SPI project. This feeling was further strengthened by the fact that the three involved companies in the SPK project clearly were at different levels in their internal SPI work, leaving the impression to the management of SSE that not much could be learnt from participating in the research project. This negative feeling potentially could cause reluctance to participate and allocate resources. This would most certainly have an impact on the ability to conduct the necessary projects and activities in the organisation. The impression that the participation in the SPK research project only to a limited extent would provide any useful results for SSE was especially noticeable just after the second SPK workshop (October 2003) in which representatives from all three companies participated. At this workshop it became evident that the approaches to SPI in the three companies were of a distinctively different nature. The approach adopted by SSE, following a norm based approach more or less rigorously, was not reproducible in the other two scenarios and also the levels of SPI maturity for similar reasons were quite differentiated among the companies.

Further, the fact that a new version of the BM was recently introduced to all projects and that every project was expected to comply with this new version before December 2003 put some stress on the SPI project. Practically speaking this meant that SSE was expected to be in compliance with CMM level 4 at the beginning of December, and the managers and staff from the SPI project were busy with consulting the projects as to what these changes meant in practice, and as to what the projects needed to change to become compliant. The SPI project was, in fact, occupied with the deployment of the new BM to such an extent that it had to reassign members from a development project into this process to be able to overcome the workload. The encouragement for spending resources on a less detailed and so far 'fruitless' research project was (understandably) low compared to the task of preparing the organisation for the 'next' maturity level.

The negative feeling put some pressure on finding a relative quick way of providing research based results to SSE. Therefore I introduced the collective knowledge mapping technique—a technique designed to: *A*) analyse the knowledge management status of SSE, *B*) identify relevant improvement areas, and *C*) do this fast and with direct participation from the SPI project.

This technique relied on previously documented approaches, rich picture drawing (Checkland, 1999) and mapping techniques (Lanzara & Mathiassen, 1985), but it combined them in a new innovative way, and in a new context—the details of the constituents and results are presented in Chapter 7.

The knowledge mapping technique was the first direct outcome of the study and had multiple objectives:

- it provided SSE with a detailed insight as to the progress of the research project by sharing the results achieved so far to thus eliminating or diminishing the growing fear of lack of results,
- it strengthened the involvement and commitment of the organisation by setting a social contract and by defining the goals for the next cycle, and

- it focused the research by providing feedback as to which potential improvement areas should be targeted in the next research cycle.

The technique was introduced in a steering committee meeting with a combined purpose of both testing the technique and, at the same time, using the outcome directly in the organisation. A comprehensive preparation and planning of this meeting was needed, as I had to construct a very detailed agenda for the meeting, namely, my own knowledge map of SSE, based on the previous data gathering.

The steering committee was chosen as plenum, because this forum consisted of both employees and researchers, meaning that both in-depth knowledge about the company and theoretical insights into the research fields were present. At the same time, the SSE representatives participating in this group possessed some formal power, which meant that decisions taken at the meeting were backed by this power when later they were presented to the organisation. The tangible result from applying the technique was a prioritisation of several identified improvement suggestions—all direct experiences from organisational practice.

However, the situation also posed a dilemma to me in my role as researcher, since I had to decide to which extent it was necessary to 'please' the representatives in order to get their full support for the further study. Often when their interpretations of specific topics were relevant, suggestions for future improvements differed greatly from mine; however an agreement still had to be made. This dilemma was one important reason for choosing a collaborative oriented analysis method. To avoid unpleasant surprises, it was important that the agreement for the future involvement was based on consensus between me and the company. The alternative approach, where I analysed data and presented a 'final' result or recommendation, could be in danger of being too far away from the already planned activities in the organisation. On the other hand, if the suggestions from the organisation's representatives weighed too heavily, the research objective might be at stake since the task conducted by me might be reduced to consulting. By applying the collaborative approach (Mathiassen, 2002) and conducting the analysis and selection in a common meeting, a compromise based on a mutual understanding of the knowledge situation in the organisation was achieved and, as such, committed both parties.

5.3.3 Results

The results from the first cycle were, first of all, an understanding of which areas of the organisation's activities that could benefit from a more thorough investigation. In this case the feedback loop from development projects to the SPI project was considered highly important and vital for the organisation, but at the same time it was found to be poorly integrated and the outcome dissatisfying.

Apart from this, an important (and intended) effect from this first cycle was to demonstrate to the managers of the SPI project how I was directly able to apply ideas from the KM literature in the process of achieving organisational goals. The development of the technique itself was an important research outcome from this cycle as it provided a new way of approaching the diagnosis step of analysing the 'knowledge situation' before initiating a knowledge management initiative, since this technique might be used in other similar scenarios, both in the same organisation, but also in others. The results from this first cycle, therefore, were important enablers of the co-operation in the following cycles.

5.4 Second Research Cycle

The objective of the second action research cycle was to design a feasible approach to improve the project evaluation process in the organisation, especially with regards to assisting future projects in learning from previous experiences. This cycle also followed the layout of a collaborative practice research (CPR) cycle and was conducted in the period from November 2003—June 2004. The research question was the following:

- *How can improvements of knowledge related improvement areas be planned by designing and aligning new organisational initiatives to streng-*

then the organisation's learning capabilities?

Based upon the set of relevant and high-prioritised focus areas which was the outcome of the first cycle, the second research cycle was directed at investigating how the project evaluation could be re-designed to better fit its purpose, namely, to secure the knowledge acquisition and distribution across the organisation's projects and over time. The starting point of this investigation was the evaluation practice in the organisation at that time, namely, the MR and PFU processes.

Thus, the second research cycle aimed at identifying working solutions and testing whether these were applicable in the organisational settings—the fine tuning and adjustment (also the careful aligning to current practices, language fit, &c.) were deliberately left to later research cycles, because these details were not relevant for testing the basic conceptual ideas and, as such, only would have created an extra workload for the involved parties.

The results from this research cycle are presented in Chapter 8.

5.4.1 Analysing the Current Evaluation Practice

The current evaluation process, which constituted the main feedback loop of experience from development projects to the SPI project, was carefully analysed as it was this process that the former analysis had proved problematic and incapable of servicing its intended purpose. A detailed understanding of both the process and, just as importantly, of the current practice was needed to be able to suggest improvements, and to be able to rethink the whole approach to the feedback problem.

This required artifact studies of the material available including:

- the MR and PFU process descriptions from the BM,
- the assets (refer to Section 3.2.1.1) connected to these processes, viz., the document templates and suggestions for good practice, and
- the results from previously conducted MRs and PFUs, viz., the MR- and PFU-reports.

At the initiation of the second research cycle, the SPI project was highly involved in the deployment of the new version of the BM which should leverage the organisation onto the fourth CMMI stage. An integral part of this new process relied on the establishment of a quantitatively based project management system. The implementation and deployment of this system introduced significant changes to the development projects and therefore took its toll both on the SPI project's employees, but also on the development projects. The development projects had to carefully describe how they intended to comply with the 56 new performance indicators prescribed by the new system, and further they had to find out how to navigate the new 200+ assets (refer to Section 3.2.1.1) of the new BM, in addition to—of course—carrying out their intended development projects!

One direct result of the high demand for resources was both the up-staffing of the SPI project with members from a development project, and also the employment of a new SPI project member. What was interesting with this new employment was that the employee was hired directly to start in the SPI project. This was a new policy, and actually in contradiction with the policy of letting only 'ordinary' employees staff the SPI project.

In any case, the resources in the organisation were tied up in the CMM efforts, and not many resources could be spared to new projects. For this reason, the research activities were following an iterative approach. The trial and refine process constituting the iterative approach could *A*) provide quick results to show progress, and *B*) at the same time be collaborative, viz., provide the SPI project with influence over the development of the new concept. A team consisting of a member of the SPI project and me was appointed to be responsible for the development.

The development work was based on the results achieved from analysing the knowledge map. This enabled the team to produce quick initial results directly related to practice, and in this way quickly show progress and thus achieve commitment from the SPI project's managers. The iterative approach made it possible to spread the data collection, and in this way distribute the work load to the involved parties. Each iteration would require less data than a large up-front complete analysis or waterfall strategy

(Hughes & Cotterell, 2006) would.

5.4.2 Designing and Testing Improvements

Since quick results were required, a brainstorming session was conducted in the development team. This brainstorming focused on providing ideas to a first draft of the new evaluation concept and it was informed by several sources of input:

- a literature study of the knowledge management field conducted by the researcher (refer to Section 2.2),
- the already conducted (to inform the knowledge map) analyses of the current evaluation process,
- the existing evaluation report of the PFU process conducted internally in the SPI project, and
- the initial results from the above mentioned artifact studies of the currently used process descriptions and templates.

The initial concept which was presented and discussed at a steering committee meeting was the result of the first iteration. The work of refining the concept was continued through several smaller cycles. Whenever a change was introduced to the concept the steering committee was informed. The purpose of involving the steering committee was to provide expert opinions and viewpoints to improve the concept, and at the same time to generate formal acknowledgement from the managers of the SPI project. A draft depicting the overall layout of the new project evaluation concept is represented in Figure 5.2 on page 115. Comparing this draft with the sketch of the final concept (refer to Figure 8.4 on page 201) shows that whereas the overall concept did not change much, several important details were changed as the development progressed and resulted in a refining of the concept's content. The details of the concept are explained in Chapter 8.

The overall concept relied on a set of improvement ideas resulting from the brainstorming:

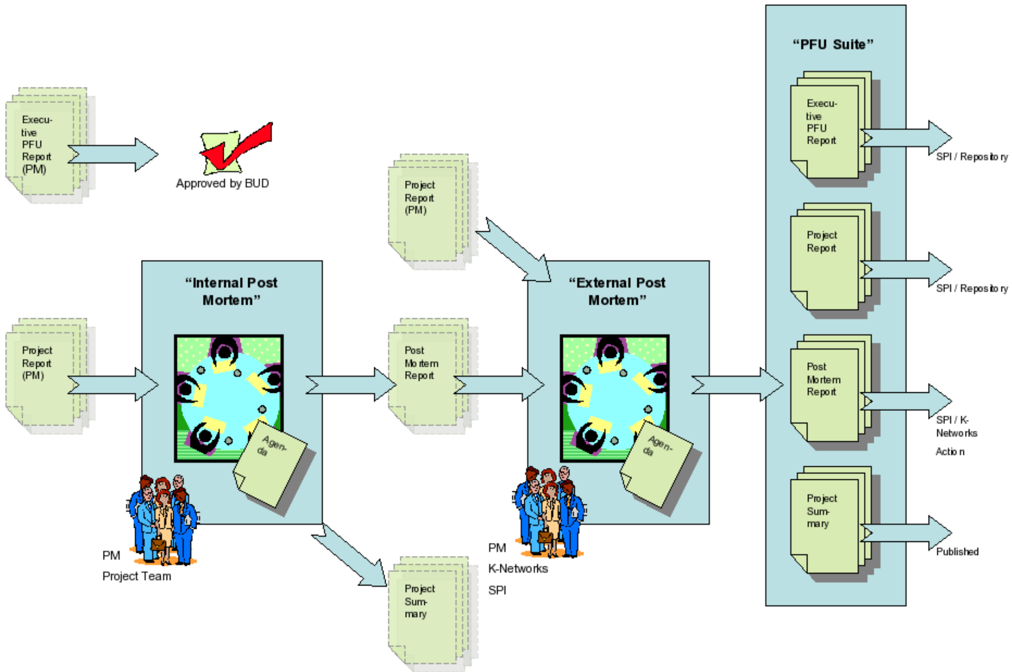

Figure 5.2: The initial draft of the evaluation concept

- the concept should rely on a personalisation based strategy (Hansen *et al.*, 1999),
- the root cause analysis (refer to Section 8.2.3) should be an integral part of the process,
- the recently established professional networks or knowledge networks[3] should be actively involved,
- the well functioning procedures from the current practice should be reused, and
- the results from the evaluation process should be visible.

The new concept actively implemented a personalisation strategy, almost solely relying on people as carriers of experiences and knowledge rather than

[3]These were established independantly from my project, and are introduced in Section 8.2.4

explicated reports, and this way, introduced a shift towards a situational knowledge organisation. This was a dramatic change in the basic assumptions of how knowledge was intended to be transferred between the organisational elements, viz., people, projects, &c. This change also was the primary obstacle to be overcome when presenting the new concept to the steering committee.

The process framework and the model behind it (the CMMI model), to a large extent, relied on written reports based on factual information as transfer mechanism and storage. Thus, to accept a concept which implemented that formally written reports were 'degraded' to support mechanisms was quite difficult for the SPI project managers, as they themselves, to a certain extent, questioned this approach.

However, the initial analyses confirmed that the knowledge from the PFU process did not leave the project in which it was achieved. The written reports were 'write-only', and they were stored in binders on a shelve in the SPI project without having effect on neither the design of the next level process framework nor on the practice of the development projects. The PFU reports were a cul de sac for the experiences and the valuable learning that could be achieved based on them. At the beginning of the analysis this problem was considered to be due to the fact that the current PFU process, and thus the templates for reporting, were not well suited for this task. It was expected that a major revision of the templates could leverage the standard of these and thereby make them effective bearers of experiences. But after further analysis, the development team realised that more radical changes were needed. This was reviewed with the steering committee who agreed. The two primary reasons which convinced the SPI project managers were: *A*) all analyses pointed towards the currently conducted MR process as being very effective as a means for sharing work related experiences within a project. This process was primarily relying on direct communication between the project's members, and not on written reports. *B*) The interviews (conducted during the first interview round) showed that a general opinion among the employees was that complex work situated knowledge was very hard to codify and explicate in written reports. This view was further strengthened by a common explanation to why the PFU reports were not actively used—their contents was of too little significance since the material was reduced to one line 'lessons learnt', and thus the necessary context for understanding why a lesson was learnt was missing.

It came to my knowledge that a PM from a large research project was in the progress of designing a new evaluation concept for this project. He did not find the official process well suited to meet his (and his project's) needs to learn from the experiences from past projects. I contacted the employee to learn more of this private initiative, and a collaboration was established. By integrating the work from the PM it was possible to save time and effort by implementing already developed and tested material. The collaboration between the team responsible for the new concept and the PM was very fruitful, and later 'his' project was chosen to host the first pilot study (refer to Section 8.4).

5.4.2.1 Second Interview Round

The thorough analysis of the knowledge map from the first research cycle constituted a solid foundation to build upon, and data from this was reapplied in the process of analysing and redesigning the current evaluation process. However, to further inform this investigation, a second round of interviews was conducted in January and February 2004. These interviews were, as the previous ones, based on an interview guide (refer to Appendix D.3).

The interview guide applied during this interview round was based on the project staff interview guide from the first interview round (refer to Appendix D.1), with the exception of the following changes:

- the section concerning the interviewee's own project was, because the analysis from the first research cycle showed that the project evaluation process was not optimal in its current version, replaced with a section exploring this current practice in more depth,
- the section concerning experience gathering was changed to include the knowledge networks initiatives (refer to Section 8.2.4),

- the question regarding the change to CMM level 3 was changed to questions regarding the change from CMM to CMMI, and from CMM level 3 to 4, and
- the detailed questions regarding the BM and PDP were omitted.

All in all, the new layout of the interview guide concerned the following:

- the interviewee,
- the project management practice during the year prior to the interview,
- knowledge and experience gathering, and
- the SPI project.

The respondents for these interviews were selected from different levels in the projects and from different project types to identify the differentiating needs regarding the PFU. Three different projects from three different business units participated—each with a developer, their PM, and their BUD. The same interview guide was used for all the interviews, and I prepared the interviews by reading the latest available PFU and/or MR reports from the projects in question. This made it possible to address specific problems experienced during the project work.

5.4.2.2 Cultural Analysis

In addition I conducted a contextual analysis of the company's culture to judge applicability of each of the suggested improvements. The results from this analysis, in details presented in Chapter 6, were applied in two ways; first, the conduction of the cultural analysis enhanced my understanding of SSE and this way directly affected the idea generation phase, and secondly, the results from the cultural analysis were utilised as a means of judging the estimated organisational effects from each of the suggested initiatives.

5.4.2.3 Pilot Studies

The basics of the new concept had to be tested to show how well the identified improvements fitted the organisational practice. Thus, it was necessary to conduct actual tests of the concept in real organisational settings. For this reason, two pilot studies (refer to Section 4.4.4) were conducted in two development projects. The pilot studies were intended to test the feasibility of the new evaluation concept and therefore the layout of this concept was to be followed as in an ordinary evaluation. During the first pilot study the new MR concept was tested, and during the second the new PFU concept was tested. As prescribed by the new concept, the first pilot study consisted of one meeting with all of the project's participants. The second pilot study was conducted in two PFU meetings with only the project management present.

Before the pilot studies the PMs from the projects were thoroughly briefed as they were to be the meeting leaders during the pilots. The meetings followed the agenda specified in the new project evaluation concept. The project members were briefed before the pilot studies via formal invitations describing the purpose, scope and layout of the pilots, and the pilots concluded with a debriefing amongst the participants to capture the participants' impression of the new concept.

A period, approximately one month, separated the two pilot studies. This made it possible for the design team to adjust the concept based on the output from the first pilot study. Planning the pilot studies was a challenge since they relied on development projects actually reaching a process state in which an evaluation was needed, viz., they had to either reach a milestone or actually close. Given the number of active projects in SSE, and taking into account the length of the average project, not many projects were candidates for participation. Furthermore, the frequency of finishing projects was low since the number of new projects was small. Fortunately, the project of the PM, who collaborated with the design team, had reached an important milestone and, as such, could be the source for the first pilot study. The second pilot study was conducted in a project, which had reached a state where it was ready to conduct a PFU before re-scoping its goals and staff.

At that time, the SPI representative who was working together with me in the design team suddenly left SSE, and therefore a new SPI project member was appointed to continue the work. Of course, this set back the planning phase since this new employee needed to acquire all the knowledge about the current evaluation process, and the ideas and intentions with the new.

In the first pilot study, conducted 3rd May 2004, the project followed the new concept for conducting a MR. The primary purpose of this pilot study was to test the applicability of new techniques. The PM from this project was, because of his involvement in the development of the new concept, highly motivated to test the new approach. He was greatly convinced that new initiatives were needed to establish a complete learning cycle.

The design team (the newly hired SPI project member and I) participated in the pilot study with the role of passive observers. Only if needed would we interfere as consultants with respect to interpretative or practical matters. The pilot study was documented as prescribed by the concept, viz., via the MR report, and additionally by photographs of the whiteboards and slides used during the meeting (refer to Section 8.4).

The second pilot study followed a similar overall layout, with the exception of covering a PFU conducted after a project was closed. The major difference was the selection of participants, and that two meetings were required for the PFU; first an internal project de-briefing meeting and second an external meeting directed towards sharing and transferring the project's experiences to the organisation.

During the first part, conducted 9th June 2004, the PM and TLs participated (in all 8 persons excluding the design team). During this phase only the management participated since the project had employed more than 50 members. The PM was in both cases the meeting leader; the researcher and the SPI project representative were facilitators and documented the course of the pilot. The PM documented the PFU by applying the new report template (reproduced in Figure 8.5 on page 203).

In the second part of the pilot study, representatives participated from the then established seven knowledge networks, the PM, and the researcher and a SPI project representative. The pilot meeting was conducted 18th June

2004, and the outcome was documented by the PM (using the template in Figure 8.6 on page 206), and by the design team. A notable side effect from the second meeting was that it was one of the first occasions for the knowledge networks to be actively involved in a project routine and, as such, the purpose of this pilot was—apart from testing the PFU Concept—also to test the applicability of involving these networks into the de-briefing process as external experts.

5.4.3 Results

The results from conducting the pilot studies were presented to the steering committee afterwards. The opportunities and future plans for the concept were discussed—resulting in the decision of letting the development of the new evaluation concept enter its final stage. This stage prepared for its implementation into the organisation—the purpose of this study's third research cycle.

The main contribution from the second cycle was the validation of the applicability of a personalisation based approach to conducting the project evaluations. This confirmed the value of capturing and transferring relevant knowledge in the organisation with the employees as carriers, rather than only documenting and transferring knowledge via written reports and documents. The study showed that the shift towards a situational knowledge organisation can be beneficial even in organisations which base their organisational habits on maturity programmes and rigid requirements to documentation. A balanced approach was developed which secured both the CMMI requirements of measurability and traceability and the needs and requirements from the organisation regarding a suitable approach to knowledge transferring and sharing.

Apart from this, the research demonstrated how the developed concept in practice provided important insights as to which further changes were required before the concept was made final and ready for deployment. The results from the pilots thus were channelled directly into the next research cycle, to be further analysed, and used to develop a deployment plan. A detailed description of the results from the second cycle is found in Chapter 8.

5.5 Third Research Cycle

The third, and last, cycle of this study was aimed at transforming the evaluation concept into a final organisational process ready for deployment in SSE, viz., moving it from concept to practice. The cycle was conducted in the period from June 2004—July 2005. The conceptual research question to be answered was the following:

- *How can the improvement initiatives be facilitated and implemented in order to secure acceptance and continuous evolution?*

The initial phase of this cycle consisted mainly of an analysis of the data collected during the pilot studies and from the cultural analysis. The original goal of this analysis was to conduct a full dpeloyment of the new MR and PFU concepts into the organisation. However, this goal was later revised as described in Section 5.5.3. The adjusted goal was to prepare the implementation by producing a feasible deployment plan. The results from this research cycle are described in detail in Chapter 9.

5.5.1 Working Remotely

The conduction of this third research cycle followed a different approach from the two previous. As part of my PhD programme, I was visiting a foreign university[4], and therefore not able to visit the organisation during the second half of 2004. The plan for conducting the third cycle thus was based on my participation on a more remote basis. The idea was to develop the concept until it had reached a level where a quality review (refer to Section 4.4.5) would allow it to pass as a new part of the official process framework. This meant that all material concerning the concept had to be aligned with the

[4]University of Limerick, Ireland

surrounding parts of the process framework to make it compliant with the BM (and the CMMI). It also meant that all material involved had to be translated into the SSE language to make it an integral part of the daily routines.

The plan was to let the development team (a SPI project member and myself) refine the concept based on the already conducted analyses and tests, but without further practical tests. The next version was to be the 'final' version, which was to be implemented company-wide. The nature of the evaluation process would mean that it would be slowly propagated into the organisational practice as the projects reached points in their life cycles where MRs or the PFU were needed; thus practically speaking, the deployment phase would span over a long period because of the low frequency of the MRs and PFUs.

This phase of the research consisted of modifying the new evaluation concept's constituents in a way that they matched the nature, form, and language used in the organisation. This way, the process descriptions, templates, course material, &c., would match the formal requirements and, at the same time, minimise the possibility of misunderstandings and misinterpretations. As in the previous cycles, the main portion of the work was conducted by the design team. However, some of the practical work during this phase was sourced back to the organisation while I was abroad.

This labour division led to many delays. The main reason was that the energy and initiative left the design project when I left. I was the primus motor of the initiative and without me to continuously request resources, plan meetings, test sessions, &c., the drive left the design team, since the organisation (and especially the SPI project members) was busy working with the plans and implementation of the step from CMMI level 4 to level 5.

This resulted in this cycle lasting much longer than originally intended, and no intervention was made until I personally re-entered the process in January 2005.

5.5.2 Organisational Regress

When I returned and continued more actively in the work in SSE, the situation in the organisation had changed dramatically. The business situation for SSE had changed during my absence with a decrease in the number of new contracts, and significantly lower need for the already employed workforce. This led to SSE having to lay off people for the first time in the company's history.

This was a very unpleasant experience and one with which the employees of SSE were totally unaccustomed. 28 employees were laid off, and more resources moved to an active sales oriented department. Previously no such sales department existed, a fact that points to: *A*) the company's high success and confidence in the future, and *B*) the relatively long lasting involvement with the current customers securing orders in a foreseeable future. These were common understandings among the employees who felt secure and confident both in their own capabilities and in the future outlook. The firings and general reduction of results reached a level where several national newspapers commented on them, probably due to the sudden changes they signalled compared with the always self-confident and progressive press statements so far released from SSE.

The crisis also manifested itself in the financial results which for the first time in SSE's newer history showed a decline in turnover. The decline amounted to €2.000.000, which when compared with the figures in Figure 3.5 on page 75 is a drastic change for the worse.

At the same time, the many years of continuous improvements and a steady climb up the CMMI ladder began to result in a sort of organisational tiredness. The many changes had left the organisation in a uneasy state, and management agreed that a consolidation phase was required to secure the current maturity level before continuing on towards the fifth level. If not, it was argued, the organisation might end in a paralytic state unable to absorb more new initiatives.

Also, two important employees from the SPI project during this phase 'resigned' from the project to return to development projects. These were the

PC and the employee who was responsible for the quantitative project management initiative and the intellectual capital reports. The exit of two such important employees meant that the SPI project (in spite of the knowledge sharing initiatives) lost a large amount of practical experience and contact points in the development projects, since the PC was the direct 'interface' between the SPI project and the development organisation.

5.5.3 Adjusting the Goal

The delay in progress and the changed organisational environment affected the plans for the third research cycle. Instead of expecting a full deployment of the new process, the new goal was to have a process ready for deployment. This meant that the goal now was to have a new process approved by a formal quality review. Because of the rather low frequency of projects closing, the study's time span was too short to encompass the results from the following project closures; therefore, the steering committee agreed that this approval was a valid goal. The quality reviews constitute the formal acceptance of new processes in SSE, and thus a new approved process in principle would be deployment-ready.

The work with refining the evaluation concept continued during the spring of 2005, and a third team member, a co-researcher from the SPK project, was in this period included in the design team. The team work was conducted in a series of several small cycles (which the design team called work camps), each closed by a short internal evaluation of the latest changes to the evaluation process. The output included, apart from the the final process, several practice oriented working materials: BM process descriptions, new MR and PFU procedure descriptions, new document templates, and educational course material.

5.5.4 Formal Quality Review

The process of conducting formal quality reviews is as explained in Section 4.4.5 an integral part of the BM and constitutes the formal process for examining new initiatives before they are introduced into the organisation.

Two reviews were conducted by a representative from the SPI project and two researchers. The purpose was to examine whether the new MR and PFU processes were ready to be deployed in the organisational settings and to what extent they would result in changes in other parts of the process material. The reviews each were conducted at a meeting in which the concept and all relevant materials were ‘walked through’ and discussed, and comments were made about what final changes were needed.

These formal quality reviews and their result, an approved final suggestion for a new evaluation process, was the conclusion of the last research cycle and thus of this study. From then on it was the intention that the organisation itself continued the effort with deploying the process into a standard procedure or normal practice. As can be seen from the conclusion in Chapter 10, this was subsequently to a certain extent achieved.

5.5.5 Results

The primary result from this cycle was the new ready-to-use evaluation process with all the detailed working materials approved and ready for deployment. Unfortunate circumstances (refer to Section 5.5.3) made it impossible for this study to be a part of the actual deployment of the process into the organisation as originally intended. Participating in action oriented research might often require revision of intentions according to actual circumstances as the study propagates. Fortunately for SSE, their crisis was overcome and the organisation continued on its impressive course upwards. The results from the third cycle, viz., the final layout of the evaluation concept, is described in detail in Chapter 9.

5.6 Conclusion

With this narrative the course of the study has been laid out. The chapter has provided a broad overview of the three action research cycles and details about the study itself. The chronological presentation of the details of each of the research cycles is intended as an ‘interpretation tool’ to make it easier to understand the study’s results which will be presented in Chapters 7—9. Without this section as background information, much of the context that interconnects these three sections would be lost and, as such, the overall picture of the results of the study would be more difficult to grasp. It is important to point out that the linear and chronological description of the study in this section was conducted in retrospect. Doing so allowed me to include useful reflections for understanding my study after the events had occurred.

Chapter 6

A Contextual Analysis of the Company Culture

In this chapter the results from the cultural analysis are presented. The chapter is initiated with a description of the approach chosen for this analysis. Following this are descriptions of the official values of Systematic Software Engineering (SSE), and of the values as they were experienced by the researcher during collaboration with SSE. The values are grouped into three categories termed cultural axes. The values from each of these axes are then combined with the purpose of describing how these values affect SSE with respect to conducting Software Process Improvement (SPI).

6.1 Analysis of the Company Culture

The analysis is based on an identification of the company's shared values since

> "Culture [...] is a system of collectively held values." (Hofstede, 1981, p. 24)

The accumulation of values in the organisation comprises its value system. According to (Schultz, 1990) such a value system can be viewed as a denominator of the culture of the organisation. As shown in Section 2.2 the organisational culture plays an important role for the knowledge management capabilities as it is a key parameter for determining the knowledge organisation type.

To further detail the analysis I use a distinction between explicit values and implicit values—inspired by (Bødker & Pedersen, 1991).

Explicit values are those which are 'publicly available'. These are the official company values designed and described by the company's management. These values represent the official image of the organisation, and therefore the image the employees should adopt—or adapt to. A description of these values can be found on the company website[1]. It is important to stress that these values represent the management's view and constitute a professional codex for the employees. These values thus are a managerial tool. Therefore they are easily obtainable both via the website but also in a (mandatory) introductory course aimed at new employees.

Implicit values are not explicated in the same way. They are the values which direct the norms enlived in the organisation:

> "[...] hidden behind or in the various artifacts, symbols, workroutines, and established patterns of cooperation." (Bødker & Pedersen, 1991, p. 124)

An identification of these values therefore required me to analyse such organisational elements. The interviews and my presence in the organisation constituted the primary data sources for this analysis, and the interaction with the organisation informed my decoding of the values underlying the surface.

The data to be analysed represented a large quantity of unstructured material and a grounded theory (Glaser & Strauss, 1967; Strauss & Corbin, 1998) inspired approach was chosen as method for the analysis. The descriptions of grounded theory include high-level guidelines indicating how a search after issues and interrelationships can be made and organised. The emphasis is

[1] http://systematic.dk/UK/About+Us/Vision+and+Values/Values.htm

especially placed on three sequential techniques: Open coding, axial coding, and selective coding.

Open coding, is the process of identifying interesting statements with regard to the researched phenomenon. This is achieved by looking for different meanings in the statements and classifying part-statements with labels to explain the meanings of the different parts. The result is a range of different codes and concepts comprising the thoughts, ideas and meanings of the text.

The purpose of axial coding is to find the categories into which the discovered codes and concepts can be classified. The meanings of these are compared and categorised in main and sub categories, which together present patterns or a set of axes to explain the data material and relationships between the concepts. Thus, the located categories reflect the parameters that are important for the researched subject.

Based on the axis categories, the purpose of selective coding is to explain relationships and contexts to refine the overall explanation into a coherent picture of the observations. The overall picture is based on central categories and represents a complete framework of explanations for the field in focus.

These techniques were in my study applied in the following way:

Open coding Simultaneously with the two interview rounds I conducted a 'continuous brainstorm' to identify candidates for categories that might reveal the company's culture. This continuous brainstorm consisted of listing all the different relationships and ideas about relations that immediately came to mind and organising them with the already recorded relations. The brainstorm produced a number of statements constituting the immediate relations perceived during my conversations with the respondents.

Another major source of input was the knowledge mapping session (refer to 7.2). This produced a large set of data regarding the participants' view of the organisation and its implicit values. And the session generated a visual guide to the organisation's communications and knowledge flows—including evaluations and opinions concerning the importance of these flows.

I recorded all relevant statements and their origin in a document. This allowed me to identify the source of the statements and simultaneously to view all the statements in one place, which subsequently made it easier to find relationships between the different respondents' statements.

The document emerged as I conducted the analysis—amplifying or contracting already recorded statements.

Axial coding Based on these statements, I proceeded in an exceedingly iterative process and created a range of categories, under which I could fit the different meanings behind the statements. In practice, this was achieved by continuously reorganising the statements in the document into coherent categories. Some statements appeared frequently, and therefore suggested to represent a prevailing idea or concept.

As a result, I achieved a textual categorisation of the statements. This enabled me to assess which statements contributed to clarify the importance of the different categories.

Selective coding The last part of the analysis was based on these categories. I combined these in different ways to search for themes along which they could be arranged in a way that helped clarify the understanding of the culture. I chose to use several themes—or as I chose to call them—axes, since they represent a line along which statements with similar meaning can be grouped. I used the same document as base, this time rearranging the categories along fewer axes. In this iterative process the different constellations of results affected the creation of ideas and led me to identify new axis candidates, and the 'final' axes emerged as a direct consequence of this combination process.

To operationalise the results the axes were combined into statements regarding *A*) which state the organisation was in regarding new initiatives, and *B*) which minimum requirements these initiatives needed to address.

The two types of values, the explicit and the implicit, in this case were significant as they informed me about *A*) the management's view of which values were desirable, and *B*) how well the implicit values corresponded with these. This knowledge provided insights as to what extent the published material, e.g., the formally specified process descriptions, corresponded with the organisational reality.

1. The Customer as Our Partner
2. Respect for the Customer
3. Quality above Quantity
4. Freedom with Responsibility
5. Flat Organisation
6. Constant Change
7. Active Knowledge Sharing
8. Modest Level of Costs
9. Systematic and the Society

Figure 6.1: Explicit values of SSE (SSE, 2004b, p. 9)

6.2 Explicit Values

This section describes the explicit values of SSE as they are defined by the management of the company.

The values are based on the company's vision, and describe the set of ideas and thoughts that the management identifies as being 'correct' for SSE. The values are intended to guide the company and its employees in the 'right' direction to make the company achieve its overall strategic objectives. For this reason the values also constitute an important signal for customers and employees. These values are an important part of the company's official marketing programme and an integral part of much material presented both internally and externally, e.g., at the website and in the intellectual capital reports. The values are also communicated to new employees during the mandatory introductory course. The values are reproduced in Figure 6.1 on page 133.

6.2.1 The Customer as Our Partner

SSE's management promotes that the company's customers are treated as partners. As mentioned, SSE's project portfolio mainly consists of long term projects with a high degree of complexity. Further, the typical project tends to be continuously prolonged because of requests for upgrades and extensions. In projects with these characteristics the customer plays an important role as sponsor. This type of relationship encourages partnerships rather than the typical ad hoc project customer relation, based on short term contracts (or one time contracts). According to management, the type of products developed in SSE's projects also suggests that long term partner-like relations with customers are preferred—at least for the largest customers. High tech niche products with a rather small customer base favour close cooperation.

6.2.2 Respect for the Customer

Management in SSE underpins the importance of the customers by showing them respect. This respect reflects the fact that SSE's client portfolio consists of few and large customers, and with five customers representing 50% of the revenue, it is judged wise to treat these clients with proper respect.

An important consequence pointed out by the management in SSE is the importance of carefully selecting the customers with whom SSE will do business and the projects in which SSE will participate. This way, SSE's intention of delivering world class quality affects its choice of customers. SSE's high requirements regarding quality and delivery times mean that the (management of the) company sometimes rejects projects in which the chances for success are estimated as being too low. As long as the order books are full, management can choose the projects which they estimate as best suited for SSE. In many respects, these requirements translate into SSE expecting its customers to have a certain level of maturity to guarantee that the co-operation will run as professionally as possible.

6.2.3 Quality above Quantity

The management's strategy for SSE is to deliver high quality products. As a rule, maintaining this world class quality, SSE aims at conducting fewer, but better projects, because the high demand for quality requires a larger investment of time and resources. The management wants to signal that SSE does not compromise its level of quality; it will participate in fewer projects in which the quality is acceptable, rather than accepting every order and risking, for various reasons, orders not complying with their quality requirements. At the same time, this signals that, when needed, it is acceptable to spend a little more resources on a task if this assures that the result will meet the organisational standards.

6.2.4 Freedom with Responsibility

The management expects the employees to act responsible. For this reason the employees have a high degree of freedom to coordinate their own daily tasks. The idea is that if an employee is involved in making a decision s/he tends to respect this decision and its consequences. This involves decisions which affect the ability to keep the schedules and quality agreements. SSE employs well educated and highly skilled people, and the management assumes that such staff is capable of—within the frames of the organisational process framework—to manage their own jobs. The projects and teams are, to a large extent, self managing and, thus, the management is little involved in the direct daily operation. The employees are trained to be capable of operating within their own domains without having to ask for permission or to wait for others to provide directions. This enables SSE to move faster and save on the coordinating activities.

Additionally, the management expects that free working conditions are preferred by a creative and intelligent workforce, and thus SSE attracts this type of employees.

6.2.5 Flat Organisation

In SSE decentralisation is a widely used concept. By maintaining a high level of de-centralisation, SSE has a short distance between the top management and the ‘shop floor’, which is believed to make communication flow easy. Bureaucracy and ‘red tape’ are considered as incompatible with high adaptability and flexibility, and thus a hindrance for achieving high quality. At the same time, by having a short distance between management and employees, a close relationship exists and the rationale for decisions is easily transferred.

This limits the need for a rigid control structure and, accordingly, establishes a common approach to securing organisational unity and conformity.

6.2.6 Constant Change

The management of SSE expects the organisation to be under constant change. On the company website a reason for this is given as an encouragement to its employees to constantly train and educate themselves further to seek new challenges. However, this value also signifies that SSE is a company which does not rest on its laurels. What was good enough or even excellent yesterday might today only be adequate. In an environment of change SSE needs to be able to change as well. New requirements from customers and society need to be dealt with—preferably pro-actively.

6.2.7 Active Knowledge Sharing

In SSE the employees are considered the most important asset. Therefore, an active approach to sharing and developing the employees' knowledge is a crucial management parameter. The management signals that knowledge should be shared among employees to avoid potential bottlenecks. Another important reason for establishing effective knowledge sharing is to protect the organisation from what internally is known as the 'line-16-effect'. The 'line-16-effect' refers to the (hypothetical) situation where a key employee is hit by a bus (for some reason no. 16), and thus—without notice—is no longer available to the organisation[2]. In a situation like this it is important to have an established redundancy process with respect to the knowledge that this employee possesses, or it will be lost for the organisation. This redundancy can be achieved by sharing relevant knowledge, and thus rendering the company 'line-16-effect'-proof.

[2]Of course, less dramatic situations can have a similar impact; an employee might leave the organisation for a position in another company, but in these cases the suddenness is less significant, and mitigating actions can be initiated to reduce the impact.

6.2.8 Modest Level of Costs

By keeping a modest[3] cost level at all times—also when it is not strictly necessary—the management signals a sound critical awareness to what is needed and what is not. None of SSE's customers wants to see an extravagant resource consumption unless it is required for some reason. Keeping costs low on standard projects also saves more resources for research, training, and organisational upgrading. And by explicating this as a value it acts as a constant reminder to the employees.

6.2.9 Systematic and the Society

SSE recognises that the company is part of a community and therefore is an integral part of the environment surrounding it. If SSE wants resources available (e.g., well educated employees), the company must also pay back to society with some of its surplus. SSE considers itself an active player in this regard, as SSE can contribute with funding, resources, empirical data &c., and thus gain on several fronts. SSE is highly involved with local research activities, and also sponsors an art museum in Århus.

6.3 Implicit Values

The analysis of the values of SSE has resulted in the identification of three axes, 'managed', 'proud', and 'open', which describe three distinct sets of values prevailing in SSE (refer to Figure 6.2 on page 138). Each of these is explained in greater detail below.

[3]I have translated 'modest' from the Danish 'jysk' which means "from the western part of Denmark". The saying goes that people from these parts are not very generous with their money. This term is deliberately used in the official value definition to signal the company's geographical origin.

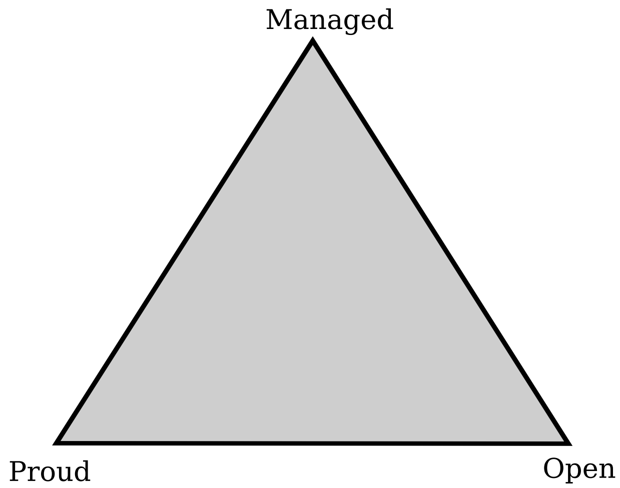

Figure 6.2: The three cultural axes in SSE

6.4 Managed

The verb to manage originates from the Italian maneggiare*;* to handle, train (horses) and is derived from the Latin word manu meaning hand. SSE is a managed organisation, and in many respects an invisible hand guides the practice as it takes place in the development projects and the rest of the company. The concept of management plays an important role in SSE, and almost every activity is somehow planned and to a large degree formally described. Management in SSE is highly based on configuring the projects' tasks with respect to the formal process descriptions, and to make certain that the projects steer according to these configurations.

In the following, four characteristic values along the managed-axis are described. The first concerns the processes which constitute a key factor in the management in SSE. These processes rely heavily on the measurement system, which indirectly affects the (future) processes, and the expected outcome, throughput, &c., of the projects. In spite of SSE having 'a flat organisation' and 'freedom with responsibility', a de facto top down management is prevalent in the organisation which is largely founded in the respect for the results achieved by the managers and management.

6.4.1 Processes are Our Power!

The spinal column of SSE is its processes. These constitute the company's core asset and most important competitive advantage. In SSE's own words:

> "Processes are our power!" (SSE, 2004b, p. 19)

This quote expresses the fundamental assumption prevailing in SSE, namely, that almost all practice can be formulated, viz., put on formulae. If all the relevant parameters concerning a specific task (and its surroundings) can be identified, a scheme can be established which prescribes the optimal configuration in a given situation. Further, this scheme can be applied as a managing method following and controlling the practice. The approach to problem solving (or management) in SSE thus is norm driven (as is the CMM model, refer to Section 2.1.2) because it relies on an underlying model. This model describes how relevant parameters affect each other. Thus, identifying the 'correct' method or formula—or process—is to have gained power over the practice, and the process then becomes the most important asset—and the natural outset for and outcome of organisational development.

Based on this assumption, the endeavour of identifying the best process that matches a certain task or task area (process area) then constitutes the organisational development effort or, in SSE, the software practice improvement effort. This effort consists of a combination of an 'educated guessing' approach and a trial-and-error approach. The 'educated guess' relies both on formal methods, such as CMMI, and on the SPI project's qualified guesses. If a practice area is to be (re-)formulated into processes, the translation or formulation is done first on the basis of a profound understanding of this particular practice area. Either this understanding is already present or it is obtained by studying the relevant parts of the organisation. Second, suggestions from other qualified sources, e.g., management literature, research papers, &c., are considered. Since SSE has adopted the CMMI approach, this model constitutes a significant inspiration for the translation process. Every new process description has to be compatible with the CMMI requirements. The prescriptions from the CMMI, in reality, often comprise an initial step before the two above mentioned are performed, since the CMM model can point to specific key task (or process) areas of interest as future improvement candidates.

Models are an integrated part of the daily life in SSE. The process descriptions in most cases are based on a model, either self-invented, but more often models adapted from teaching materials, research papers, both from industry and academia. Thus, many models are combined in the process framework, and one important task of the SPI project is to align these different models into coherency with the process framework. This task involves the translation of terms and phrases, but also the more fundamental task of making the different models fit each other and the 'stockpile' of models already incorporated into the process framework.

6.4.2 Measure, Measure, Measure

Another conspicuous property of SSE is the urge to measure everything. The supposition is that by measuring and collecting data of the past, it is easier to foretell the future. By carefully recording various parameters regarding the practice conducted in the organisation, it is possible to make better predictions about similar future situations, or as it is officially put:

> "The best prophet of the future is the past." (SSE, 2004b, p. 23)

The measurement system (refer to Section 3.2.1) is one pronounced outcome from this urge. The measurement system is generally considered as an opportunity to seek organisational improvement, rather than as an inconvenience or threat, which easily could have been the case if the measurement belief were not so prevalent in the organisation. The measurement system, being of a quantitative nature is supplemented by several other measurement or data gathering techniques such as resumes from every meeting, evaluation reports from projects, recommendations from pilot studies, &c. The data gathering follows an inclusive approach, since it is not possible to know in advance which data/measures will be interesting in the future. According to the official policy, every formal meeting required by the process framework must have an agenda, and minutes must be produced. This is to secure not only that the meeting's decisions are recorded, but also to make the data available for later analysis with respect to the process, viz., to be able to investigate whether this particular type of meeting is the proper approach to the task in question. Even among close colleagues, and in spite of a limited number of participants, this rule is obeyed, and almost any meeting results in minutes recorded in the document storage system.

Of particular interest for future analyses are the evaluation reports conducted in relation to the MR and PFU processes, which consist mainly of comments and critiques of experiences with project work and the process framework. These reports combined with the quantitatively based measurement system constitute a rich base for later process optimisation being grounded directly in practice experiences.

The data collection is according to the SPI project exhaustive and correct, and much effort has been put into automating as much of the process as possible. Every night all the relevant information is extracted and calculated, and all the different report tools updated. Most of this task is carried out by a set of batch routines which traverse the versioning systems and electronic documentation storage and also extract and store the many different measures. Based on these, several key figures are computed and stored as well, and the historical track record is updated. Automation is necessary because of the amount of data processed, and because the collection process must be as effortless as possible.

The disadvantages of this extensive data gathering are several. It can be hard to cope with the amount of information in any serious way since the data are not necessarily collected with any specific analysis objective. This leaves the later analysis with no particular hypothesis, but only a vast set of records. To identify specific information can also be difficult, according to some of the respondents in the organisation, because of the documentation mechanisms. Some characterisation or classification systems have been introduced, but have not yet been widely used, and the idea of combining the measurement (both quantitative and qualitative) storage with a sort of 'who knows what' or 'good practice' systems has not been of any success either. If the data is not somehow crunched or pre-analysed, it is impossible for the majority of the organisation to find any use for it. No PM has the time to browse through historical reports to identify possible risks facing a current project.

Such pre-analysis of the data is also not straightforward. If a specific new hypothesis or calculated figure is needed, it can be added to the batch programme running every night, but the number of these analysis tasks must be kept at a minimum because of the resources, especially time, which they require. Problems have been met with batch processes not being able to be finished in time—that is before the data starts to change due to people starting to work on the projects the following morning.

These disadvantages have also caused a certain doubt about parts of the measurement system. If the data stored is not valid, it is questionable using it as a source for prediction, both with respect to suggesting actions, but also with respect to comparing projects' progress with the historical track record. One reason to store the measures is to predict the expected duration of a specific task, and if the data material used to calculate these forecasts are not accurate, the projects might end up being held responsible for unrealistic expectations. Further, the learning or collecting of 'lessons learnt' examples can be questioned if the data are not reliable.

The urge to measure has also led to a sort of an organisational fetish for numbers. Numbers are believed to hold the key to the understanding of complex practices. Numbers are indicators, and the relevant parameters of a certain model can be condensed in a few (easily and objectively measurable) numbers, preferably only one. In SSE many different indices are provided as means for comparisons and (the task of) management, some being of a more significant nature than others; for example, the bicycle index, the pizza index, and the carrot index (refer to Section 3.2.1.2) are not in themselves very vital to the organisation; nevertheless they illustrate how indices are an integral part of the language.

The quest for higher levels in the CMM model is a good example. All effort apart from producing quality software products is concerned with pursuing the next level, the next number. At the initiation of this research project the office walls, especially around the SPI project's desks, were equipped with

Figure 6.3: The certification wall (from (SSE, 2004b))

large styrene '3'-digits symbolising the CMM level 3 assessment which at that time was achieved one year prior. The plans for achieving the higher levels in the CMM hierarchy in themselves reflect the strive for numbers, as the scheduled dates for the future assessments are 4th April 2004 (444) and 5th May 2005 (555), respectively. Also, other visual artifacts spread around in the SSE offices signify that numbers are unavoidable in this organisation. Paper balls in transparent plastic tubes (refer to Figure 6.3 on page 143) placed in the atrium court represent or remind as the term is in the official description the number of (software) certifications achieved by SSE employees, and equally apparent is the 'Wall of Fame', which is a large map showing the level of SSE projects with respect to their self-assessments, viz., at which CMM level the individual projects currently are.

The ‘open SSE scale’ is used to measure all things that need to be evaluated onto a scale (e.g., high vs. low, or long vs. short, &c.) This scale which, by the way, has 1 as low and 5 as high boundaries, is the global measure of anything that needs to be measured and stored with the purpose of comparing between projects or with historical figures. In accordance with the rich use of models, numbers from empirical studies are cited and used as measurements to compare actual performance with expected performance.

An important reason why the numbers play such a significant part in the organisation is the fundamental belief that:

> “What gets measured, gets done” (SSE, 2002, p. 22).

If it is possible to follow up on a specific parameter or compare it with estimates, historical figures, other similar projects figures, &c., the figure will act as an motivator. The assumption is, that if an employee knows which parameters are used to evaluate whether a task is successful or a failure, s/he tends to make certain that these parameters are under control. The argument follows then, that if it is possible to pinpoint the relevant parameters, it is possible to control a development project quantitatively by focusing on these parameters, and thus with as little effort as necessary, guide the project in the ‘correct’ direction.

6.4.3 De Facto Top-Down Management

The focus on norms and models also results in a climate in the organisation where authorities are important and managers’ actions have a large impact. The process framework is the official method in SSE, and this method is widely accepted and used by the employees. This removes parts of the decision process from the projects and via the framework up to the designers and implementers of the processes, who are widely guided by management and management’s visions and strategies. This lack of degree of freedom with respect to the autonomy of the projects results in a large part of the practice being directly influenced by management, thus providing a de facto top-down management.

This management style has had its impact on the relations between employees and managers. These relations are generally of an authoritarian nature, with management's decisions being carried out as if they were orders. This, however, does not imply that contradictions do not exist, and that employees never are counselled with respect to the decision making process. The authoritarian nature also does not affect the working atmosphere, and the climate between the employees and managers is in a fine state, with informal, but sound communication and a relaxed attitude. This suggests that the employees have nothing against the authoritarian management style, or at least, that they respect the approaches that management chooses and the decisions made.

There is no doubt about how the hierarchy is defined, and any order given from higher levels is immediately obeyed and carried out. All are familiar with their place in the formal hierarchy (their 'rank') and know their task, and how to carry it out. This type of organisational structure bears much resemblance with the one governing a professional army.

At first sight this seems to be in contradiction with the official values of keeping the organisation flat and delegating responsibility, since these values are not normally associated with the way armies are organised (classically they have been like the machine bureaucracy or the simple structure in Mintzberg's (1983) terms). The machine bureaucracy is among other things characterised by having a rigid structure and having everything laid out in formal rules and regulations, providing few degrees of freedom to the 'workers' at the 'factory floor' or 'soldiers' in the 'front line'. However, the army analogy is valid if one looks at how modern armies adopt the concept of smaller self maintaining groups (or squads) with a high degree of freedom, of course within the limits of the overall set of orders. In this setting the soldiers are considered specialists in each of their own fields, and are able to make decisions on their own, viz., more like Mintzberg's professional bureaucracy.

SSE is not an army, but its internal organisation in many ways resembles that of some of its largest customers in the defence industry. The choice of basing the development activities on the CMM model also has an impact on the formal organisation, since the background for this model, and thus its suggestions for good practice, primarily originates from suppliers to the defence industry in the USA.

The formal process descriptions provide an effective means for the developers to focus on each of their own task, leaving the coordination tasks preplanned. This is not the same as saying that the developers do not think for themselves or never utilise their specialities, since the process framework primarily is concerned with coordination tasks, and also because the processes are not detailed down to the lowest task level.

Very often the processes are followed rigidly, but sometimes this is not the case. However, on these occasions the process is abandoned due to a deliberately considered cause, and this is always supported by a manager (at least a PM). The reason is often that conforming to the official process will delay some vital parts of the project's work, e.g., bring the project in danger of not meeting a non-negotiable deadline. In these cases the management can cut through, and demand that specific settings in a project require that parts of the framework are abandoned. But, as mentioned, always with an extraordinary reason—it is not a general practice to abandon the prescribed method.

6.4.4 Respect Based on Results

A reason why the processes are applied and followed very rigidly is that they represent the visions of a management that can prove their value empirically. The success of SSE has created a widely adopted respect for the current management among the employees. The employees value the process framework and its continuous development as one of the prime factors for achieving these results, and are therefore very adaptive when it comes to using and utilising the processes.

The employees respect the management and its previous results, which as mentioned in Section 3.3, financially have been impressive, and therefore the employees find the management's strategy wise, believing that they will lead to a better and stronger organisation.

Respect is not the only reason for the employees backing management and their process programme. If the developers and project managers did not themselves believe in the general scheme with a process framework based on the CMM model, they would probably be less willing to adopt the descriptions. On the other hand, if that was the case, they would probably not be employed in SSE. So the process framework, or rather the organisational settings, attract a certain type of employee with whom it is possible to work in an organisation with a quite developed process scheme. However, the company's success which constitutes a proof of concept is not to be underestimated as a cause for the very high diffusion of the project framework.

The fact that the top management owns the company, in the employees' view, stands as a guarantee that the decisions taken by the owners are well considered and are thought to provide SSE with a genuine advantage. No board of directors to whom SSE is only a step on their career ladder is pushing ideas to promote itself. Instead, the owners to whom SSE is their life's work are behind the strategy, thus giving it argumentative power and confidence among the employees.

6.5 Proud

Proud in the meaning of manifesting pride originating from the Latin verb prodesse—to be of worth, and an important aspect of the SSE life is exactly to be of worth—and to respect what is of worth. Proudness is a distinct parameter when visiting SSE, and in SSE's case the proudness can be described as a professional proudness, founded on results—but, on the other hand, false modesty is not practiced either.

Along the proud-axis of this cultural analysis the following characteristics are identified: the team spirit in SSE is a noticeable feature in SSE. The organisation stands out as being professional, and the employees provide evidence of this characteristic. As a result, a special SSE jargon has evolved linking the employees together with their own special language. Also, the management is proud and expects the organisation and its employees to deserve victory. There are always new goals to strive for, and the spirit is that of moving 'Forward, forward!'.

6.5.1 Team Spirit

The employees in SSE have a well developed sense for team work, and the (project) team members work together as an efficient whole—each contributing with their specialities. On an organisational level, SSE is a coherent organisation with a remarkable esprit de corps. The developers are proud to work for SSE, and therefore they contribute to keeping SSE an exciting and comfortable work place by helping out and filling gaps when needed.

A major cause for the well established team work is that the organisation relies primarily on project teams. The projects are longer lasting and the teams are quite stable with respect to their staffing, meaning that the team members are shifted infrequently and, as such, the teams tend to be well integrated. The efficient team work creates a vision among the team members that they are highly qualified and very well performing, and this in itself strengthens the well functioning team work. In a sense, the idea of the common being of more value than each individual is prevalent and visitors will face an enthusiastic, efficient, and energetic company.

The well developed team spirit also includes the employees recognising and respecting the many different roles upon which the organisation is build. Each member is an important part of the organisation and contributes with his or her special skills. One way this mutual respect is expressed is that everybody thanks each other explicitly. 'Thank you' is one of the most common phrases used in SSE, also across specialities and educational borders. The service personnel who work during the normal office hours are thanked when they clean the offices—because without their duties done the developers could not do theirs. This respect would be hard to obtain if the service personnel worked during night since the different employee groups then would not meet each other. Knowing a person's face is another way of making this person real. If the cleaning was done by anonymous staff during the night, the respect for this task might easily be lowered and, as a result, the willingness to keep things clean might easily be lowered as well.

The respect for each other's tasks also leads to disappointment with others if they are not contributing as required. In a specific situation a couple of developers noticed that two specific employees were taking very long coffee breaks. They mentioned (to me) that if they were the managers of these two, they wouldn't be allowed such long breaks. This showed not only their disappointment with respect to the two colleagues not delivering the expected effort, viz., not contributing to the organisational whole, but also with the respect to the co-workers' managers not following up on this, and not meeting the expected level of commitment. It needs to be pointed out that the mentioned employees were not working directly together, so the concern was on an 'organisational' level, not on an individual or project level. However, no direct interference followed—the appropriate channels of command needed to be followed, and—in spite of the synergy in the organisation—it is not good manners to express these concerns publicly.

6.5.2 Professional

The proudness also stems from the fact that SSE's employees feel themselves very professional and part of a professional organisation, which is run smoothly. The employees feel well educated, and rely on the professionalism of the organisation and its process apparatus to be capable of handling any challenge. The employees rely on this professionalism to handle most situations, and in the cases where problems occur, it is expected that managers take mitigating actions to reduce the negative impact. To an outsider the organisation seems very well run and capable of handling most requests at a short notice. Of course, in this study most of these requests were related to the meetings with SSE and the planning of interventions &c., but even so, the preparations and practicalities were carried out flawlessly. Much of this smoothness is directly related to the standard operation procedures of SSE. For instance, when booking a meeting room the number of participants is provided, and automatically coffee and cookies are ready and served by the service staff at the preset time. Also, if a break in the meeting is scheduled, the coffee is refilled, and, for example, fresh fruit is served upon return. These things are by no means unusual and hard to plan, but the seamlessness and taken-for-granted nature of the formal representation gives the impression of a well organised company.

On the other hand, this professionalism also spawns irritation and annoyance when things are not running as smoothly as expected. Even small errors or inconveniences might cause disappointment, e.g., if the coffee and cups are not ready for a meeting, or worse situations when projects fail to meet deadlines or the quality parameters are not met, e.g., an internal assessment scores lower than expected.

In these cases confusion develops, and questions arise as to why these problems, in spite of the professionalism, have occurred. This can cause some doubt to whether the model (process model or CMM model) is 'wrong' in the sense of not capable of managing every situation, or showing doubt in the colleagues' capabilities. The employees seem embarrassed when these situations occur. Their pride is hurt, because they (SSE) do not live up to the high standards that they have agreed upon. In some sense they feel that they have failed. But the sense of professionalism in these situations leads to quick error corrections to bring the situation back to normal. Whatever the reason, the professionalism of SSE will try to recover from the setback by carefully analysing the situation and searching for the main cause with the ambition of adjusting the future practice to be able to foresee such errors and prepare to avoid them in similar situations. The same can be observed when errors are found in formal specifications, e.g., the use of 'employees' instead of 'talents' in process descriptions. When a term is agreed upon, it should be used globally to avoid misunderstandings, and to help the diffusion of this term.

The quality of the formal measurement programme is also questioned by some of the employees as not living up to the standards of SSE. It makes the employees feel that the resources are not well spent on the measurement system. If it does not provide the expected value-for-money, it is not regarded as professional as intentioned.

An example of the proudness and striving for professionalism of the organisation can be seen in the way the organisation internally handled the laying off of a larger part of its work force due to declining orders and the resulting redundant staff. The story after the lay off, when the business was prosperous again, was that employees were not laid off as a result of diminishing sales, but because the organisation needed to trim itself and to adjust its employee portfolio to the current demands. The story therefore changed from being about a crisis situation into being a situation were SSE pro-actively changed their employee portfolio. So the story was, more or less purposely, changed from being a crisis-story to a hero-story: it was hard to lay of the people, but a necessary step to keep up appearances and to show professionalism. If the market situation had not changed and hirings of new employees not started shortly after, the story might have been different.

6.5.3 SSE Jargon

The BM and its derivatives comprise such a complex system, that a special language including all the TLAs[4] has developed among the employees. Almost every significant part of the BM has its own TLA (e.g., project follow up (PFU)), but also every employee's initials are three letters long (CHK, PVP, &c.) For outsiders, the decryption of these codes can be hard. Initially, it was hard to follow every detail of a conversation between employees because of this special lingo or SSE jargon. This active language constructing tendency also covers a special need, namely, to name or label everything with its own term—a fact that has confused many outsiders, including external CMM assessors.

The SSE jargon is especially explicit in written materials in which references to other parts of the model occur frequently. This is not just a problem for newcomers, who want to participate in the organisational workings, but it also serves as a means for creating an identity based on the axiom that: "If you share our language, you are one of us."

An example on how this specific use of language is also used to shape the

[4]Three-letter acronym

proudness and professionalism of the company was recorded during a meeting where one PM specifically wanted to avoid the words ‘fire fighting’ in the minutes as these were believed to be incompatible with the SSE practice. If not as intentional as Orwell’s (1949) ‘Newspeak’, this deliberate control of the language in use is a part of the employee’s esprit de corps and striving for professionalism. By selecting one word over another, the image of SSE as a competent organisation is supported and thereby strengthened among the employees. It is not an official policy to control the language used in this sense, but the fact that it occurs shows that keeping the right vision and shaping the view upon the organisation are tasks taken seriously by employees.

6.5.4 Deserve Victory!

The general and official view is that the employees should expect to be successful! If work is done properly, the expectation that goals will be reached is an underlying assumption in SSE. A clear manifestation of this assumption is the poster on the wall in a BUDs’ office. This is the famous poster from the Second World War picturing Winston Churchill demanding that the onlooker deserves victory (refer to Figure 6.4 on page 153). This poster perfectly signals the assumption that you have to believe in what you are doing and that you can achieve it by working hard towards the common goals. The implications for this axiom are also that if you as an employee do not work hard, you do not deserve victory, and further you do not deserve to be on the team. Nothing comes for free!

On the other hand, the father like figure of Churchill promises that if you do deserve the victory, the means to achieve it will be provided to you. The confidence in the management’s and own capabilities is an unwritten law in SSE. There is very little doubt in the qualities of both the organisation as a whole and its individuals. Everybody is selected to be part of a winning team; thus, by participating and doing one’s best, SSE will be successful and deserves victory. The poster being a war time poster, at the same time underlines the somewhat military influenced climate which exists in SSE, both

Figure 6.4: 'Deserve Victory!' poster from manager's office

as a result of the management style and because of the close collaboration with the defence industry.

One important aspect of this vision of being the best and always staying ahead is the requirement of always showing progress—both internally and externally; a fact that also shows in the previously mentioned fetish for numbers. The progress results in a constant need for new goals and an attitude for always striving for new goals. Forward, forward! is as mentioned earlier the spirit in SSE, and to keep that spirit up, it is necessary to have a pipeline of coming achievements to secure that the progress never stops, because, as it is expressed in the intellectual capital report:

> "If we stop improving, we start going backwards." (SSE, 2004b, p. 18)

This is also the reason why the CMMI model is only one tool adapted in the organisation. It needs to be supplemented with others, because new motivators and goals need to be setup beyond reaching the highest CMM level, five. This also signifies that the CMM, while being very important for several reasons to SSE, by no means is looked upon as a 'religion'. The CMM model is considered a useful tool, both for achieving relevant software developing capabilities, but also as a means for creating the necessary motivation and drive in the organisation to continue its progress forward. In this respect, the CMM model as a staged model is well suited as it is easy to monitor the progress of climbing up the ladder.

6.6 Open

A third property of SSE is its openness. In spite of being a managed and proud organisation, new ideas and initiatives are welcome, and an informal and relaxed atmosphere can be observed. Most organisational initiatives' progress can be easily monitored by the employees making visibility an important feature. The visibility also shows in the architecture of the new (in 2003) facilities, which internally consist of glass. Openness requires SSE to recognise the surrounding environment, and the society plays an important role in the company.

6.6.1 New Ideas

With SSE's intentions of being in the lead in its field, openness to new ideas and innovative projects are a necessity. For this reason SSE, primarily the management, are always on the look out for new opportunities that might benefit the organisation. This is also a reason for SSE to participate in research activities, and the organisation has been quite active within this field, e.g., with one manager co-authoring a scientific book. Participation in conferences is also a way to collect new insights and ideas, and several SSE employees have written scientific papers about SSE and its practice, and in this way have received experts' feedback as to how this practice can be improved further. Scientific journals and books are a source for collecting new potentially beneficial suggestions to organisational development.

Employees (or talents) are welcome to propose new ideas; it has happened several times that these initiatives have had significant impact on the process descriptions. The employees feel that they share a part of the process since they can influence the process framework. This way the SPI project—apart from receiving well thought through and usable suggestions—strengthens the employees' motivation to understand and implement the process framework. While working on this thesis some of the improvement initiatives were designed in close cooperation with a PM from one development project, viz., not a SPI project member.

The openness in the organisation also concerns the qualifications of the employees themselves. If some new knowledge is required to better be able to solve a problem or carry out a task, the necessary means for achieving this knowledge are provided. In the office complex there are several small study chambers made available for employees who need to study some material in depth away from the normal work situation, i.e., their desk. These chambers are small rooms with no windows, only a small desk, and in some cases a small laptop with Internet connection—apart from the laptop very much alike the study cells found in monasteries. The idea is that if some subject is of crucial importance to a project, e.g., a specific software standard, an employee can withdraw to this chamber and in an undisturbed environment obtain the necessary understanding which later can be shared with the rest of the project.

However, this openness to new ideas has also led middle management to consider that there are too many new initiatives at one time. This has caused the notion of "protecting the organisation from the ideas from management". If too many initiatives are initiated at once, the focus of the improvements—and the vision of the organisation—can easily get blurred. The management steering group (MSG) is in this respect an important coordinating forum in which new ideas are discussed and compared with existing and planned initiatives.

The SPI project also defines its tasks to include the alignment of new initiatives with existing ones to minimise the negative impact on currently running improvement programmes.

6.6.2 Relaxed

Another way of showing openness is by the relaxed and informal attitude that the employees in the organisation show among themselves and to strangers/outsiders. The employees are dressed casually, and no official dress code exists. The impression a visitor gets is that this is a house of production (or engineering) more than one of sales or representative tasks. The suits and ties, however, are produced when they are needed, e.g., when important customers are visiting. But such visits do not affect the expectations of the rest of the employees—meaning that they will continue to dress casually at the same time that the visitors and their hosts are more formally dressed. Visitors can easily see what is going on in the organisation, that is, they can see that the developers are continuing their business as normal and that it is not affected by the sales effort.

In spite of SSE having its own language, the tone used among employees and also towards visitors is similarly informal, which, at least in most parts of

Denmark, is considered as a quality, meaning that business is conducted in a friendly, but serious way. The employees speak frankly about their concerns and have seemingly no problems in voicing their own opinions regarding specific topics; this gives the impression that the employees are used to being listened to and are used to being part of the decision making process in the organisation. The informal tone is also used between employees and their managers. The managers' doors are always open for anyone to come by to have an informal chat if necessary.

This is also true for the top managers whose offices are located just above the reception area. However, these are not very often visited by employees, but according to tales it has happened. Whether this is a myth or not, it is an important property since this gives the employees the impression that their voices can be heard when necessary. In most cases an employee can approach the BUDs or other managers for an informal discussion if s/he needs advice or information at a certain point of time. However, being busy people, sometimes more formal meetings need to be arranged for more important issues. This is also respected by the employees who know that the managers' time is limited and therefore they only come by when they have important or quick matters—otherwise they book a formal meeting.

The frankness and informality suggest that the information provided by the employees is valid, meaning that they don't have any hidden agendas or need any reasons to hide certain information, which in the case of collecting material for this thesis was an important matter.

The openness extends to hospitality and a welcoming attitude towards visitors. Everybody smiles at visitors and welcomes them. This is not only true for the managers and developers, the receptionists and the (omnipresent) service personnel are also very smiling and friendly. For example, when the cleaners enter an office everybody greets her/him. For me as an outsider, it was therefore quite easy to feel welcome in SSE during my visits in the organisation. People knew why I was there and were polite and very helpful—all things that made my task a lot easier to accomplish.

The attitude seems to be that everybody believes that since a visitor is there, s/he is doing something useful and requires the help and attention that any other colleague requires.

In spite of SSE's relation to the defence industry requiring a moderate to high confidentiality level, SSE manages to conceal this fact so visitors do not need to worry about entering restricted areas or stumbling across secret documents. Of course secure and restricted areas exist within the office complex, but these are hidden away from the normal working areas. Employees are all equipped with key cards which can open the needed doors, but all the common facilities are placed in non-closed areas, meaning that guests and most employees normally do not need to worry about locked doors or restrictions. I, as a visitor, had my own key card with which I could access nearly all of the facilities easily, and I was also allowed to use my own laptop to access the Internet. Local network access was only available through internal computers and was controlled in the sense that an employee needed to log me in, and to show me where to find the required information. But, the general impression was that SSE, given the fact that they are in a highly competitive and sensitive business, appears as an open organisation with a relaxed, but professional attitude towards their secrecy obligations.

6.6.3 Visibility

The openness combined with the the proudness results in a high focus on visibility. The key features the company wants to signal and signals are: professionalism and high quality. A major part of the signalling is to emphasise the achievements and, as a result, the company purposely values the external as well as internal marketing of results regarding these features very highly. The external sources for visibility span very broadly. Employees from SSE have co-authored several scientific papers about SSE's practice and experiences with their process framework, and these papers, as mentioned, have been presented at scientific conferences (e.g., EuroSPI 2004). These participations have the dual purpose of both leveraging the collected experiences by being discussed with peers and, at the same time, they guarantees to a certain extend the quality of what SSE is doing. Many employees also participate in various professional networks discussing new ideas and trends within their specific field. This is allowed despite key employees having tight schedules and being much needed in the daily practice, that is to say the benefit of being up-to-date is considered well worth the extra effort spent. A consequence of these activities is a marketing effect not only with respect to positive publicity, but also with respect to recruiting activities. Attracting the best employees is an important competition parameter.

Apart from these activities, SSE annually produces the intellectual capital report, which management considers an important outlet for company related information. Much effort is spent producing these reports, a deliberate part of the company's marketing strategy. The 2000 edition of the report was awarded the title of best Danish intellectual capital report[5]. These reports are distributed in more than 24,000 copies[6] (for more information refer to Section 3.2.1.2).

The previously mentioned certification tubes, and the company's wall of fame are examples of internal promotion through visual means which, because of their placement in the aula of the building, also are visible to every guest and, as such, are used as a means for communicating the organisational skills and progress to visitors. Another example used internally in the SPI project was a large poster containing all outstanding issues and milestones regarding the coming CMM assessment. The information in the poster was updated regularly to show the progress to the project members. But as the poster was placed on the walls outside the SPI project's offices, it was also exposed to other members in the organisation who in this way had the possibility to following the progress towards the next CMM level.

6.6.4 Open Office / Architecture

The facilities into which SSE moved in the beginning of 2003 are themselves examples of the openness of the company. Most walls in the building are made of glass, and most offices have unhindered view to the main aula, which lies underneath a glass ceiling and also houses the canteen. Most meeting rooms

[5]The 1999 issue was nominated in the same contest, and the 2001 issue was awarded 2nd best.

[6]http://systematic.dk/UK/About+Us/Quick+Facts/Milestones.htm

are located in conjunction with this area. This means that most activities in the house can easily be observed from the working offices. Apart from the obvious advantages of letting in a lot of the sparse Danish sunlight, this open architecture signals transparency and an untight milieu to the users of the building, meaning that SSE has nothing to hide, and that it also has every reason to promote their employees' whereabouts, since they are very proud of them.

The offices are not single cubicles, but instead shared between 5 to 20 people. The project teams are located together or in close vicinity to make it easier for the members to communicate and share vital information, both informally and formally. Only managers at the BUD level have private offices, but these managers also often have meetings, often unplanned, which means that their offices are often used as meeting rooms. When asked, the employees all said that they liked the idea of open and shared offices, because it made their everyday tasks easier to accomplish when they were located near those that they worked closest together with. Thus, co-ordinating activities are easier accomplished and informal activities make the job environment more comfortable, and reduce the need for formal activities, which sometimes are considered to be awkward and time consuming.

The employees respect each other in the sense, that everybody acknowledges that the offices are working spaces and that the noise level should be kept to a minimum. There are no formal regulations for office behaviour, but an informal code of conduct has developed and is applied among the employees in offices. Conversations are held in low voices, and music &c., is not allowed; 'allowed' in the sense that everybody agrees that music is not considered a benefit for the working environment and thus not considered a good idea. The codes of conduct are not necessarily the same from office to office but, by and large, they are uniform. Just after SSE moved to the new facilities a more formally founded discussion arose about the need for an formal etiquette—or behaviour codex for the new offices, since every office suddenly was visible. This discussion did not result in a written codex, but focused the employees' attention on potential problems regarding the visibility, and this in itself regulated the behaviour.

To further facilitate the acceptance of the open offices, SSE's new facilities are equipped with the previously mentioned study chambers, which can be used by employees who need more quiet than the normal open offices can offer. Also, the many meeting rooms of a variety of sizes can be booked and used by project teams or sub-teams to allow for more people to meet at one time without disturbing the rest located in offices. However, most projects keep their internal meetings in their own offices, since the teams are located in the same rooms and, as such, close at hand when needed. For more informal meetings or small discussions a number of small discussion areas or cafes are located throughout the buildings. These consist of an open area equipped with a bar table and a whiteboard. These areas are used considerably to discuss smaller affairs between smaller groups, e.g., sub-teams. By using these areas the open offices are spared the extra noise and the disorganisation that these smaller meetings can cause. The discussion bars/cafes cannot be reserved but are open for use by any employee who happens to be in the need.

6.6.5 Society

SSE recognises that they themselves are not a closed entity, but part of the society and as such an integral part of the environment. SSE sponsors a professor of pervasive computing[7] at the local university (University of Aarhus) with €606.000 to underpin that research and educational activities are an important factor for high tech companies. Without being able to recruit well educated students from the universities, it is not possible to operate a software development business in the local area. In a period with high demand for well trained and educated software engineers this donation also helps to place SSE on the landmark of the students.

SSE also sponsors the local museum of art ("ARoS"[8]) and every year invites every employee and relatives and other business associates to the official SSE Art day in the museum. The Systematic Art Price is instituted and every

[7] http://www.systematic.dk/UK/About+Us/News/Systematic+Sponsor+the+First+Danish+Professor+in+Pervasive+Computing.htm

[8] http://aros.dk

year €6.900 are awarded to "a talented Danish artist working with the latest artistic expressions: photo, video, multimedia, light or installation art."[9]

On a smaller scale SSE shows environmental responsibility by serving healthy food for its employees, and instead of candy and cakes, slices of carrot, apples and pears, &c., are served from trays throughout the offices. These refreshers are kept fresh and refilled several times a day to help improve the turnover, and the 'carrot index' (SSE, 2004b, p. 32) shows how many kilogrammes of carrots are served per employee (22 kg. in 2002/3).

6.7 Combining the Axes

The presented cultural analysis of the implicit values provides a deep understanding of the organisation and, as such, a better basis for judging its readiness with regards to the introduction of improvement initiatives. A better understanding of the organisation also serves as a means for adjusting the suggested improvements to the current organisational culture by pointing out which areas or topics are most important to the organisation. The following section describes a combination of the findings from each of the axes with the findings from one of the other axes, respectively, to identify a set of patterns. By aligning future improvements according to these patterns, these new improvements will fit better to the organisational setting and thus the chance of acceptance among the employees and thus successful adoption and diffusion will be higher.

6.7.1 Managed and Open: Organisational Readiness

The characteristics of the managed and open axes taken together suggest that SSE is an open minded organisation that is able to design and implement new organisational initiatives. The ability to actually turn new ideas into new practice is to a large extent a well established practice in SSE, and the organisational constructs regarding designing and aligning new initiatives

[9] http://www.systematic.dk/UK/About+Us/Systematic+Art+Prize

into workable and adoptable practices have been tried with success several times before (refer to for example the successive introductions of new versions of the BM).

Being managed, the employees are used to being told what they are supposed to do, and are, at the same time, used to accepting new ideas and initiatives as being well constructed and meaningful. The top-down management makes it easier to introduce these by decree, and the employees are used to having sound and manageable decrees; thus, they are not reluctant to participate in and adopt these new initiatives. Of course, this means that the initiatives have to be agreed upon by management because their support has such a high impact on success.

Being open, the employees are used to implementing new ideas, and are by no means afraid (and therefore reluctant) to try and test something new. Yet, being open, the employees can excel their right to question initiatives which therefore have to be well thought through and of high quality. Since the SPI project has been responsible for or deeply involved in most of these initiatives, this project has collected an extensive base of experience considering the planning and implementing such new initiatives in the organisation. This suggests that co-operating closely with the SPI project when designing new initiatives might provide the plans with important insights with respect to what previously has worked or not worked when considering the deployment of new ideas.

Collectively, the above suggests that SSE must be considered capable of undertaking new initiatives and carry them out into actual organisational changes, and that involving both management (for support) and the SPI project, to build upon previous experience, are appropriate steps to improve the rate of success.

6.7.2 Managed and Proud: Initiatives Must Be Doable

When combining the characteristics from the managed and proud axes in relation to the implementation and deployment of new organisational ideas, it shows that the success of these initiatives relies heavily on their ability to fit into the already established processes and, at the same time, on their expected value for the developers.

The managed characteristic suggests that to be able to keep the organisation in ship shape, new initiatives must comply with and support the existing process framework rather than disrupt it. The prevailing organisational structure resembles a mix between a machine bureaucracy and a professional bureaucracy (Mintzberg, 1983). The employees' high level of education and the complex task structure of software development suggest an organisational structure similar to the professional bureaucracy. But, based on the maturity ideals, the organisation seeks to apply the machine bureaucracy's standardised processes wherever feasible, and leaving the rest up to the (standardised) skills of the employees thereby getting the best from both worlds. The assumption is, that many, if not most, tasks can be broken down to a level, where few significant parameters can be measured, managed, and controlled in an effective way by establishing a complex of standard operation procedures. This way SSE capitalises on the effectiveness of the concept of machine bureaucracy by simplifying the control mechanisms and the organisational overhead—a development-to-scale.

At the same time, the high degree of tailoring which is needed to make the standard operating procedures fit the complexity of the real world development situations makes high use of the employees' expert skills, in this way combining the two bureaucracies in what could be described as a professional machine bureaucracy. This calls for a more conservative approach to initiatives based on stepwise or incremental innovations, rather than more radical disruptive innovations (Christensen *et al.*, 2002; Charitou & Markides, 2003).

New initiatives must, according to the characteristics from the proud-axis, be considered of value by the employees for whom they are intended. If the new initiatives are considered to not generate any improvements, the chances of adoption are much smaller since the employees act with great professionalism and are used to being measured on their effectiveness. The new initiatives must suit the needs of the projects well, and as such directly contribute to the analysis and developing tasks—which are the primary objective of the projects.

These requirements further advocate for a stepwise approach to carry out improvement initiatives. A clear path from the current process scenario to a future one has to be laid out and the reasons and consequences of following this path have to be clear to the employees involved. If the new initiatives fail to meet these qualities, the employees will neglect them. They will not see how applying these new ideas might improve the current project work.

The SPI project is very careful to avoid introducing new ideas into the organisation that might be turned down or ignored by the employees, because too many such mistakes might give the employees the impression that the SPI project is an amateurish central method department, more or less detached from the organisational practices, and as such a player who easily can be ignored because of its lack of relevance to business. Such a method department paralysis has by all means to be avoided (Kautz *et al.*, 2004).

Instead, new initiatives have to be able to provide imminent results and in this way continue to strengthen the building of respect for organisational decisions based on respect for their results.

This also means that the new initiatives must be based on the existing process descriptions and their language, and therefore have to be translated into the special SSE jargon to be more easily accepted among the employees. Thus new initiatives have to be planned in close co-operation with representatives from the SPI project, who are experts in translating concepts into the internal SSE language.

6.7.3 Proud and Open: Co-determination Necessary

The combination of the characteristics from the axes, proud and open, suggests that new initiatives relying on the participation of the professional staff have a higher chance of being adopted.

The software developers are proud and want to involve themselves into the structure of their work. They are the experts when it comes to the practice of conducting software development, so it is important to recognise this expertise and proactively use it in the process definitions. This is both to secure co-determination and to secure the relevance of the future process framework. Any improvement initiative has to involve the the developers in parts of its work, and in this way, a combination of the top-down and bottom-up management styles can be achieved, in which management decides on the major goals, objectives, and means, whereas the details are the concern of the employees by whom the work is conducted.

The professional bureaucracy relies on its experts, and their sound judgement—and in the mixed variation with characteristics from the machine bureaucracy it is of importance that the experts accept the general complexity of standard operation procedures, and thus the management's decisions regarding this. If not, the centrally devised method at best will have no practical significance since the experts themselves rule their parts of the organisation (their projects).

On the other hand, the open axis suggests that the employees are aware of this responsibility and are ready to participate on these conditions, viz., involve themselves in the formal work of specifying work processes, even if this work is not directly connected to the practice of developing software. The new ideas need to be translated into processes and practices, and need to be visible to every part of the organisation, and thus require a close collaboration between the developers (experts) and the SPI project (facilitators), the first delivering the content and the latter helping with the packaging and alignment to the overall process framework.

6.8 Conclusion

This cultural analysis of the explicit and implicit values presents characteristics which are deeply founded in SSE and as such not easy to change. This is why they will be used as environmental factors in the analysis and design of improvement initiatives, by adapting new initiatives to them rather than trying to change the organisational characteristics according to new initiatives' requirements.

The implicit values fall into three categories or along three axes, managed, proud, and open, each describing a significant set of cultural parameters of

SSE. These parameters are useful to know when designing new initiatives as it is then possible to align these initiatives accordingly to heighten the chance of successful adoption. Analysing the combination of the findings along the three axes with respect to the expected implications on new initiatives brings more insights that can be applied when designing new organisational improvements.

According to the analysis, SSE is an organisation in which changes or initiatives can be carried out with relative ease—the organisation is familiar with handling changes, and new initiatives are designed and deployed quite often. This said, the new initiatives have better chances for success if they support the current practice, and are presented in a way that shows direct applicability to the current organisational practice. If the initiatives are developed in co-operation with the involved practitioners, the chances of adoption are further strengthened—but only to the extent where the process framework is not abandoned.

These principles or prescriptions have been applied as organisation-specific design parameters, which will secure a better chance of the successful adoption and diffusion of the suggested improvements. The resulting improvement initiatives will be described in chapters 7-9.

Chapter 7

The Knowledge Mapping Technique

This chapter presents the first research cycle which focused on identifying specific improvement areas in the organisation. I introduce the concept of knowledge flows and describe how I developed and applied a knowledge mapping technique visualising the relevant organisational units, individuals and artifacts, the knowledge flows between them, and the climate and context in which these flows took place. Applying this technique in SSE allowed me to analyse KM and knowledge sharing related issues as a prerequisite to improving future development practice. I describe the benefits of the concept and the technique as they appeared in SSE and I also point to further research and application challenges of the technique.

The chapter comprises a full action research cycle and covers 8 months of data gathering and subsequently analysing qualitative data in the period from 1 April 2003 until 11 November 2003. I was present in the organisation once a week during this period and participated in the daily routines. This enabled me to get an in-depth understanding of the organisation. To further inform the research, eight semi-structured interviews were conducted with employees from all organisational levels, from BUDs to developers. Furthermore, the research relied on an analysis of artifacts used in the organisation: report templates, manuals describing organisational processes, computer based tools, &c.

The results from this cycle are further documented in the following publications: Hansen & Kautz (2004a), Hansen & Kautz (2004b), Hansen & Kautz (2005a), and Kautz & Hansen (2008).

7.1 Knowledge Mapping Technique

The goal of this first research cycle was to analyse the knowledge status of SSE in order to identify knowledge related improvement areas. To reach this goal I combined the findings from the literature survey of knowledge management and sharing in Section 2.2 with relevant analysis techniques.

This resulted in the development of a new technique for visualising and analysing SSE with respect to the capabilities in knowledge management and sharing, namely the knowledge mapping technique.

To be able to analyse the status of the knowledge sharing capabilities in SSE I focused on the organisation's learning capabilities, and—based on the survey of the KM and knowledge sharing literature—used as the central element of the analysis the concept of the learning cycle.

I needed an approach which could help me to produce results and identify areas of improvement rather fast, since the organisational pressure for outcome was growing. At the same time, the results had to convince the managers of SSE to allow me to pursue them further. To meet these requirements I developed a technique which was to be applied in a joint session with researchers and managers from SSE. An analysis which would be conducted in one meeting, would naturally be quick. In addition, a joint analysis with shared results would be more likely agreeable and as such a basis for further joint decisions.

In the following I present the prerequisites for the technique, followed by a general introduction to the mapping technique itself.

7.1.1 Knowledge Flows

As described in Section 2.2, the facilitation of complete learning cycles is a prerequisite for learning (Hedberg, 1981).

Levitt & March (1988) describe how the distinction of experience exploitation and experience exploration (March, 1991; Levinthal & March, 1993) has an influence on situations where organisations rely heavily on 'learning by doing' and describe how diffusion or 'learning from the experiences of others' is an important aspect of not falling into a 'competency trap'.

Hedberg (1981) stresses how an important task of improving the learning cycles is to unlearn 'wrong' stimuli-response connections and he emphasises the importance of not clinging to irrelevant or wrong knowledge. Similarly, communities of practice can steward a critical competence, but they can also become hostage to their history, insular, defencive, closed in, and oriented to their own focus (Wenger, 2000). Thus, the analysis of the knowledge management and knowledge sharing capabilities should be informed by the organisation's intentions with respect to whether an exploitation or exploration approach is seen as beneficial in a specific area—or which knowledge organisation type (refer to Section 2.3.2) characterises the organisation.

Similar organisational units might achieve advantages from having a close dialogue and sharing of their experiences, if no exchanges exist between them, a potential benefit might be lost. Competencies must be available to analyse experiences (Hedberg, 1981), which on an organisational scale means that knowledge somehow must be exchanged and shared to permit organisational learning to take place (Wenger, 2000).

Therefore, facilitating these exchanges is a crucial task when performing KM in an organisation. In the following I term these exchanges knowledge flows as they constitute, in the terms of Huber (1991), the basis for knowledge acquisition, information distribution, information interpretation and organisational memory as processes and constructs that contribute to learning in the organisation. Thus, they represent the backbone of the learning cycles.

According to literature, knowledge flows take various shapes and forms. Following Polanyi (1966), Nonaka (1994) describes how explicit and tacit knowledge is created and transferred by and between individuals in an organisation. This signifies that knowledge flows consist of both explicit and tacit parts. Both parts have to be examined.

A flow comprises of interaction between various structural elements in the organisation and can consist of informal discussions as well as of strictly formal half-year reports; what is important is that some actor acknowledges it as a means of knowledge exchange. Some flows are bi-directional, and some unidirectional, and some might be both, depending on who defines them. The flows can differ with respect to their frequency and the amount of information they contain, which is why it is useful to identify the type of knowledge that they contain. The importance ascribed to flows by different stakeholders is also a significant feature as it can bring potential misalignment into the open.

Further, knowledge flows are influenced by the way knowledge is stored in the organisation. According to Walsh & Ungson (1991), knowledge is stored in six different bins (refer to Section 2.2). In the description of SSE's knowledge flows I use the concept of bins to represent knowledge storages.

Wenger's (1998) description of communities of practice (COP) emphasises that it is the belonging to several communities of practice that constitutes people's worldview and thereby their capabilities to understand the environment they see. Wenger refers to the communities as the containers of competences, and explains how learning occurs on different levels. These competences evolve inside the communities, but are also exchanged at the boundaries between different communities. According to Wenger, the communities of practice, the boundaries between them, and the communities' members' identities play an important part in the social learning systems that constitute (amongst other things) an organisation. This suggests that a representation of knowledge and knowledge flows will benefit from depicting communities of practice and the interactions within and between them. Thus, groupings of employees, formal and informal, and their roles, formal and informal, constitute further important elements in conjunction with the flows of knowledge that exist within as well as between these groups.

7.1.2 Knowledge Maps

To explicate and visualise the knowledge flows of SSE I developed a representation technique, which I called a knowledge map[1]. This map visualises the complex organisational nexus of knowledge flows, individuals, groups, organisational procedures, (IT) systems, artifacts, reports, &c., which is required to perform an holistic analysis. It allows for generalisation based on specific issues expressed by different stakeholders, as well as for interpretation and negotiation.

The map combines known techniques for visualising and understanding complex problem situations, namely rich pictures and mapping techniques.

Rich pictures are defined as

> [...] the expression of a problem situation compiled by an investigator, often by examining elements of structure, elements of process, and the situation climate (Checkland, 1999, p. 317).

A rich picture seeks to outline a holistic presentation of a problem situation. The rich picture technique requires a thorough data collection, e.g., based on interviews with representatives of all involved stakeholders. A rich picture contains different viewpoints, potential disagreements or conflicts allowing for multiple perspectives at one time. Rich pictures allow for both insiders and outsiders to draw a complex human activity system in one picture. Rich pictures do not favour one way of actually drawing over another, but leave this to the picture maker(s). However, the basic elements characterising the situation have to be visualised for the picture to serve as a means of communication. Even if not all involved understand the picture the same way the drawing itself serves as an enabler for a discussion, which may support the development of a common understanding of the problem situation.

Mapping techniques are used to analyse problem areas, which are not fully or consistently understood by different stakeholders. Maps are defined as being

[1]The term knowledge map is widely used in different contexts. When 'googling' "knowledge map" in February 2007 239.000+ hits were returned—examples on definitions include tools to support mind mapping, category based indexing, and alternative methods of text representation; it however also fits my purpose.

> "[...] an interpretive description of a situation" (Lanzara & Mathiassen, 1985, p. 5)

and are, as such, an interpreted model of reality, i.e., a map consists of selections of relevant details of the mapped situation and provides information about what the mapmaker(s) find(s) relevant. Maps provide a possibility to gain an understanding of a complex problem situation and at the same time facilitate a common understanding of specific issues among different stakeholders. Different mapping techniques can be used to collect and organise relevant knowledge (Lanzara & Mathiassen, 1985): A diagnostic map contains a root cause analysis in which the mapmakers discuss experienced problems and seek causes and effects to find alternative approaches to avoid the problems. Ecological maps outline the connections between problems and the organisational context of the problems. Virtual maps outline desirable future situations. Historical maps have a retrospective perspective as they map the past; a previous situation is described with respect to its key events to learn what might be critical factors in a similar future situation. In this sense the 'story of the study' presented in Chapter 5 is a narrative based historical map of this study's progress.

To analyse the knowledge flows in SSE I utilised the strengths from each of these techniques. The rich picture technique provided the ability to visualise the different knowledge elements in a single drawing, while the mapping techniques provided relevant analysis approaches for the actual drawing process and the drawing of the knowledge map itself.

A knowledge map thus consists of the elements from a rich picture: structural elements, process elements, and a representation of the climate within which these two exist (Checkland, 1999). The actual choice of drawing symbols is of less importance. However, it is important to choose representations which are understandable, and which direct the viewer's thoughts to the relevant elements of the experienced reality.

In a knowledge map the structural elements constitute the basic nodes of the map. They consist of the different actors and groups involved in the organisation which comprise the formal organisational constructs like the organisational units, project teams, individuals, &c. Important artifacts regarding the flows also have to be considered. These could be reports or software tools, such as an error reporting system. The knowledge ‘storage’ bins are also candidates for structural elements in the knowledge maps.

The process elements of the knowledge map are the knowledge flows, i.e., the communication and the exchange of information &c., which flow directly and indirectly between the structural elements.

The situation climate is a key information provider for the analysis. It contains expressions about the circumstances under which the knowledge flows take place. This contextual information is a major indicator for pointing out problems, and contains multiple perspectives depending on the viewpoints brought forward. It consists of thoughts about why a situation is experienced as good or bad, thoughts of how a certain situation could be improved, expressions of where conflicts arise, or other comments about the knowledge flows. The techniques for constructing diagnostic maps and ecological maps are important tools in this part of the map making. By describing the climate, it is possible to gain insight into potential strengths or weaknesses of the knowledge transfer and sharing—important parts of the learning cycles in the organisation.

7.1.3 Critical situations uncovered by a Knowledge Map

On the basis of the notion of incomplete learning cycles (Hedberg, 1981), I identified four critical situations, which can be used to identify potential problems and improvement possibilities in a knowledge map:

Missing links describe situations where a link would be beneficial, but for some reason is not there or not functioning satisfactorily. As such, missing links are problematic to spot in a map, but to look for incomplete learning cycles is an obvious starting point.

Springs are areas from where lots of flows origin, but none are oriented towards. They might indicate potential innovative centres where lots of ideas are created and exported to the rest of the organisation. A spring might also point to an area, which is not using others’ experiences. This is not necessarily a problematic situation, as it can represent a highly specialised unit, which does not need any input, but it might as well point to a potential problem in that superstitious learning might be the outcome.

Black holes are places where no flows originate. This means that knowledge only flows one way towards this area. This might not be problematic, but if learning from experience is an important part of the organisational development, and specific parts of the organisation are not feeding experiences back, it is not possible for other parts to learn from these.

Hubs are specific individual or organisational units with a large number of connecting knowledge flows. A hub might be useful to have in an organisation, if it can cope with the knowledge flowing to and from it, and can effectively use it, but too many flows ending in one place might easily create congestion and thus a hub might end up developing into a bottle neck, slowing or discharging knowledge flows. This can lead to a situation where employees believe their actions affect the environmental response, but in reality they do not, because of a slow or dysfunctional knowledge flow.

7.2 Knowledge Mapping in Practice

The application of the knowledge mapping technique consisted of two phases, a preparation phase which I conducted alone and a collective mapping phase in which two leading members of the SPI project together with four researchers created the actual knowledge map.

In the first phase I made a preliminary knowledge map of the organisation (refer to Figure 7.1 on page 177) as a preparation for the actual joint map creation session. This preliminary map was based on the data I had gathered from the beginning of the study as well as on the results from the first interview round. The map was used as the basis for the joint map creation phase, and kept the actual mapping task on track, even when discussions moved in different directions. Preparing the map in advance ensured that all aspects, which I had considered relevant were covered. It allowed me to prepare a note of questions on topics, which I felt were not explained satisfactorily in the collected data. Drawing the map in advance also provided the

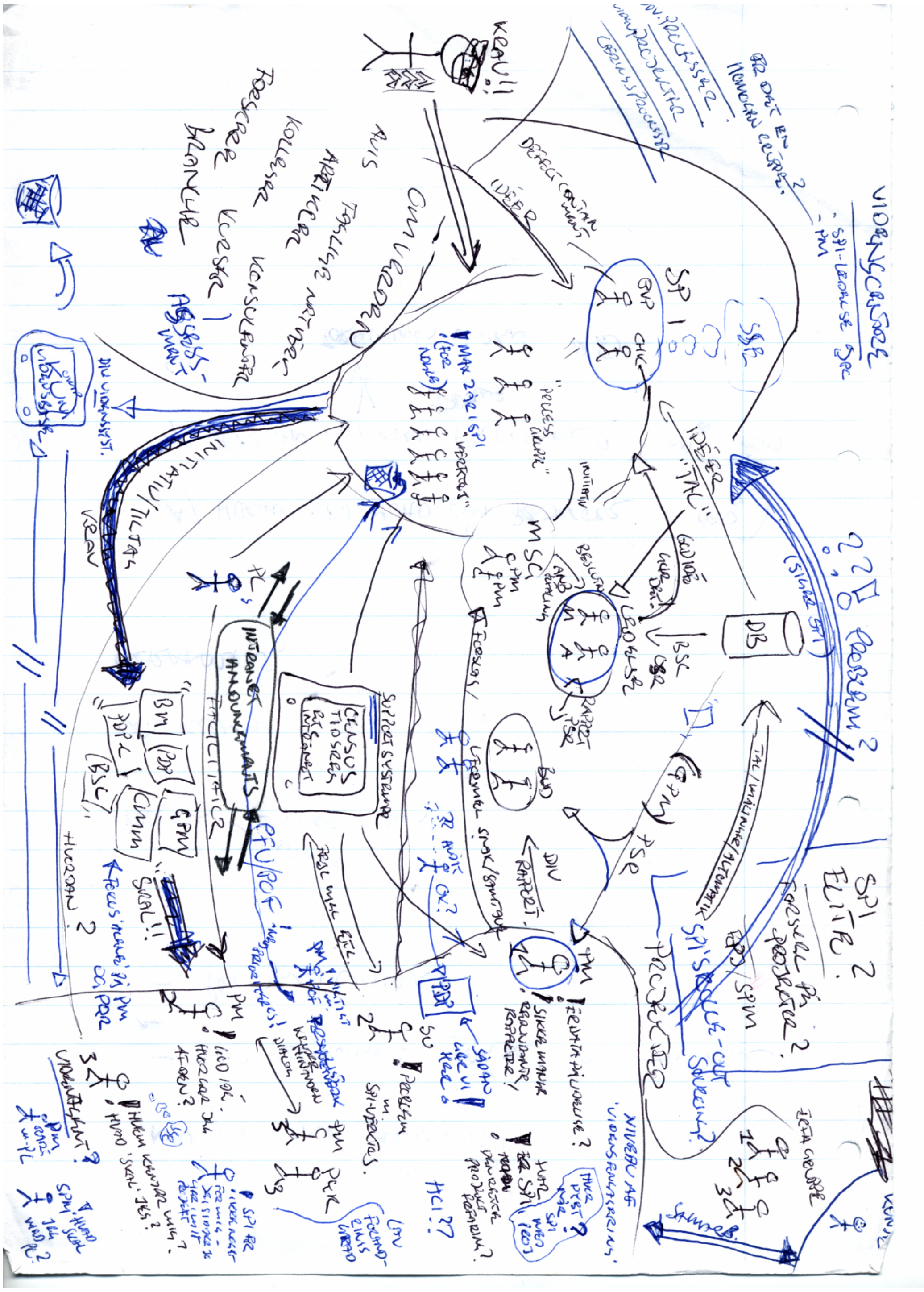

Figure 7.1: The preliminary knowledge map

opportunity to list what I had identified as major problems and improvement areas. These were used as discussion topics, in situations where the process needed stimulation. Preparation of a map in advance, without interference from others, enabled me to record my understanding, and thus provided the whole joint mapping phase with the quality of having an outsider look at the organisation. This external input would not have been so clear had the map been created in collaboration with internal stakeholders.

The second phase was the joint mapping phase, viz., the collective creation of the map. It consisted of four steps and took place in a day long meeting session. The steps together functioned as verification, clarification, and extension of the preliminary knowledge map. The various elements of the map were discussed in an open atmosphere with me acting as the meeting leader, which meant that I introduced and facilitated the process. Because not all stakeholder groups were represented, I—based on the preliminary map—brought the viewpoints of the not represented groups forward whenever relevant. I was also responsible for facilitating the discussion and for continually documenting the results on a whiteboard.

The first step consisted of drawing all relevant structural elements on the whiteboard. To begin with, I selected one part of the organisation (the SPI project) and started drawing the organisational units, artifacts, people, &c., listed on the preliminary map. While doing this, I presented my understanding of the role of each of these elements. This promptly initiated a discussion among the participants because some of my understandings were not 'correct' according to their opinions—or rather they did not align with their understandings of the same element. The discussion facilitated a common or broader understanding of the phenomenon in question, and the drawing on the whiteboard developed quickly.

To represent individuals, I used 'stick figures', some with additional characteristics because they represented individuals with specific roles and importance. I used groups of stick figures to represent certain organisational units, like development projects and sometimes I circled these to mark specific boundaries with the context. I used a picture of a document to represent written reports, and their formal abbreviations to distinguish them. Furthermore, I used various symbols for technical systems; these symbols were easy to understand for all participants, and were, if necessary, equipped with explanatory text.

The second step consisted of describing all relevant knowledge flows among the identified elements. Again, I introduced a specific flow between two or more people or artifacts, and described my understanding of it. This quickly facilitated a discussion outlining special cases and corrections, thus providing clarification and richness to the map. This step also introduced people, roles, and artifacts, which had not been identified during the preliminary analysis to the map.

The third step concentrated on the climate in which the knowledge flows took place and thus provided the context for these flows. For this purpose, characteristic statements identified during the data analysis were added to the map. The step included a discussion of which flows were found problematic and which were missing. During this step further problematic issues surfaced, and the organisation's representatives started to take a defencive stance. This led me to steer the discussion away from defending current practice by emphasising that this session should be treated as an opportunity to develop ideas for improvements—not for hiding or covering problems. This way the focus was directed towards addressing the question of why some members of the organisation experienced these problems, even if the SPI project's representatives did not acknowledge them. Here, the mapping technique showed its value, since it was possible to demonstrate that some parties might experience problems or conflicts, while others were not seeing them. A new colour was used to highlight the problematic areas, and they were denoted with a large exclamation mark. Finally, this step was also used to indicate on the map where new ideas and initiatives originated by marking these with a light bulb symbol.

The fourth step consisted of analysing the identified problems in order to understand their roots and causes. The map allowed the diagnosis of each problem and its particular context with respect to structure and process, which made it easier to identify which parts of the organisation were affected and should possibly be involved in the search for a solution.

The knowledge map resulting from the mapping session is reproduced in Figure 7.2 on page 181.

Even though the steps above are described as a linear process, the actual mapping was characterised by letting the discussion follow interesting topics, and thereby mapping larger organisational 'chunks' rather than finalising each step at a time. Thoughts were allowed to drift, and the discussion moved more iteratively from one topic to another; I also had the preliminary map to fall back to when the process needed to proceed. To allow for further analysis of the documentation of the map creation process, the last item of the agenda consisted of photographing the map on the whiteboard.

7.3 Outcome of the Analysis

The results of the analysis was the identification of problems concerning the sharing of knowledge and key information regarding development projects.

This knowledge was, according to the current process, presumed to be collected in formal project reports. However, the PMs responsible for creating the reports felt that these reports never reached the SPI project. As a consequence, the PMs spent less time providing this knowledge and information, thus making fewer experiences available. On the other hand, those responsible for analysing the reports in the SPI project felt that the reports offered very little of relevance, and therefore did not spend much time analysing them.

This constituted an incomplete learning cycle that limited the efficiency of the project evaluation process, and thus SSE's capability to learn from the projects' experiences. The recognition of this missing link led to the decision of investigating this process more thoroughly in the following research cycle.

Several other issues were identified, among the most relevant were:

- Top management continually fed the organisation with new ideas and suggested new initiatives; this could become problematic, especially in

Figure 7.2: The final knowledge map

situations where the organisation first needed to settle and evaluate an ongoing initiative before starting a new one. This situation bore the characteristics of a spring.

- The organisation's knowledge sharing tool constituted a black hole. It was mainly used by the employees to store experiences, but was hardly ever applied to search for help. This made it a 'write only' asset from which little or no knowledge was fed back to the organisation.
- One prominent person was a hub - he had several roles in different parts of the organisation, that is, the map showed that many flows led to him and many came from him. Again, while this did not have to be an immediate problem, it could cause severe difficulties, if this person should fall ill (the line 16-effect—refer to Section 6.2.7) or choose to leave the organisation.

These revelations resulted already at the meeting in the creation of a list of possible improvements among which the most important were the following:

- analysis and improvement of the existing project evaluation process,
- further analysis and improvement proposals for the common project's defined process (PDP-C),
- improvement of the communication between the development projects and the SPI project, and
- development of a project status report tool.

After discussing and prioritising all improvement opportunities the project evaluation process was chosen as most relevant for the organisation and for my research.

The knowledge mapping process led to an additional result: The participants were presented with viewpoints other than their own, and had to reflect upon these. This had an impact on the way they understand a given situation, and provided them with a broader conception of the organisation and its members.

Further, the first research cycle produced an example of the quality of my work. The knowledge map was a solid example of how I suggested and implemented a new organisational analysis techniques, which showed immediate and usable results. These results laid the ground for acceptance and approval of my work during the following research cycles.

7.4 Conclusion

In this chapter I described how I, in close collaboration with the employees of the company, identified possibilities for improvements. I introduced the concept of knowledge flows and developed and applied a knowledge mapping technique which visualised the relevant organisational units, individuals and artifacts, the knowledge flows between them, and the climate and context in which these flows took place. In this context, the concepts of springs, hubs, black holes, and missing links were helpful in structuring the (discussion of) knowledge flows. I used a range of qualitative data gathering methods throughout the 8 months of this cycle to inform the application of the mapping technique in the organisation.

The first research cycle generated the following results:

- It showed how the knowledge mapping was applied as a helpful means for understanding the complexity of the knowledge flows in a software development company. The technique produced valuable results when it was applied in SSE as it resulted in the identification and selection of the project evaluation concept as a prime candidate for improvement.

- The research cycle produced a case description of a new approach to analyse software development settings. It enabled the identification of potential knowledge related improvement areas. As such, the research contributes to the existing body of knowledge in the SPI field.

The technique does not rely on any specific SPI approach and does not prescribe or promote any specific improvement ideas. Instead, the suggested improvement areas are grounded in the actual settings. Introducing a knowledge oriented view upon the software development field, the research performed in this first cycle acts as a link between the software development field on one side and the KM field on the other. Thus, it provides a broader range of possible improvements in software companies.

Chapter 8

Designing a New Evaluation Concept

This chapter describes the second research cycle in which I focused on designing a new project evaluation concept in SSE. The design of the new concept is based on a thorough analysis of the existing project evaluation process in the organisation. The analysis shows that the existing process did not appropriately support the transfer of relevant knowledge from the projects to the SPI project, and as such, that the existing organisational tools for capturing and sharing knowledge did not efficiently contribute to SSE's knowledge sharing capabilities.

A design team, consisting of an employee from the SPI team and me, was established to propose a new evaluation process. The team's proposals were based on the analysis of the current process, and the cultural analysis of SSE (refer to Chapter 6). The team developed a range of improvement proposals and successively combined them into a new coherent evaluation concept for SSE.

The new concept introduced a significant shift towards implementing a situational knowledge organisation (refer to Section 2.3.2). The applicability of the new process was tested in two pilot studies.

The second research cycle of my project as described in this chapter lasted for approximately 8 months from November 2003 until June 2004. The research cycle relied on material which had been gathered in the first research cycle, on artifact analyses of the existing process material and tools, as well as on 8 semi-structured qualitative interviews with stakeholders from all levels in the organisation.

8.1 Analysis of the Existing Evaluation Process

The existing processes in SSE for collecting and distributing project experiences in SSE were based on a two-tier structure consisting of a milestone review (MR) and a project follow up (PFU) process.

The MR is conducted when a project reaches a milestone, and the more comprehensive PFU is conducted after a project's closure.

The purpose of the two processes is to collect relevant experiences to be shared both by the projects' members as well as the whole organisation. The SPI project should facilitate this sharing process. The findings of the knowledge mapping analysis presented in Chapter 7, however, suggested that the processes were not as efficient as intended and described in the BM. Therefore, I performed a further analysis of the process descriptions and their application in practice.

The feedback loop that was expected to secure the knowledge sharing was based on a formal flow of written reports—outputs from the MR and PFU processes. The SPI project was responsible for processing these reports and for disseminating relevant information and experiences to the whole organisation through updates of the BM.

In the following before I present the results of my analysis I first describe the existing MR and the PFU processes.

8.1.1 The Existing Milestone Review Process

The purpose of the MR process is to evaluate a project phase immediately after a project reaches a milestone. It is therefore performed several times

1. [Instructions]
2. General Information identifying the project and the evaluation period covered by this MR report
3. Lessons learnt and future business. This section is mainly intended for communication to the BUD
4. Risks. Collection of risk data from the Milestone Review period
5. Financial status. All data in this section must be obtained from the Project Controller
6. Process data. Collection of data related to the Projects defined process
7. Other information. Other important information, not captured in Section 3, which could be of interest for other projects in SSE

Figure 8.1: The table of contents of the milestone report

throughout a project. The existing MR process in SSE consists of several steps. The most important of these is a meeting in which all project members participate. This meeting is called by the project management, and every project member is asked to re-think the just concluded project phase: how it was conducted and what could be learnt from it. At the MR meeting the recently conducted project phase is 'walked through'. The format of this walk through is not formally defined, but the common way of doing it is by letting a meeting leader, often the PM, draw a vertical timeline on a white-board with all the important events from the project phase. While drawing this timeline the participants suggest more events that they find relevant, and often small discussions arise regarding which events are considered important, and in which order the events should be listed.

The purpose of conducting the walk through is to re-create the important events, and to refresh the memories of the participants. The walk through secures that the MR is concerned with the events that occurred during the past project phase. Previous and later events are excluded from the evaluation.

As a post mortem (Birk *et al.*, 2002) this approach focuses on examining what can be learnt from successes and failures from the concluded phase instead of trying to find scapegoats for the failures or heroes for the successes. Thus, discussions can be carried out in a open environment.

After the walk through, each of the participants is handed a number of yellow and red stickers to write down ‘good things’ and ‘bad things’ concerning the phase of the project. The stickers are placed on the whiteboard with the events to which they relate. Each participant places the stickers and comments on what is written and why it is written.

After all participants have presented their stickers, a general discussion is opened in which the identified experiences are grouped according to similarities. This grouping is conducted collaboratively but is facilitated by the meeting leader. The discussions during this phase of the MR are often lengthy, but they are considered relevant by the participants, as they address their diverse opinions and varying understanding of the discussed matters.

The discussions result in several groups of stickers each representing related topics which are given suitable titles.

The MR’s results fall into two categories: The explicit and formal reporting is contained in a written report, while the less formal outcomes consists of the face-to-face sharing of viewpoints and experiences. The sharing of experiences is an important purpose of the MR. The employees like the MR and appreciate it as an opportunity to ‘clean the air’ between project phases.

The formal reporting from the MR consists of an MR report. It is normally produced by the PM to provide other parts of the organisation with detailed information regarding the progress in the concluded project phase. This includes a resume of relevant issues and their effect on the course of the project flow. The layout of the report is depicted in Figure 8.1 on page 187.

Section 2 contains overall information concerning the size, goal, and similar general characteristics of the project that are useful for classifying the project (and its performance). Sections 4 and 5 consists of management reporting, key financial figures and identifying risks for the project. These sections are directed at the project’s BUD. Section 6 includes comments and changes to

1. [Instructions]
2. Introduction with project overview and executive summary of important key points
3. General information, identifies the project and the evaluation period covered by this PFU
4. Lessons learnt and future business. This section is mainly intended for communication to the BUD
5. Project data. Collection of various project specific data from the follow up period
6. Financial PFU. All data in this section can be obtained from the project controller
7. Process data. Collection of data related to the project's defined process
8. Other information. Other important information, not captured in Section 3, which could be of interest for other projects in SSE
9. Checklist. The checklist contains references to other resources that must be filled in when conducting the PFU

Figure 8.2: The table of contents of the project follow up report

the project's defined process (PDP) and therefore is intended for the SPI project, which in this way is informed about how the project adopted the process framework. This section is also of particular interest for the internal assessor of the business manual (BM). Sections 3 and 7 are intended for other parts of the organisation. These sections contain the experiences directly related to the practical conduction of the development project. These sections are often further processed by the SPI project, which is responsible for leveraging the outcomes of the MR process onto an organisational level.

8.1.2 The Existing Process Follow Up Process

The PFU is only conducted once after the project's closure. The PFU is an integral part of the formal process for closing projects, and the PFU constitutes an important part of the reporting from finished projects.

The PFU process results in the PFU report. The table of contents for this report is reproduced in Figure 8.2 on page 189. The conduction of the PFU normally involves the PM, the PQR, and other key personnel from the project, often the TLs.

The PFU meeting is conducted quite informally. The PM prepares an executive summary. It constitutes the agenda for providing further input for the PFU report, which is produced collaboratively during the meeting. The PFU does not necessarily include a meeting and in these cases the PFU is produced by the PM alone without involvement of other project members.

The previously produced MR reports are an important input for the PFU, but other relevant material informs the process as well; especially data from the task management system in which all tasks related to the project are recorded—including their planned and actual completion dates and the resources spent on each task.

8.1.3 The Processes in Use

The analysis of the existing evaluation process in SSE is based on extensive studies of the existing MR and PFU process descriptions, several MR and PFU reports, and the results from the second interview round. It comprises both the SPI project which extracts and uses the stored knowledge from the reports, and the viewpoints from the project participants', who use the reports to learn from the experience of other projects. The prevailing knowledge management strategy in the existing process is based on codification of knowledge in the BM. As such, the organisation acts as a exemplary knowledge organisation (refer to Section 2.3.2). In its digitalised form the BM allows the whole organisation access to the process descriptions. It provides guidelines for conducting project work in an effective manner. The

BM is based on the requirements from the CMM combined with the organisation's collective knowledge about good software development and project management practices.

The SPI project and the interview subjects judged the exisiting evaluation process as beneficial for the projects in which it was conducted. However, the reports were not considered an effective means to facilitate organisational knowledge sharing and to support the creation of common knowledge. The recipients of the reports regarded the quality of the description of experiences which were collected in the reports as low. As such, the reports were not seen as an effective means to transfer information regarding improvements of the development process to the SPI project.

The reports excluded too much context information to extract suitable contributions to a shared organisational knowledge base. For example, many lessons learnt were described as one line statements in the form of "Never do this, before that!" These statements were the results of a thorough analysis of a specific situation experienced in a project, and covered insightful information to avoid or repeat this situation. This rich context was, however, not available to the readers, and thus the specifics describing the rationale for the advice were missing. This pointed to a weakness in the existing processes. No education, techniques or basic help regarding the transfer of relevant and important lessons were included in these, and the report creators had to find out themselves how to explicate their experiences in a way considered useful for others.

Further, the recipients of the MR and PFU reports stated that other relevant information was not included. The templates for the reports did not clearly explicate who were supposed to read an analyse the reports. Thus the report creators had to rely on their own assumptions about for whom the reports were intended. As a consequence only few reports included what was required by their ultimate recipients.

Thus, important experiences and conclusions from the evaluations reached only the projects' own participants, and were not shared across projects.

The parts of the reports that relied on 'hard' data from the measurement system provided a quantitatively oriented summary of the projects' performance and, as such, constituted a means for an objective analysis of the projects' achievements. However, the projects differed in so many respects, that the quantitative data was of little use without contextual information from the projects. The evaluation processes did not specify how this contextual information should be collected and presented. Therefore, this information was not included on a regular or meaningful basis. The intended correlation between the quantitative and qualitative information in the reports thus was non-existing. This further reduced the value of the reports.

The low value of the reports, as stated by the users, resulted in a low incentive to invest an effort in creating them which further decreased the value of the reports—a vicious circle which was important to be addressed.

This said, the participants evaluated the project's own outcome of the evaluation processes as positive. The thoroughness of the MR process made it highly usable as an internal evaluation process for the projects. The MR process identified critical events, and because it was conducted in plenum, more than the project management's viewpoints were represented in the evaluation. This revealed information regarding how the project was experienced by its own participants. Further, the participants of the MRs experienced the MR process as an effective way of sharing knowledge among project members as many covert details from the project were uncovered in the discussions.

The conclusions of the analysis can be summarised as follows:

- the MR process was very meaningful and effective as an internal project evaluation tool,
- the purpose and recipients of the PFU report were not described in detail, which resulted in variations in quality and usefulness of the reports,
- the relevant context of quantitative data was missing, which made it difficult to analyse, and
- the character of the qualitative material in the reports varied and excluded relevant contextual information to be of useful for analysis.

Summing up, the MR process was considered an effective means to analyse and understand a project's achievements and, at the same time, collect and share meaningful lessons concerning the development process of SSE. However, the PFU process was not able to leverage these onto an organisational level, neither from development projects to the SPI project, nor from one project to another. The reports were used as management reports and not, as intended, as means for organisational learning.

8.2 Suggested Improvements

Based on the results of the analysis of the existing evaluation process I developed as a part of the design team a new concept for the evaluation process. This concept is grounded on the following principles:

- reuse of well established practices,
- a shift towards a situational knowledge organisation,
- inclusion of root cause analysis,
- involvement of the knowledge networks,
- a clear definition of actions and appointment of patrons for these, and
- a clearer visualisation of the lessons learnt.

The overall approach of a two-tier evaluation concept is not changed, it follows the CMM model recommendation to collect experiences when milestones are reached and at project closure. Before presenting the new evaluation concept in Section 8.3, I now explain the guiding principles in more detail.

8.2.1 Reusing Well Established Practices

The cultural analysis (refer to Chapter 6) has shown that if the users of a process did not understand its purpose they were less committed to use the process in practice. Therefore the design team retain the elements of the existing evaluation process which the analysis has shown to be valuable. To use a popular term, it is unnecessary to fix something which is not broken.

The PMs and project members stated that the MR process was a beneficial tool in the internal project evaluation. For this reason the basic layout, purpose, and scope of the MR was not changed. The PFU, however, was not considered as valuable, neither by the development projects nor by the SPI project, and therefore the design of the new PFU process was guided by the design of the MR process.

8.2.2 A Situational Knowledge Organisation

The existing evaluation process did not secure that the identified lessons were explicated in a way that made them understandable for the intended recipients. The analysis showed that in most cases, the relevant lessons learnt were hard, if not impossible, to transfer via the written reports. The dilemma was that if the necessary context for understanding the situation was included the descriptions of the lessons were comprehensive and, as such, required a large effort to document and later to analyse. On the other hand, if the description of the context was not included, it was hard, if not impossible, to analyse the lessons in order to re-create the necessary context. Thereby it was hard to understand the situation in which the lesson was learnt and to judge its importance. This suggests that the nature of the lessons learnt makes them hard to codify.

SSE has formalised its processes and tries to achieve a high level of reuse of organisational practices, internally in the projects, as well as between projects. This suggests that SSE would benefit from establishing an exemplary knowledge organisation. However, the analysis showed that the actual practice consisted of too many parameters to be easily codifiable. Therefore the design team suggested a shift to a more situational knowledge organisation (refer to 2.3.2).

The design team proposed that the knowledge which is created in the projects should directly be shared through the involved persons. The suggestion required an implementation of a personalisation based approach (Hansen *et al.*, 1999) in the project evaluations and that more project staff participates in the evaluation meetings, and further, that the reports would serve as connectors of people rather than carriers of knowledge.

The suggestion included that representatives from the SPI project participated in the evaluation process to directly involve the SPI project in the analysis of the lessons learnt. Finally, the layout of the report templates was changed to include the rich contexts from which the lessons derived to capture the detailed stories behind these lessons.

8.2.3 Root Cause Analysis

In the existing processes the identification of relevant events was facilitated by the timeline, the brainstorming, and the coloured stickers, but the BM did not provide any help for a further analysis of the available data. Therefore the projects and PMs were using their own, if any, techniques to identify lessons from the project work.

In one project the PM utilised root cause analysis (Birk *et al.*, 2002) as a tool to conduct a detailed examination of the experiences in the project. It enabled the project to construct a coherent representation of its actions and events. On this basis the PM and the project members were able to explain the lessons learnt—and to explicate them in a way that facilitated their sharing.

Root cause analysis (Birk *et al.*, 2002) is a technique which can help identify the deeper causes of an experienced event. The technique successively asks the question: “What caused this event?” Eventually, when causes cannot be further detailed, the deepest—the root—causes are identified, and a chain of causes explains the event.

In the project the root cause technique was applied in the following way:

- the evaluation’s participants were divided into smaller groups of 3-5 people. Each group focused on identifying the causes of the event to be evaluated,

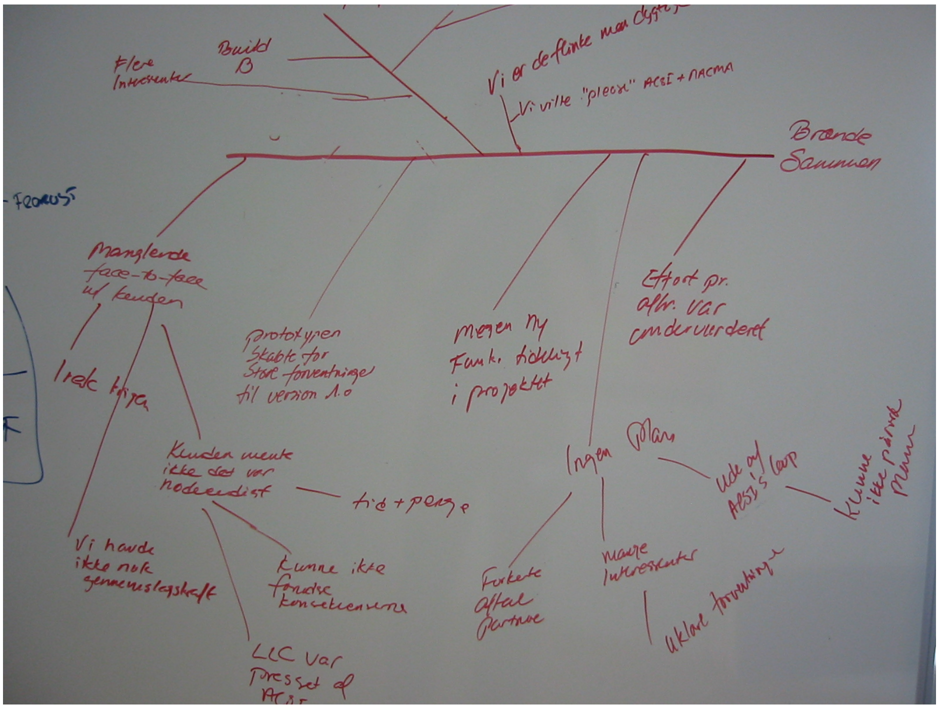

Figure 8.3: Root cause analysis (fish-bone diagram)

- then the groups presented their results to each other. A meeting leader facilitated the presentations in a coherent representation using a fish-bone diagram (see below), and
- the process was documented by photographing the fish-bone diagram.

The fish-bone diagram (Tiedeman, 1990; Birk *et al.*, 2002) is a visual technique which supports the root cause analysis. It visualises the topics of the analysis and in this way facilitates collaborative evaluations. The event that is investigated is written on a whiteboard and a vertical line is drawn. For each answer to the "What caused this event?"-question a new line is added which connects the answer with the vertical line. For each of these lines—or rather the answers they represent—new lines are added, until the root causes are identified. This results in a diagram which resembles a fish-skeleton. In Figure 8.3 on page 196, the output from a root cause analysis is reproduced.

The design team found that root cause analysis fitted well with the existing approach of the MR process, as it facilitated the transformation of the events or group of events into explicable explanations. The technique makes it possible to analyse the topic in-depth, and to facilitate a coherent and common understanding of this topic among the participants.

The PM who had described the root cause analysis in his project was invited to participate in the team, and his work was directly incorporated into the new evaluation concept.

The root cause inspired approach was suggested for the new PFU concept. We, however, proposed that not all project members participated in an root cause analysis. As many as 50 people participate in the largest projects, and we felt that these were too many for a feasible timeline, brainstorming, and root cause analysis. Instead, we limited, participation to the project management and key personnel appointed by project management.

8.2.4 Involve the Knowledge Networks

Knowledge networks (KN) were introduced into SSE i late 2003. Pries-Heje *et al.* (2008) describe the introduction of these KNs in great detail. In the context here it is important that these networks are formalised experts' fora, which each focus on a specific subset of the software engineering disciplines represented in SSE's process framework. The KNs covers the following 7 areas; programme management, development, test, release management, user experience, product management, and the SPI project. The KNs' primary task is to make their knowledge and insights available for the organisation both by contributing to the BM, but also by qualifying, training and educating the staff within their respective professional fields.

The KNs represents communities of practice (Wenger, 1998). Employees participate in activities in the KNs which correspond to their field of work. E.g. a test manager from a project participates in the test KN. The activities in the KNs are not formally defined, but the networks are responsible for developing the employees' knowledge related to the area of the network. E.g.

the test network initiates activities which consolidate and develop the test capabilities of the employees and thus of the organisation.

Further, the KNs act as knowledge sharing fora in which the current practices of the organisation are discussed and improvements suggested. The KNs are supposed to become responsible for the maintenance of the process framework relating to their field.

The management of SSE appoints a knowledge leader (KL) or coordinator in each KN. The KLs are top specialists of the organisation and the KLs use approximately 10% of their working time on KN related work. This shows that management fully recognises the KNs importance for the organisation.

The design team utilises the KNs in the new evaluation concept as they retrieve knowledge related to the different expertise field and they are the formal 'storage bins' (Walsh & Ungson, 1991) for the organisation's practical experience. Assigning an active role in the project evaluations to the KNs will result in that the expert knowledge they possess will produce more precise explanations of the project events. In this way, the KNs will act as consultants to interpret the various experiences, thus supporting the leverage of the lessons learnt.

Further, including the KNs into the evaluation process will facilitate the organisational diffusion of these networks into the organisational practise. At the time of the analysis the various KNs were performing quite differently; some had already established themselves as organisational units and had created many activities for their members, whereas others had not even conducted an initial meeting. By defining a task of active interaction with the projects, the design team provided the KNs with an important raison d'etre.

8.2.5 Actions and Patrons

The analysis showed that many recommendations from projects never result in any changes to the organisational practice The recommendations are written down in the MR and PFU reports, and the SPI goes through these reports to look for improvement candidates. However often these recommendations are never carried further than to the written reports and thus have no impact outside the project from where they origin. This is due to the fact that no person or team was appointed to refine the recommendations into applicable solutions.

As the high work load of the organisation results in any task without a specific owner risks being left undone, to reduce the risk of failing to complete tasks a common approach to task handling in SSE's process framework is to appoint a responsible person or team to any task. To handle these appointments, SSE has a widely accepted tool, the task management system (refer to Section 3.2.1). In this tool all formally defined tasks are entered and their progress measured and managed.

The design team suggests that in the new evaluation concept a specific task patron is assigned to improvement proposals which have been identified and selected for further action and that the task management system is utilised in order to record the specific task patron for any improvement proposals. When the proposals are converted into tasks they are no longer left without an appointed person responsible. The new concept therefore implement an action list, which clearly states the required action, who is responsible for it, and when the task has to be completed or reacted upon.

Identifying a patron and assigning the responsibilities for the lessons learnt are improvements compared to the existing evaluation process. They proactively place the responsibility of identified improvements to a specific person or organisational unit and the SPI project is in charge of the follow up of tasks registered in the task management system. Most of the tasks will be assigned to the SPI project, and as it is the primary recipient of improvement ideas the SPI project will request their resolutions.

8.2.6 Visibility

Finally, the design team suggests that the projects' closures are made more visible to the rest of the organisation. To inform other members of the organisation about a project's closure and its achievements strengthen the sharing of knowledge across projects and signals organisational progress. The suggestion involves the PFU process to include a project summary which states the original goals, achievements, and other relevant or remarkable information about the project. It is proposed that this summary is broadcasted to the rest of the organisation on the SSE Intranet which features a virtual bill board onto which messages, notices, &c., of interest to all employees are published.

8.3 The New Evaluation Concept

The suggestions described in the preceding section resulted in a new set of descriptions for the two evaluation processes. The new concept includes, as the existing process did, a two-tier structure which consists of several MRs and one final PFU. Root cause analysis is introduced as a technique to translate individual experiences into coherent and understandable sets of lessons learnt. Our analysis showed that the projects assessed the existing MR process to fit its purpose well, thus the overall layout of this process is not changed. The only major change is the introduction of the root cause analysis as a new step, which is supposed to follow the conceptualisation and grouping of the experienced events (refer to Figure 8.1 on page 187). Therefore the remainder of this section focuses on the new PFU concept.

Our analysis has shown that the existing PFU process would benefit significantly from a change. The design team therefore suggests several improvements to this process. The new PFU concept comprises two post mortem analyses (PMA) conducted in two separate meetings which are with separate participants and different objectives. One post mortem is performed internally in the project, the other with external experts. The new PFU concept facilitates a shift towards a situational knowledge organisation (refer to Section 2.3.2). The shift is primarily based on the SPI project's and the KNs' active and direct participation in the projects' evaluations. This means that the organisation will have to rely less on written documents and more on face-to-face communication. The overall layout of the new concept which the design team incrementally developed during the research cycle is represented in Figure 8.4 on page 201. The initial draft is represented in Figure 5.2 on page 115.

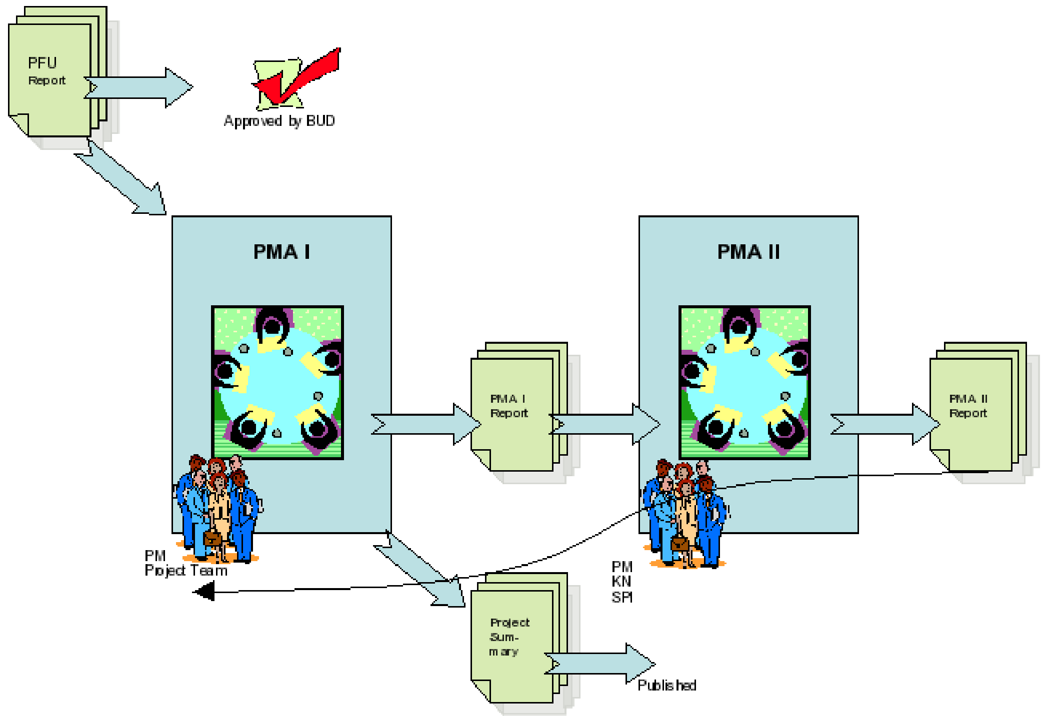

Figure 8.4: The final draft of the new PFU process

During the process of developing the new evaluation concept, the design team cooperated with other parts of the organisation to reduce the work load, as well as to utilise the organisation's expertise. An example for this approach is the reuse of the description of the root cause analysis which had originally been created by a PM.

8.3.1 Internal Post Mortem

The first part of the new PFU concept is the internal post mortem (PMA I). The focus of the PMA I is the project's internal debriefing. The PMA I is extending on the well performing parts of the MR process—the brainstorm and the time-line techniques. The scope, however, is changed to comprise the whole project's life span.

The purpose of the internal post mortem meeting is to create a common understanding among the project's participants as to what was achieved during the project, and how it was achieved and to provide an opportunity to discuss critical matters in a safe environment. Understanding the experienced problems enhances each participant's knowledge concerning development projects in SSE. It extends their experience base and thus their repertoire of future behaviour.

As a starting point the preliminary PFU report is produced by the PM on the basis of her/his thorough analysis of the project's events, objectives, goals, registered resource consumption, general performance, &c. All information is registered from the PM's viewpoint. To broaden the scope of this information the PMA I is conducted in a 2-4 hour long meeting, in which key personnel from the project de-brief the project by following the agenda from the MR process. The participants are selected by the PM. The PMA I is called with at least a week's notice to allow the participants to prepare themselves. The participants' preparation is crucial for the results as the PAM I covers a long time span.

The timeline of the whole project is reconstructed following the agenda of the MR process. The timeline, the brainstorming, and the coloured stickers analysis are applied to provide more and possibly different viewpoints regarding the perception of the success of the activities during the project. The 'good things' and 'bad things' stickers are placed onto the timeline, and their meaning and impact are discussed individually. When all participants have contributed their viewpoints, the stickers are grouped into coherent categories, each depicting an important issue regarding the course of the project. The issues are prioritised, and the most important two or three topics are further analysed applying the root cause analysis technique. The results from the analyses are recorded in the PMA I report. The template for this report is depicted in Figure 8.5 on page 203. The PMA I report is a final project report. It captures the output and details of the discussions during the meeting in a form which is usable for later retrieval and which is understandable for staff who has not participated in the project.

Based on the findings from the discussions, a project summary is created and published onto the organisation's Intranet in order to provide colleagues with an overview of the project's achievements.

PMA I Report Template

Project name:	
Project number:	
Date of PMA I:	
Participants:	

Roles

PMAI leader	
For the minutes	

Timeline

(Photograph of time-line of project – supplement with list of major events from POF Report)
[…]

Experiences

(Include commented photograph of list of experiences – remember that the items should be understandable for employees from outside the project)
[…]

Root Cause "Diagram"

(Include commented photograph of list of experiences – remember that the items should be understandable for employees from outside the project)
[…]

Lessons learned

(Knowledge Network, Topic, Causes, Actions/Recommendations, contact person(s)) – Commented photo - remember that the items should be understandable for employees from outside the project)

KN	Lesson Learned (Topic, Causes)	Actions/Recommendations	Contact person(s)
			…

Figure 8.5: PMA I report template

8.3.2 External Post Mortem

The second part of the new PFU process also consists of a post mortem analysis (PMA II). Its focus is on capturing recommendations which are relevant for the whole organisation based on the project's experiences. To achieve this the group of participants is extended to include representatives from the KNs and from the SPI project. The representatives are experts from each of their respective fields and participate to obtain as much information regarding their fields as possible from the just concluded project.

The PMA I report acts as an agenda for the PMA II. It is in advance forwarded to all the participants to give them an initial overview of the topics that were discussed during the PMA I. The participants prepare themselves which areas they want to examine in detail on the basis of their interpretations of the PMA I report.

The meeting is planned as an informed discussion. The PM acts as meeting leader. The PM describes the project's overall progression and introduces the timeline and the PMA I report. After the walk through of the project's events the meeting continues with a discussion of relevant topics which are defined by the representatives from the KNs. The topics are directly related to clarifications regarding the just concluded project's work, or to ongoing projects in the KNs in which 'practice' observations are needed. The PMA II facilitates that experts from the various fields analyse and evaluate a common subject. This results in relevant discussions and establishes links between the KNs.

The output from the meeting is an agreed list of actions—including task patrons—which represents the experts' improvement recommendations. The accompanying report template supporting this recording is an amendment of the PMA I report. It is reproduced in Figure 8.6 on page 206.

The establishment of a formally defined means of communication between the KNs and the projects is important in itself as the KN representatives report the findings to their respective KNs. In case a KN has been assigned a patron role it can then decide which actions are further required to develop a recommendation for the whole organisation.

After the PMA II the PM composes a summary of the findings. This summary is presented to the project's original participants so they are informed about which recommendations their project contributed with. This feedback is a crucial part of the new concept, as it proves how the evaluation leads to change. It shows that the employees contribute and participate in the evaluations and that their opinions are actually used in the future planning regarding the organisational practice. It supplements other sources of feedback e.g. the employees' direct involvement in the KNs where they also participate in the further analysis and improvement work regarding their 'own' project and practice experiences.

8.4 Pilot Studies

To test the new concept, two pilot studies of the new processes were conducted. The pilot studies implemented an actual MR and a PFU. The opportunity to test the concepts under real work conditions provides, as discussed in Section 4.4.4, valuable feedback concerning the concept's applicability. In the following section the two pilot studies are described.

8.4.1 First Pilot Study, the Milestone Review

In the first pilot study the new MR process was conducted in a project team which had just delivered a major part of a large IT system. The project manager in this project was the patron of the root cause analysis technique. He had participated actively in the specification of the new evaluation process and required no special introduction, as he was familiar with the concept's layout, scope and purpose.

The first pilot lasted approximately 3 hours. All the members from the project team were present, and in total 14 people participated. The design team of the evaluation concept was present as passive observers to record and facilitate the meeting.

PMA II Report Template

Date of PMA II:	
Participants and affiliation:	

List of actions and responsibility

#	Action	Responsibility (e.g. KN name)	Time frame (e.g. Q1)
			...

Figure 8.6: PMA II report template

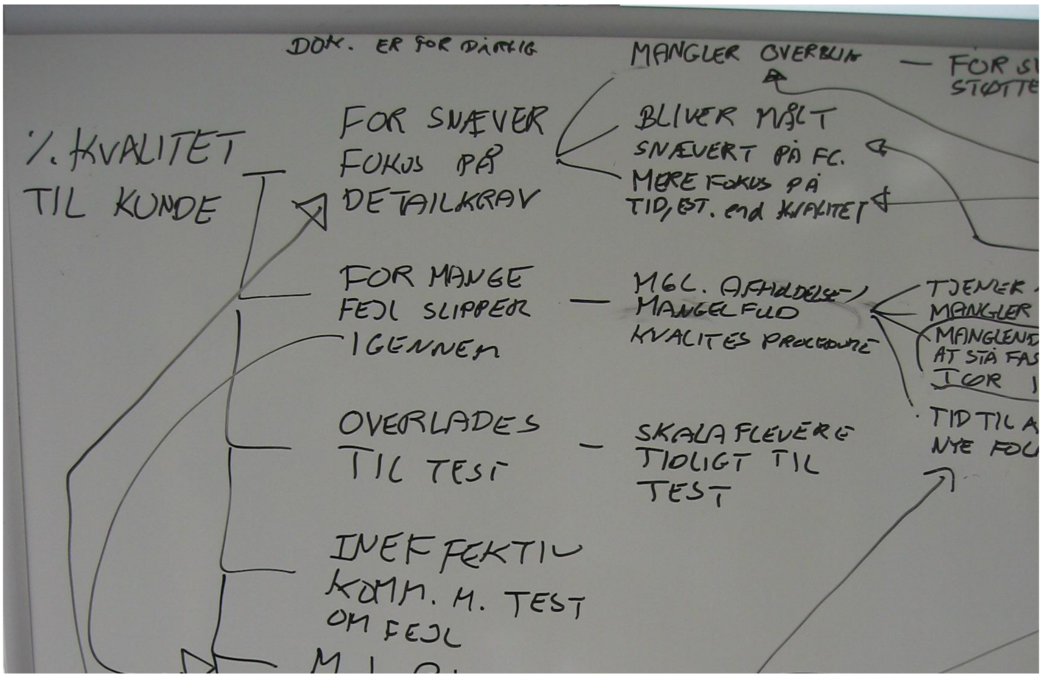

Figure 8.7: Excerpt from a root cause analysis, first pilot study

The PM acted as meeting leader and had in advance prepared a timeline diagram and an introductory presentation of the recently concluded project phase. The participants were used to conduct the MR process and no questions regarding the process were asked, neither during the reconstruction of the timeline and project events nor during the brainstorm and grouping phase.

Based on the PM's presentation a list of discussion topics was generated. This list was prioritised as to which topics were considered most important to be analysed further. This prioritisation was a difficult task, since the different participants had different viewpoints regarding the importance of each of the topics. The participants, not surprisingly, scored the topics that related to their own daily work highest. Eventually the group agreed that the topics that the organisation as a whole would benefit from were to be analysed. Based on this prioritisation scheme, the list was more easily sorted and two topics were selected to be further analysed with root cause analysis.

After a brief introduction from the PM the participants had no problems applying the root cause analysis technique and the analysis quickly progressed. All participants collaborated actively in composing the diagrams. The following de-briefing showed that all participants had learnt something new, especially concerning the working conditions and daily practice of other participants. Several ideas and good practices were shared during the discussions. The fish-bone diagram from one of these analyses is presented in Figure 8.7 on page 207.

The meeting was formally closed with a conclusive discussion about what had been learnt during the project phase, and which direct actions, based on the outcome of the analysis, needed to be taken into account in the project's future phases. This discussion was difficult for the participants to conduct, because the details of the next phases were not yet known.

After the meeting the observers conducted a debriefing with all the participants. The conclusion was that all members had learnt at least one new thing regarding their work and their project. The root cause analysis was seen as an improvement of the existing evaluation process as it provided the possibility of digging deeper into and identifying possible causes for experienced problems. This allowed the participants to directly improve future project phases.

8.4.2 Second Pilot Study, the Project Follow Up

The second pilot study tested the new two-tier structure of the PFU process. The two PMA meetings were conducted in a project, which recently had concluded a large sub-delivery. The project had consisted of several teams and had lasted for more than 2 years.

The design team conducted a preliminary meeting with the project's PM to brief him about the new layout of the concept and to plan the practicalities of the PFU meetings as well as to allow him to prepare the PMA I.

The PM invited team leaders (TL) and the quality responsible (PQR), in all 8 persons from the project to the PMA I. The design team participated as observers and facilitators. The PMA I lasted for approximately 3 hours.

The observers introduced the meeting briefly by explaining the rationale for the new project evaluation concept. Thereafter the PM was in charge of the meeting. He presented his analysis and introduced the project results to the other participants in his statement. The project timeline was presented and on this basis the participants performed the brainstorming and applied the coloured stickers technique. The diagram from these activities is presented in the excerpt in Figure 8.8 on page 210.

The techniques were well known to the participants. The pilot study confirmed that analysing a long time span did not present problems for the applicability of the techniques.

Several topics of interest were identified and compared to the first pilot study prioritised without any problems. As the participants in this PFU meeting all were managers, the viewpoints expressed during the brainstorming were all oriented towards the task of managing the project.

Initially the participants did not understand the rationale for the root cause analysis. However, when the PM had described and demonstrated the practical application of the technique, the participants understood its purpose and actively collaborated in subsequent work. The discussion provided a deeper understanding of the project and its many facets. The example in Figure 8.3 on page 196 is taken from one of the root cause analyses of the second pilot study.

The PMA I concluded with a discussion of possible proposals for improvements. During the debriefing the participants expressed that the new concept was promising, but also time consuming. Two topics were analysed during the meeting, and according to the participants it would have been possible to analyse more topics if fewer people had participated.

The PMA II was scheduled a week after the PMA I. All KNs were invited to participate and all but one accepted the invitation. The PM and five KN representatives eventually participated in the PMA II. I acted as observer, and the SPI project representative from the design team represented the SPI project.

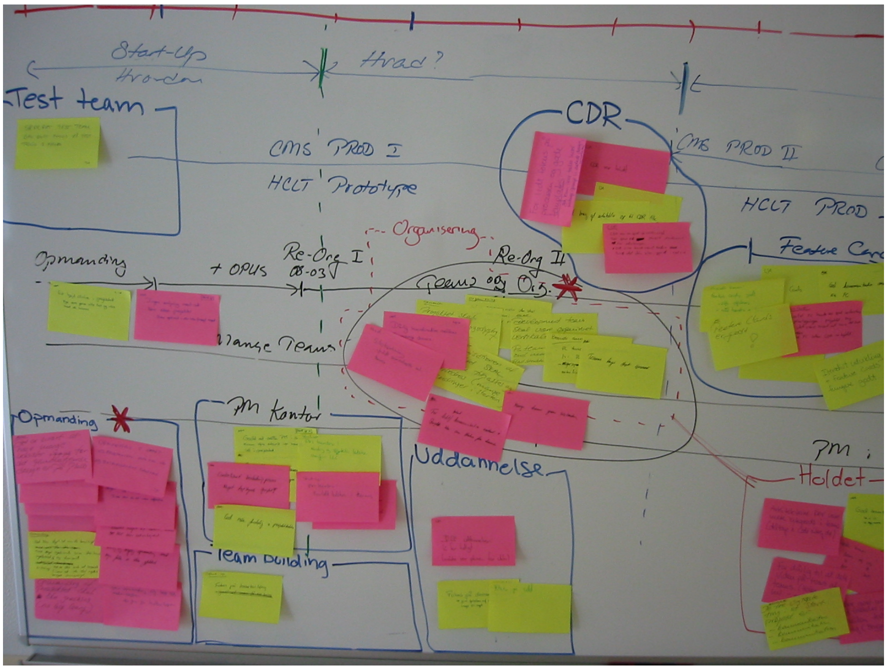

Figure 8.8: Example of timeline and grouping of coloured stickers, second pilot study

The PM presented the results from the PMA I. After this presentation the floor was open for discussion. The KN representatives asked clarification questions and provided explanations of their own understanding of the project experiences, which they had prepared on the basis of the PMA I report.

The pilot clearly showed that meetings in which practice was discussed were in demand. This was also expressed by the KN representatives in the concluding debriefing. There was too little time to direct the discussions towards practical actions and to produce a list of actions. Instead, each of the participants made his own notes to feed the results back to their KN. This was not in line with the new evaluation concept as it did not provide a joint document which would be traceable through the task management system.

The KN representatives concluded that more meetings to discuss practice were needed and in addition recommended that the agenda for the meeting should include a questioning round to enable each participant to ask questions if needed. Overall, however, the participants agreed that the new concept was a successful means of providing empirical data and transferring practice experiences from projects to KNs.

8.5 Conclusion

In the second research cycle I conducted an analysis of the existing project evaluation process. This analysis was based on semi structured interviews as well as on artifact studies of the material for the exisiting process; process descriptions, guide lines, and summaries. Based on the results of the analysis a new concept was designed and tested in two successive pilot studies. The design process was further informed by the results from the cultural analysis.

The interviews conducted as part of the analysis of the existing evaluation process, showed that the employees did not find that it was possible to codify highly specialised knowledge. Too much of the relevant context was excluded and the result was not de-codifiable by others. Therefore the design team suggested a new concept based on a shift towards a situational knowledge organisation.

The new evaluation concept relies on direct communication between people. The employees meet face-to-face and share experiences. In this way important knowledge is captured, shared, and stored up in the organisation's individuals. In summary, the following suggestions were introduced:

- a shift towards a situational knowledge organisation,
- reuse of well established practices,
- inclusion of root cause analysis,
- involvement of the knowledge networks,
- a clear definition of actions and appointment of patrons for these, and
- a clear and visible manifestation of the lessons learnt.

The proposed shift is in line with Hansen *et al.* (1999) who suggest a personalisation strategy for organisations which produces a highly specialised product as is the case with SSE.

The new evaluation concept was tested in pilot studies with representatives from the newly established KNs. The experiences from these tests showed that both individual projects and members of the KNs found that the new concept improved identification and sharing of relevant knowledge between projects and the organisation as a whole. The KN members found it meaningful to gain new insights in their specific areas of competence and interest by accessing and discussing empirical data. At the same time, the ability to ask about relevant context increased the usefulness of the outcome since the relevant stakeholders were present and thus are could provide details if needed—they did not solely rely on written reporting as with the existing process. This reduces the risks of superstitious learning and similar misinterpretations (Hedberg, 1981).

The pilot studies of the new concept showed that the ability to transfer practice related knowledge from projects to other parts of the organisation is possible when it is based on collaboration between relevant personnel.

In conclusion, the new concept was considered efficient and applicable and as an important step towards a new improved evaluation practice in the organisation.

Chapter 9

From Concept to Final Process

This chapter describes how I refined the evaluation concept into a deployable process for conducting project evaluations in the organisation. I present how I tailored the concept described in Chapter 8 into practical work constructs: documents, procedures, &c. The tailoring was based on an extensive study of the pre-requisites of the formal process framework of SSE and further informed by the previously conducted interviews and the cultural analysis. Further, I show how I conducted two formal quality reviews to verify the new process's applicability. The third research cycle, in which this took place, was conducted from June 2004 until July 2005.

9.1 Redesigning the Evaluation Concept

The goal of the third research cycle was to facilitate and implement the evaluation concept which was designed during the second research cycle (refer to Chapter 8) into workable practice in SSE. The main tasks were to: *A*) create a coherent process based on the approved improvement suggestions, *B*) balance the concept with existing procedures, and *C*) produce formalised descriptions and materials to fit the concept to the SSE jargon.

This work was conducted as a collaborative effort in a development team consisting of an employee from the SPI project and myself. During the

Spring of 2005 a co-researcher joined the team and helped finalise the process. The collaboration was based both on meetings as well as on remote work coordinated via e-mail and instant messaging.

The development team conducted the work based on the following input:

- studies of the texts available from the exisiting version of the process framework,
- the requirements described in the BM,
- collaboration with the process framework experts from the SPI project, and
- the results from the previously conducted research cycles

The team initiated the design process with an analysis of the requirements for SSE's process framework. The analysis revealed which descriptions were necessary and the level of detail of each of these descriptions. The process descriptions in SSE exist on three levels, each with its own granularity of specification (refer to Figure 3.4 on page 73). The business manual (BM) is on the highest level and it it has the lowest level of details. The project's defined process (PDP) and the PDP common (PDP-C) are more practice oriented, and include more details.

In this phase the design team adjusted and refined the concept which the previous research cycle had produced. The team formalised the earlier developed descriptions into a coherent and applicable version. The defined process had to be self-supporting and self-explanatory, i.e., it had to be implementable in the projects with little training and support.

Originally I intended to participate in the deployment of the new process in the organisation. However, circumstances (refer to Section 5.5.1) made this approach impossible and, instead the original goal was adjusted to have the new process approved and ready for deployment. The actual deployment would follow after my research concluded.

The major part of the research was conducted in the spring of 2005 and was based on several small iterations. Several successive versions of the evaluation process were designed and discussed among the team members. The final approval of the concept was then achieved through formal quality reviews (refer to Section 9.2).

Based on the analysis of the SSE process framework the design team introduced the following design criteria for the new evaluation process:

- compliance with the existing process framework,
- conformity with the existing SSE jargon,
- internal consistency,
- introduction of opponents,
- introduction of meeting facilitators, and
- reporting as managerial tool.

In the next section these criteria are explained in details. The evaluation process in its final version is presented in Section 9.3.

9.1.1 Compliance with Existing Process Framework

The final version of the process provides detailed descriptions on each of the three levels of the process framework. The process is documented in Appendix E. This appendix contains detailed process and procedure descriptions for the milestone review (MR) process. The process documentation of the MR also includes representative samples from the complete portfolio of documents.

The final process is designed to be in full compliance with the latest version of the BM (version 4.2). Therefore, the documentation consists of templates, procedure descriptions, and process descriptions. It includes high level descriptions for the BM (refer to Appendix E.1), high detailed procedure descriptions for both the MR and the PFU processes (refer to Appendix E.2). These descriptions are all parts of the PDP-C (refer to Figure 3.4 on page 73), and are guidelines which are used in the projects, primarily by the PMs.

The procedure descriptions are used in practice to guide the conduction of the processes and, as such, supplement the training material concerning the MR and PFUs.

Finally, the processes descriptions are supplemented with a set of report templates (refer to Appendix E.3). These templates (or assets—SSE jargon) are part of the PDP-C as a supplement for the process and provide a pre-configured report which matches the reporting requirements.

9.1.2 Conformity with Existing SSE jargon

The cultural analysis showed that SSE has a special professional jargon (refer to Section 6.5.3). To make the adaption of the new process easy the design team described it in a jargon that conforms with the language used in the existing documents. By using known terms and notions the process descriptions are more precise. Due to his knowledge of the company and its jargon the SPI project member in the PFU team was mainly responsible for this work. The quality reviews of the process descriptions (refer to Section 9.2) led to further adjustments.

9.1.3 Internal Consistency

The cultural analysis also showed that SSE is a professional organisation. The PMs are busy managing their projects and they expect the process material to be ready to use. Internal consistency is also required by the CMM model. Therefore it was important that the process material was produced professionally. Already before the quality reviews the descriptions were carefully assessed with regard to their internal consistency and coherence. The same concepts and terms are used throughout all documents and sub-procedure numbering, content, and order are consistent in the different parts of the process descriptions.

9.1.4 Introduction of Opponents

To underline that the purpose of the PFU process is to extract useful organisational knowledge the participants in the PFU who have not taken part in the project under evaluation are called 'opponents' in the new process. With the rationale that opponents constructively evaluate the project with regard to their own expertise. The term 'opponent' stresses the evaluational role of the representatives from the KNs. Meeting some opponents also emphasises that the PM's preparation is thorough and detailed. In SSE's professional environment the PM will not risk to present 'sloppy' material in front of a committee of experts from the KNs. The process bears much resemblance with the review process from scientific defences of research. All participants are professional and also highly skilled within their respective fields. For this reason the PFU process documentation does not prescribe a specific approach to the opposition of the PM and the project team. This allows the participants to follow their own agenda for 'opposing'. However, the root cause analysis is recommended to use as an outset for the discussions.

9.1.5 Introduction of a Meeting Facilitator

It is important that the PFU is conducted as a means to feed the KNs' experts with relevant information regarding the project's achievements, good as well as bad. To facilitate the adoption of the new PFU the process makes special use of SPI representatives who participate in the PFU. The representatives act as meeting facilitators who help the participants, the PM and the opponents, to conduct the project defence, e.g., by suggesting relevant defence techniques. This focuses the meeting agenda on knowledge creation instead of looking for scape goats.

9.1.6 Reporting as Managerial Tool

The new process underlines that reporting is a significant management tool as the information that is recorded in the PFU reports is difficult if not impossible to collect a long time after project closure. The process of creating the report forces the PM to re-think the project's course, and thus the report creation is an important tool for re-creating the events that happened during the project. The BUDs and thus the management require written project reports, as they evaluate the projects performance on the basis of the financial figures contained in these reports. The hard facts in the PFU reports are also important for the KNs later work. Furthermore, the ritual of formally approving a written report as the final act in a project's life is important. The BUD's signatures on the PFU report is the proper way of terminating a project.

The PFU report template has not been changed, but has been supplemented with sections describing the responsibilities and actions which resulted from the PFU meeting.

9.2 Quality Reviews

The new evaluation process was assessed in the organisation during two quality reviews: one external and one internal, conducted in May and July 2005 (for details refer to Section 5.5.4).

The two reviews were conducted to find errors and misalignments in the reviewed process. The two reviews had identical agendas, but different participants. The external review was conducted by two researchers, a SPI representative and an external expert, the PM from the SPI project. The internal review was conducted by a SPI project representative and myself. During the review meetings the relevant documents were carefully investigated and walked through as if they were used in an actual project (refer to Section 4.4.5).

9.2.1 External Quality Review

The purpose of the external review was to introduce the documentation of the process to someone outside the design team. This made it possible to test whether the descriptions and used terms were understandable for the

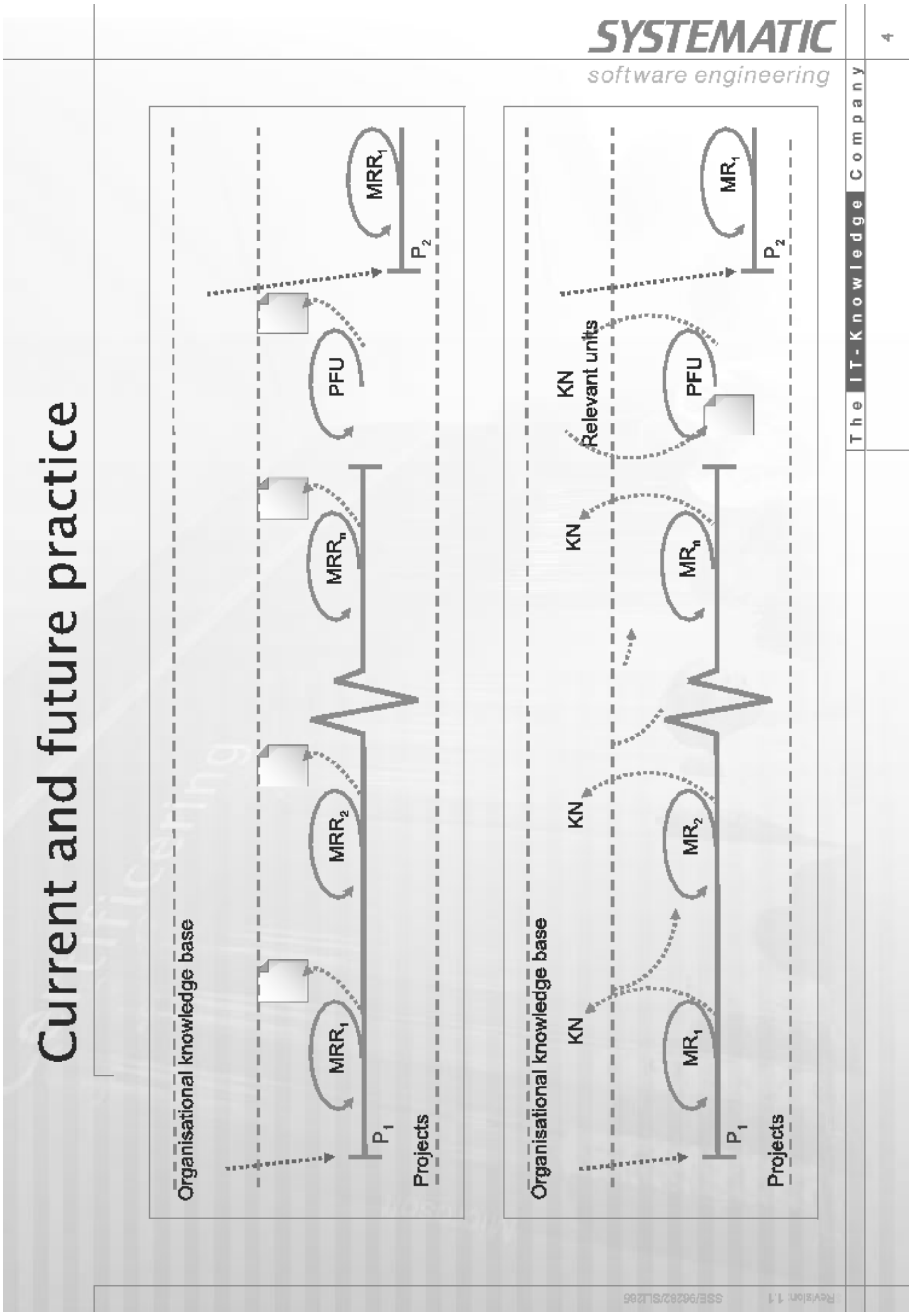

Figure 9.1: Differences in layout of the old and new project evaluation process

employees. The concept's completeness was tested during this review. The external participant was an experienced reviewer and an experienced process designer from the organisation.

The review lasted approximately 2 hours, and immediately afterwards the design team de-briefed the review and planned the future actions to handle the suggested improvements.

The review revealed that the process descriptions needed to be reformulated. The external reviewer argued that the procedure descriptions were too generic and that they did not fully cover the needs of the participants.

Based on his practical expertise and knowledge of the process the external reviewer suggested alternative terms to be used in the descriptions.

Based on the outcome of the external review the design team revised the evaluation process during one more iteration before the internal review was conducted.

9.2.2 Internal Quality Review

The internal quality review was conducted as the last test of the process before it was submitted to the SPI project to be approved and implemented into the coming version of the BM.

The review participants carefully walked through each step of the process to assert consistency and coherence. As the process documentation was kept electronically corrections were made directly in the documents. Thus, when the review concluded, the corrections were incorporated in the final process.

9.3 The Final Process Proposal

In the final proposal for the project evaluation the main flow of evaluation activities for a project is unchanged, but the activities themselves are changed. As can be seen from Figure 9.1 on page 219 the MRs occur frequently during a project, either when an internal milestone occurs, or when a pre-determined

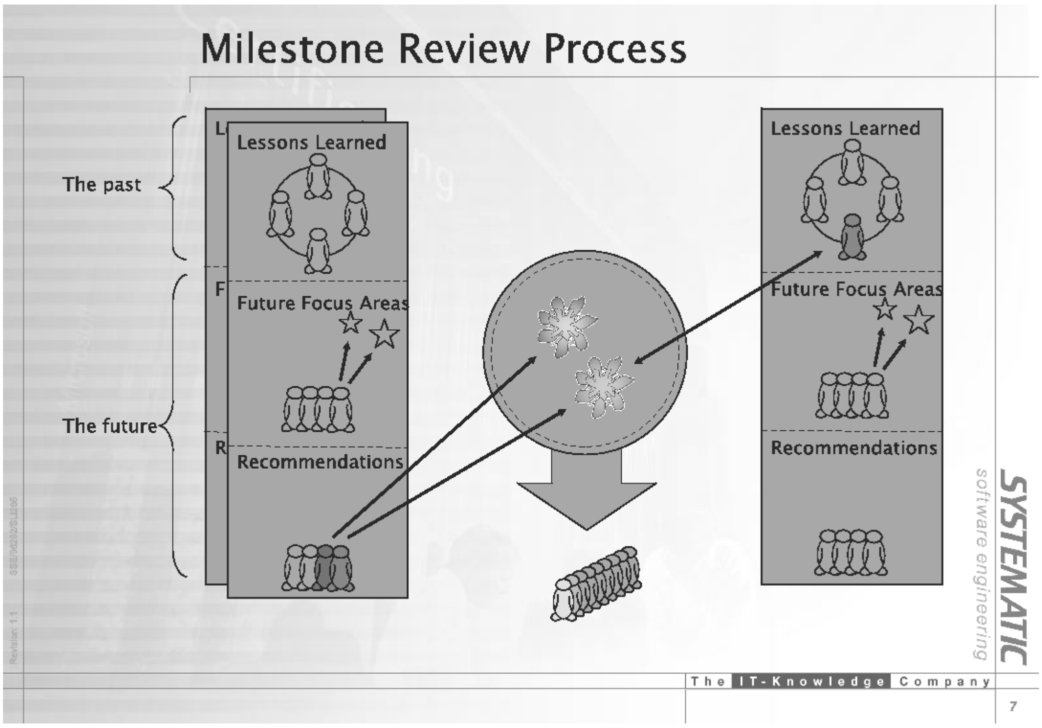

Figure 9.2: Overview of the new MR process

period has passed. The PFU closes a project and is only conducted once in a project's life time. The PFU constitutes the formal closure of a project. In the following a detailed description of the new MR and PFU processes is presented. The new evaluation process was subsequently approved by the SPI project for inclusion in the next version of the BM and thus for organisational roll-out.

9.3.1 The Final Milestone Review Process

The new MR process, which is illustrated in Figure 9.2 on page 221, implements a meeting which all project members attend. The meeting is divided into several parts with different focus areas. First, the project's participants evaluate the just concluded project phase. Second, the participants point out areas to be improved during future project periods. Third, the MR participants select recommendations that are beneficial for other projects. Eleven formal steps constitute a full MR which is conducted within three hours. The time constraint is important. It is easier to allocate a time slot of three hours in which all project members are able to participate, as it fits well as a 'before noon' meeting, which is a well established practice in SSE.

The 11 steps are:

1. Prepare Milestone Review The PM or the PQR prepare the MR. The preparation consists of practicalities, such as, calling the MR meeting, booking a room, and preparing a project status presentation. The project presentation includes a timeline, a re-construction of the latest project period and examines the activities and achievements of that period.

2. Present Project Status This is the first part of the MR meeting. The PQR (or PM) presents the timeline to the participants. The timeline is drawn on a whiteboard. This exercise establishes a common ground of the subject areas for the MR meeting. It is important since the MRs often are conducted a little after a project has reached a milestone and, thus, the employees work with new areas or even in other projects. The status presentation secures that the scope of the MR is agreed upon by all participants and allows them to focus on the events which occurred in that specific period. The presentation is open for discussion and events or activities that are not on the time line can be added.

3. Feedback from and Follow Up on actions The purpose of this step is to feed back the status of the project's previous organisational recommendations (refer to step 7). Every recommendation has an appointed contact person or patron termed as the point of contact (POC). Each POC presents the status of the recommendations for which s/he is POC. This way the project is updated as to how their recommendations support the development of the organisation.

4. Identify Lessons learnt A brainstorming session is conducted to initiate a discussion of what can be learnt from the just concluded project phase.

The participants have 10 minutes to write down their suggestions based on the most important lessons learnt during the last project phase. These suggestions are written on post-it notes with different colours. After this, each participant presents his or her lessons, and places the post-its on the time line. When all are done, two persons group the notes into related categories, and labels for these categories are identified in plenum. The categories are then prioritised with respect to their importance to the project and the top four are selected as the ones which during the remaining steps of the MR will undergo further analysis.

5. Perform Root Cause Analysis The participants are divided into two groups, each analysing two of the prioritised issues using root-cause analysis (refer to Section 8.2.3).

Each group presents the outcome of their analyses using fish-bone diagrams and the identified findings are discussed in plenum.

6. Determine Project Actions Based on the findings from the root cause analyses, a set of actions for the coming project periods is listed, discussed, and agreed upon by the project team. The actions identified are treated as change management issues, and thus are recorded directly into the organisational task management system. The participants appoint a patron for each task.

7. Propose Organisational Recommendations The project members consider which of the identified causes and activities are relevant for other projects or other parts of the organisation. Candidates and their applicability are discussed. For each of these recommendations a project member is chosen as responsible, or POC. The POC often is a member of the KN which covers this specific area. The POC is responsible for *A*) taking the recommendation to the relevant KN or the SPI project, *B*) following up on the recommendation, i.e., to track the changes the recommendation causes, e.g., in course material &c., and *C*) reporting these changes back to the project in future MRs (refer to step 3). The POC is also the person whom the KNs can contact if they are in need of further details concerning the recommendation. This step concludes the MR meeting.

8. Document Milestone Review The results from the MR are documented in the MR report (refer to Appendix E.3 for template). The MR reports from a specific project collectively constitutes the 'MR book' for that project. The first part of the MR book consists of the list of tasks which is continuously updated as these tasks are acted upon. The second part consists of short minutes from each of the MR meetings. The MR report records the results from each of the phases of the MR, supported by photographs of whiteboards, timeline and fish-bone diagrams. The MR book is the formal documentation of the course of the project.

9. Approve Milestone Review Report The last step of the reporting is the approval of the MR report. The PM reviews the report thoroughly to assure it contains all relevant information regarding the evaluated process phase and that the report describes the MR satisfactory. This review assures that the contents of the MR is ready to be inspected by its recipients. The approval is necessary only in cases where the PM role is not identical of that of the project's PQR.

10. Forward Organisational Recommendations Forwarding organisational recommendations to relevant KNs and/or the SPI project secures that the appointed POCs handle the communication with the KNs and the SPI project. It assures that the recommendations are brought to the relevant KNs and that the KNs have a contact point in the project who acts as a source for clarification and for further information. If no recommendations are identified, this step is not performed.

11. Forward the Milestone Review Report The MR report is forwarded to the SPI project which assesses that the MR process has been conducted according to the formal process framework. The SPI project registers the report and assures that the report conforms with the specified

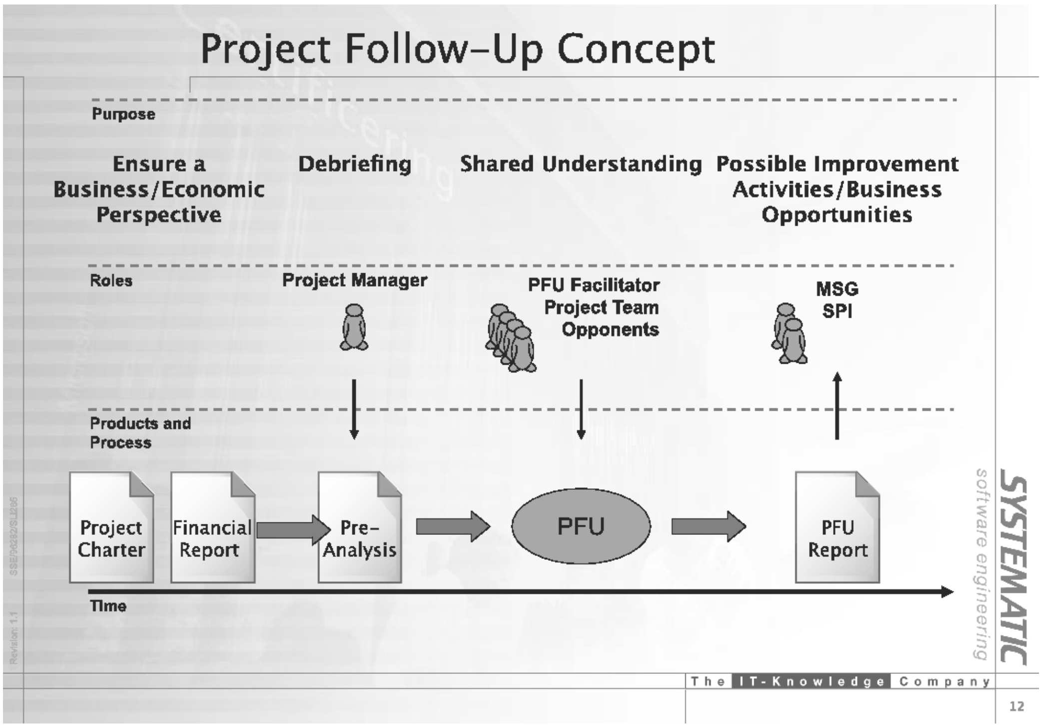

Figure 9.3: Overview of the new PFU process

procedures. The registration of the MR report is a part of the compliance with the CMM. This step concludes the MR process.

9.3.2 The Final Project Follow Up Process

The new PFU process is conducted whenever a project is closed. The PFU lets a group of opponents evaluate the project's achievements. The opponent group consists of experts from the organisation, e.g., from the KNs, the SPI project, and management.

The new process reduces the codified documentation to a minimum and replaces it with a personalisation based strategy for transferring relevant information.

The outline of the process is presented in Figure 9.3 on page 225 and consists of two major stages, one preparing the PFU meeting, and the meeting itself. The process consists of nine steps. Steps 1-5 consist of the preparation of the

PFU meeting. Step 6 is the PFU meeting. Steps 7-9 concern documentation activities after the PFU meeting.

1. Gather Data for the Project Follow Up meeting In this initial step the project management collects relevant data about the project. Candidates for information include the project charter (contract), the project plan, the financial report, the project's risk management plan, and the MR book. Other relevant data sources are consulted as well.

2. Document Project Progression and Results In this step the project management creates the pre-analysis report. The pre-analysis report is the first part of the PFU report. The pre-analysis report includes a timeline which describes the major events of the project. The pre-analysis report covers the following mandatory topics: the project's effort (resource consumption), quality, customer satisfaction, warranty, and future business opportunities.

3. Analyse Project Progression and Results (Pre-analysis) This step captures the project management's comments on the project's results. It includes a detailed analysis of the course of the project and identifies and discusses critical events in some detail.

4. Plan Project Follow Up Meeting Relevant staff members are invited to participate in the PFU meeting. These include representatives from the KNs, from the SPI project, and from the management, e.g., the BUD. The invitees receive the results from the pre-analysis.

5. Prepare for the Project Follow Up Meeting In this step the opponents prepare themselves for the PFU meeting. The preparation includes analysing the PMs pre-analysis to establish an overview of the project in question. On this basis, the opponents each plan their opposition. This includes to identify which subjects they find interesting or unclear and which information they require to analyse the event further. If a KN focuses on a specific subject, this can be examined by preparing questions regarding how the project handled situations concerning this subject.

6. Conduct the Project Follow Up Meeting In the PFU meeting the participants evaluate and discuss critical events from the project. The PFU focuses on revealing lessons learnt and provides the KNs with empirical data concerning the project practice in the organisation.

To reach an understanding of why each of the identified critical events occurred the PFU meeting performs a root cause analysis. Based on this understanding the participants can identify general trends and propositions that are of value for the organisation. The documentation of the PFU meeting consists of registering the lessons, trends, and propositions and follow up actions. Each action is appointed a patron.

7. Generate Project Follow Up Report In this step the PM or PQR registers the list of actions and patrons into SSE's task system. The SPI project is responsible for following up on the actions.

8. Approve Project Follow Up Report The BUD approves the final PFU report and thereby concludes and terminates the project. By approving the report, the BUD sanctions that the project has been conducted according to the process framework and in accordance with the rules of SSE. The approval constitutes an acceptance of the occurred progress, not a managerial approval of the results. The economical evaluation of the project's and its management's achievements are not a part of the PFU process.

9. Distribute Project Follow Up Report After approval, the PFU report is distributed to relevant recipients for further processing. These include the SPI project, which collects every PFU report for later analysis. The PFU report is stored as a part of the data material concerning the organisation's processes. The management steering group (MSG) receives a copy to: *A*) get an overview of the general trends in the projects, and *B*) promote certain improvement initiatives if these are of particular interest or benefit for the organisation as a whole.

9.4 Conclusion

In the third research cycle I finalised the new evaluation process for SSE. At the end of this cycle the design team, of which I was a member, presented a final process ready for inclusion in the organisation's practice. The new evaluation process is based on the results from the pilot studies conducted during the second research cycle and on the results from the cultural analysis. The new process was tested in two quality reviews, which assured that the descriptions were consistent with the organisation's process framework.

The new evaluation process changes the process in use in several ways. The most significant change is the switch towards implementing a situational knowledge organisation in SSE. The new process is based on a personalisation strategy for knowledge sharing. The personalisation strategy manifests itself in the involvement of the KNs in a formally prescribed PFU meeting. This meeting constitutes a project 'defence' in which the representatives from the KNs oppose the project's achievements. This new process design combines the collection, storage, and utilisation of the collective experiences based on personal interactions and written reports. This goes beyond a codification strategy which is based exclusively on written documents. The reports are maintained to assure compliance with formal improvement models such as the CMMI and to keep the BUDs' formal control over the project closure and project approval.

The finalisation and approval of the new evaluation process concluded the third and last research cycle of this study.

Chapter 10

Putting it all together

In this chapter I summarise and discuss the results of my study. The chapter presents my study's answers to the three research questions defined in Section 4.3.2. These answers make up the contributions of my work. I describe how the study contributes with empirical data from the SPI practice in SSE and with insights concerning the application of an collaborative practice research (CPR) (Mathiassen, 2002) inspired approach.

My results fall into three conceptually different parts.

First, the intervention produced direct results in the organisation. Second, the application of new combinations of theories contributed with new insights to the body of knowledge within the SPI field. Third, the documentation of the action research approach provided results concerning the application of this research framework in software organisations.

Therefore, my study provides results regarding the area of interest (A), theoretical framework (F), and methodology (M) (Checkland & Holwell, 1998) as illustrated Figure 10.1 on page 231.

I present the A, F, and M contributions under the headings organisational improvements, theoretical contributions, and methodological contributions, respectively. Future research areas are pointed out to position my research within the SPI field.

The study contributes directly to the body of knowledge created in the SPK project. The collective results of this project are published in Nielsen & Kautz

(2008). The complete list of the publications which originated directly from my study is included in Appendix F.

10.1 Organisational Improvements and Contributions to Practice

The results presented in this section are the results which were directly implemented in the organisation. In an action research based study this type of results constitutes a major part of the total results of the study. The results presented below concern the improvements of the organisational practice. They regard the A part of the A, F, and M taxonomy (Checkland & Holwell, 1998). The results concern the SPI practice as they suggest approaches and workable solutions to practising SPI in a software development company.

10.1.1 Identifying Knowledge Related Improvement Areas

As an answer to the first research question

- *How can the knowledge management status of a software organisation be analysed in order to identify knowledge related improvement areas?*

my research shows how the knowledge mapping technique (described in Chapter 7) enabled me, in close collaboration with the managers of the SPI project, to point out several improvement candidates, rank them, and select those that were the most relevant.

The thesis provides means for understanding and visualising the KM status of an organisation as well as for ranking and selecting the most relevant improvement candidates (referred to as A1 in Figure 10.1 on page 231 which contains a list of all contributions of this thesis).

The knowledge mapping technique combines already well established techniques from the software development field, namely the mapping techniques

Organisational Improvements (A)

A1) The knowledge mapping technique, which supports organisations to identify knowledge related improvement areas.

A2) The new project evaluation concept which is based upon a shift towards a situational knowledge organisation.

A3) Empirical documentation of the application of pilot studies as a technique to verify the new evaluation concept.

A4) Application of a cultural analysis as a technique to align improvement ideas to a final and applicable process.

A5) Empirical documentation of the application of quality reviews as a means to test the process descriptions' applicability.

Theoretical Contributions (F)

F1) The distinction between exemplary and situational knowledge organisations archetypes.

F2) An emerging balanced theory of KM in SPI which combines the axes of exemplary vs. situational knowledge organisation and normative vs. reflective SPI approaches.

F3) Empirical documentation of how techniques from the KM field are utilised in a SPI project.

F4) A detailed case description of a high maturity software organisation.

Methodological Contributions (M)

M1) The application of a CPR inspired approach to action research, which leads to results on both the A, F and M-levels of the SPI field.

M2) A description of how suitable combinations of analysis and intervention techniques are applied to match the different settings in each of the three research cycles.

Figure 10.1: The A, F, and M-contributions of this thesis

(Lanzara & Mathiassen, 1985) and the rich picture drawing technique (Checkland, 1999) with theoretical concepts from the knowledge management (KM) field, namely, learning cycles (Hedberg, 1981), organisational memory (Walsh & Ungson, 1991), and communities of practice (Wenger, 1998) into a new technique which provides a means to describe and understand the knowledge flows in an organisation. The analysis of the knowledge map helps to select relevant knowledge related improvement candidates in an organisation, by identifying four critical situations (missing links, springs, black holes, and hubs), .

My research further documents in detail how the knowledge mapping technique successfully was applied in the case organisation, and how its application helped the organisation select an important area for improvement, namely the project evaluation process. Thus, the thesis provides a proof of concept by showing that the technique is both applicable and capable of producing results.

The results from this part of the research also point to further research which can establish more insights regarding the applicability and practice of the knowledge mapping technique.

The use of rich pictures has to be carefully considered. Checkland (1999) underlines that some people easily handle rich pictures whereas others have problems with drawing and discussing them. In my study, the researchers all had experience with rich pictures and were able to facilitate the process for the other participants who were not acquainted to it. The meeting leader further supported the use of rich pictures by drawing the first version of the picture based on a preliminary map.

The knowledge mapping technique can be applied in several ways. Section 7.2 describes the way I applied it in SSE. However, the technique always incorporates participant involvement as a necessary condition to strengthen the relevance and validity of the map. The therapeutic effect of discussing and cooperating in the map making process is an important side effect of the technique.

SSE is a systems and software development company. In this context SSE is only an exemplar of a contemporary, knowledge intensive organisation. SSE constituted an ideal setting for testing the approach. However, I propose that the technique is also applicable and will provide useful outcomes in other knowledge intensive organisations and in different settings. To refine the technique, this, as well as other applications of the approach, must be subjected to future research.

The technique, as it was carried out in this study, relied heavily on an outside observer as interpreter who also played the role of a devil's advocate by raising 'taboo' questions. An outsider is not engaged in the political and power struggles in the organisation and can more easily make suggestions and provide interpretations and beneficial insights that are not in line with the prevalent views and opinions in the organisation. An outside observer requires a thorough understanding of the organisation. To obtain this requires a time and resource consuming data collection.

In SSE, the knowledge mapping technique provided useful results and valuable feedback. The same setting might not lead to the same achievements in another organisation or with other participants. The technique is no silver bullet and no guarantee for success. In SSE the long-term cooperation, the extensive presence, mutual respect, trust and a sincere atmosphere had developed and allowed for a frank dialogue and discussion throughout data collection and in particular throughout the final mapping session. I, as the producer of the original map, was acquainted with the organisation, its jargon and concepts as well as its procedures and tools, and I focused the mapping process, which progressed easily. A close relationship with a company and its employees also presents a danger. The apparent inside knowledge might lead to misconceptions and a distorted image of the organisation. In this case the collective mapping session, in which matters are openly discussed by representatives of different stakeholder groups, functions as remedial action.

However, the application of the approach might be criticised for having only representatives from the SPI project and no development project members present at the mapping session. To avoid this more personnel could be involved in the mapping session and more resources made available. In my study, resources were limited and I, backed by the steering committee, decided that for a pilot test of the technique the smaller forum was adequate, and that test results were sufficiently reliable to base the further work in the organisation on. The conflicting demands of the mapping process were balanced and compensated by me as the creator of the preliminary map. In this way, the outcome of the session was not restricted to management views and did not have limited input. The quality of the analysis was confirmed by the fact that the resulting improvement proposal was positively received and accepted by other members of the organisation, not only by those, who participated in the mapping session.

Further research into the applicability of the technique will address the possibility of knowledge mapping sessions conducted without an outside observer. The focus of the session could be a specific organisational context. Conducting the mapping technique internally reduces the effort involved because the outside observer is omitted. This reduces the preparation effort and the technique can be applied more frequently. Employees from different parts of the organisation than the 'mapped' one can provide the outsider's view. Such internal 'outsiders' know the company and have a well established understanding of the organisation's culture, but still are able to provide new suggestions to specific work areas with an outsider's open view. This idea can further lead to creating knowledge maps of specific parts of the organisation, with mapping sessions established as a more routinely practiced technique for identifying knowledge related improvements candidates.

This said, my study provides empirical evidence for the applicability and validity of the knowledge mapping technique in its current form.

10.1.2 Designing Initiatives to Strengthen the Organisation's Learning Capabilities

The second research question,

- *How can improvements of such areas be planned by designing and aligning new organisational initiatives to strengthen the organisation's learning capabilities?*

has been answered by the development of a new evaluation concept. The new concept is aligned with the organisational requirements and focuses on addressing the identified issues. My research shows how a thorough analysis—based on extensive artifact studies of the established evaluation process, interviews with key members of the organisation, in combination with a contextual analysis of the company culture—leads to the identification of a portfolio of suggestions, each of which directly addresses one or more inappropriate parts of the process. The new suggestions were developed by a design team which worked in a project which was established within the SPI project.

Further, my thesis documents how the suggestions were incorporated into a new evaluation concept and how this new concept itself was evaluated in two pilot studies. The thesis contributes with insights as to how the practice in a high maturity software organisation directly benefits from an analysis based on theoretical concepts from the KM field. In my study, the paradigmatic switch from an exemplary knowledge organisation towards a situational organisation (refer to Section 2.3.2) improved the value of the new evaluation concept compared to the existing process. The new concept leverages the knowledge sharing from a project level onto an organisational level. The new concept relies on root cause analyses, and implies the direct involvement of the experts' networks, the knowledge networks (KN), in the organisation; inter-linking these networks with the practical experiences from the projects. The new strategy provides a feed of experiences to the experts, and it adds the experts' guidance and analytical capabilities to the projects, thus strengthening the value of the KNs.

Additionally, the thesis provides insights as to how the new project evaluation concept was tested in the organisation through the pilot studies. The thesis confirms that pilot studies carried out in settings comparable to practice settings function as a beneficial means of assessing a proposed concept. In this case, the pilots provided refinements to the concept and showed that the concept was both applicable and expected to improve the evaluation practice.

My research thus provides results concerning both how to actually design SPI improvements in practice, and how to test such improvement initiatives (referred to as A2 and A3 in Figure 10.1 on page 231).

Integrating the KNs in the evaluation procedures, links them closer to the organisation proper. This secures that the holders of knowledge, the experts of the KNs, also have direct access to experiences from all over the organisation. The concept grants the KNs formal responsibility promoting them from mere discussion fora. To use the terms of Basili *et al.* (1994a) the new concept connects the ‘experience factory’ with the ‘software factory’. This breaks down the organisational boundaries and increases the applicability and usability of the made propositions because the improvement proposals’ relevance for practice is secured.

The transfer of responsibility will continue and in the future it will be the KNs that are responsible for developing and maintaining the BM and other formal process and procedure libraries. The SPI project will then define the strategic and co-ordinating activities. The design team suggested, in line with the SPI projects long term strategy, that the KNs should be the new ‘method department’ in the organisation.

The suggestion of decentralising the responsibility for the organisation’s process framework is important, since it act as a means for reducing the risk of ‘method department syndrome’ in which the employees consider the method department and its recommendations out of sync with organisational practice, as recognised by Kautz *et al.* (2004). Empowering the projects in the organisation enforces the organisational value of letting employees have ‘freedom under responsibility’. This is, according to management, an important motivational factor, and, as such, it increases the adaption of the process framework. In my study, the management, including the SPI project, found this approach too ambitious to deploy in one single step. Therefore, they recommended that the KNs should establish themselves more, before they become in charge of the actual processes and procedures.

The new concept introduces a personalisation based approach to knowledge sharing. Direct person-to-person relations should not only supplement, but largely replace the formalised reports as the organisation knowledge sharing mechanism. Management showed reluctance to give up the formal reporting of the evaluation process, because they found it difficult to measure the results from a personalisation based approach compared with one based on a codification strategy. The codification was based on a strategy in which documents could be tracked and traced, and references to them could be monitored. The SPI project which was responsible for carrying out the company's CMM compliance programme was reluctant to solely base the feedback loop upon the 'softer' personalised approach since this was harder to document according to the requirements from the CMM model.

Management's reluctance to accept the new concept led to the situation where the formal requirement of producing a written report that explicates the lessons learnt or the experiences gained from the PFU subsists. This situation exists even though my results have shown that they are of little practical use except for providing a tangible documentation of the project evaluation. My study shows how a compromise was reached to balance the different needs from the organisation's different stakeholders.

Introducing a decentralised approach to update the process framework in a high maturity software organisation will provide further insight as to how well a situational knowledge organisation may implement SPI initiatives; as such, this study suggests that further research into the de-centralisation and personalisation oriented strategies is of much relevance.

10.1.3 Securing Acceptance and Continuous Evolution

To answer the third research question,

- *How can such improvement initiatives be facilitated and implemented in order to secure acceptance and continuous evolution?*

this thesis shows how the suggested concept was transformed into a process suitable and applicable for the specific organisational settings. This transformation was based on aligning the concepts with the findings from the pilot studies, and with the recommendations from the cultural analysis and from studies of the requirements and restrictions from the CMM model and other regulating standards.

The thesis provides insight regarding the practical implementation of SPI activities in high maturity organisations in which appraisals and the compliance with standards are crucial elements of the SPI task.

The cultural analysis of the explicit and implicit values provided a means for identifying the organisation's cultural values. A grounded theory (Glaser & Strauss, 1967) inspired analysis revealed the underlying and covert patterns in the analysed data and facilitated the identification of the hidden values of the organisation.

The new process adopted a disputation based approach to conduct project evaluations, and the study documents how the introduction of the opponent role links the project experiences and future process prescriptions.

The new process lets the representatives from the projects vindicate their results before a committee of experts from relevant parts of the organisation. In this way the new process ensures that the project management puts the necessary effort into preparing a proper evaluation as it is their responsibility to provide the experts with useful information.

The new process was tested in two formal quality reviews. The application of quality reviews approves new process' initiation into the organisational process framework. The reviews verified that the new process specification are in compliance with the formal requirements and with the organisational practices, culture, language, and jargon.

Thus, my research provides results concerning how it is possible to transform concepts into a formally defined process which is documented in compliance with the prevailing standards and further, how quality reviews can act as means for testing this compliance (referred to as A4 and A5 in Figure 10.1 on page 231).

The new evaluation process was proposed to be included in the next revision of the process framework, viz., the next version of the BM. After I concluded my study the process has undergone the following changes[1]: The integration of the KNs directly into the project evaluations is implemented successfully

[1] To follow up on my research I have had an e-mail exchange with a representative from the organisation, who updated me on the status in Spring 2007.

and this approach constitutes the backbone of feeding the project's experiences to the KNs. The frequency of the evaluations is high to allow for shorter evaluation cycles which has become necessary after SSE introduced an agile approach to software development.

This study concludes that the process introduced is applicable in the organisational settings and therefore valuable as an KM inspired approach to SPI. Future research can provide more insights as to how the new process was implemented after I had left the organisation and further, how it has evolved in practice.

10.2 Contributions to Academia and Theoretical Insights

The second part of the results concerns the reflections on the interventions and will provide the research community with insights concerning how software developing companies operate and how practice in these companies can be changed, specifically with the focus on their knowledge related and learning processes. Academic and theoretical contributions fall into the F-category of the A, F, and M-framework (Checkland & Holwell, 1998) and the contributions in this section provide insights on a higher theoretical level than the A-contributions reported above.

In this study I introduce the distinction between exemplary and situational knowledge organisation types and utilise this distinction in the work of improving SSE's evaluation process. Additionally, my study, based on reflection of the results from the interventions, points towards an emerging balanced theory of KM in SPI. This theory balances SPI activities along two axes: the organisational knowledge type (exemplary vs. situational) and the choice of SPI approach (normative vs. reflective).

My study contributes to the SPI field by introducing new techniques to conduct SPI in practice: the knowledge mapping technique for identifying improvement areas, and the cultural analysis to align new initiatives with the organisational requirements. The study contributes to the body of knowledge with a case study of the improvement effort in SSE.

10.2.1 Towards a Balanced Theory of KM in SPI

In this study I introduce and utilise the notion of exemplary and situational knowledge organisation archetypes. The archetypes are distinguished by differences with respect to: knowledge type, approach to knowledge creation, learning type, knowledge retrieval type, and knowledge management strategy. The archetypes define which knowledge characteristics are the prevailing ones in an organisation and, as such, they provide a means for understanding the knowledge sharing capabilities of the organisation.

SSE practices a norm driven approach to SPI, in which the underlying model, the CMM, prescribes which improvement areas are of relevance to rise in maturity, viz., to comply with continuously higher levels of the CMM. My study describes how this normative approach to SPI does not fully satisfy the SPI requirements of the organisation. Other important improvement areas were shown as relevant which were not prescribed by the norm. In this case the normative approach benefited from being supplemented with an alternative approach. My study introduced a problem oriented approach which originates from *A*) perceived problems in the organisation and *B*) suggestions from the KM field. This shows how a balanced approach to identify SPI improvement areas was beneficial to the case organisation and led to the identification and design of a new evaluation process.

Therefore this study introduces the distinction of an exemplary and situational knowledge organisation, and further, shows how the combination of theories from the SPI field and from the KM field points towards a balanced theory of KM in SPI (referred to as F1 and F2 in Figure 10.1 on page 231).

The prevailing knowledge organisation in SSE was of the exemplary type. The KM strategy in the organisation was anchored in the formal documentation requirements prescribed by the CMM. The approach relied on a codification strategy to knowledge sharing in which documents acted as the prime source of explicated knowledge. According to the theory as presented in Sec-

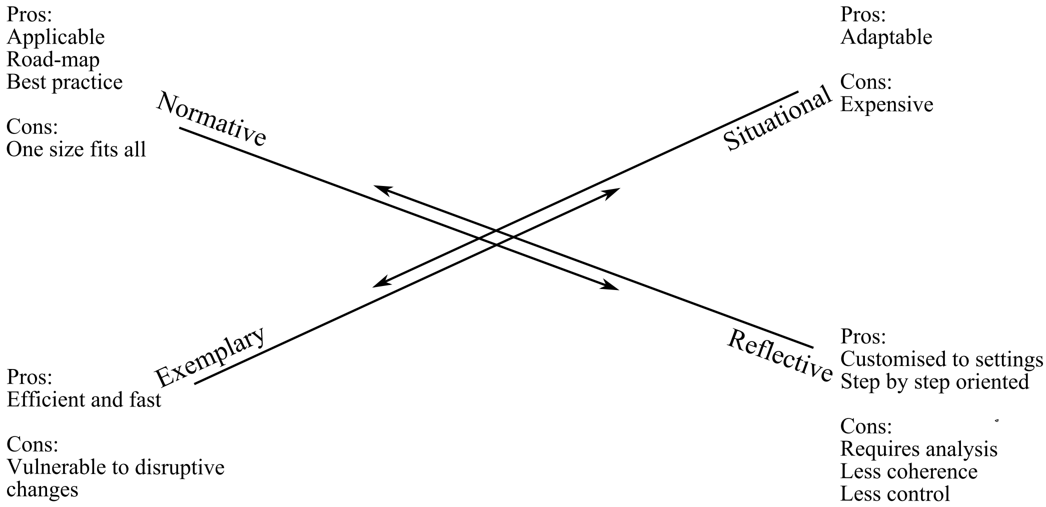

Figure 10.2: A Balanced Theory of KM in SPI

tion 2.3.3, Figure 2.3 on page 50 such a setup would best be supported by a norm based approach to SPI. My analysis showed that whereas the SSE setting met the requirements of traceability, documentation, and formalism required by the norm (the CMM model) and suited management well, the organisation was not able to leverage the knowledge sharing from a project level onto an organisational level in an efficient way. To overcome this problem, the evaluation process was changed to rely on a personalisation strategy for knowledge sharing. This assures the transfer of the highly complex and contextual information that makes the experiences, which were gained in projects, useful for other parts of the organisation. This shows that the relationship between organisational knowledge type and SPI approach is more complex than the conjunctive relation depicted in Figure 2.3 on page 50. It points to a balanced theory of KM in SPI as depicted in Figure 10.2 on page 241. This theory balances the choice of SPI strategy on two axes. One axis balances, on the one hand, the adaption of a normative model which prescribes which areas are relevant to improve. On the other side of the axis is the reflective approach which is, as described in Section 2.1.1, anchored in actual problems experienced in the organisation and supplemented by suggestions from theory. This axis corresponds to the normative—reflective distinction applied in the survey in Chapter 2.

The other axis balances the prevailing knowledge organisation type which has an impact on the organisation's ability to collect and share experiences on several organisational levels. This axis corresponds to the distinction between the exemplary and situational knowledge archetypes which is described and discussed in Section 2.3.2.

The balanced theory of KM in SPI shows that it is important to critically asses the current SPI approach when further developing SPI in an organisation. The existing paradigm affects the portfolio of possible improvements. A normative approach cannot identify improvement areas 'outside' the chosen model. It can provide a 'complete' and consistent approach to plan a large SPI effort with regard to the model. A reflective approach provides specially designed solutions, often to actual problems. However, it does not combine these into a larger framework which coordinates the SPI effort.

The two axes of the balanced theory are neither conjunctive nor disjunctive. Therefore the axes in Figure 10.2 on page 241 are neither parallel nor orthogonal. A correlation between the normative and exemplary ends of the axes, and similarly between the situational and reflective ends exists. Most normative approaches are based on an underlying rational model which describes how a software organisation functions. Therefore, within a normative paradigm, an exemplary knowledge organisation, implementing a codification based approach to KM, is preferred. In this setting the underlying model can be used to decode codified information into usable knowledge. At the other end of the axes the situational knowledge organisation supports a reflective approach to SPI. In an organisation relying on a reflective approach to conduct SPI an exemplary organisation provides the details and context needed to make the proper reflections concerning the understanding of the organisation.

As shown in Figure 10.2 on page 241 each approach has its particular pros and cons. A normative SPI approach contains a road-map which makes it easier to apply the approach in an organisation. The norms prescribed by the approach are based on best practices from other organisation. This makes it possible to re-use these practices and this way achieve faster results. On the other side a norm based approach is limited to present only one model, and therefore might only partly fit the organisation in which it is implemented. This might result in the implementation of irrelevant initiatives or in implementing initiatives based on false premises. A reflective approach to SPI is customised to precisely the organisational settings in which it is implemented, and only includes those initiatives which are of relevance. On the other hand a reflective approach requires an effort to customise it and to analysis the settings in which it is implemented. The reflective approach does not secure a coherent approach to SPI which might reduce the synergies from several initiatives that are not coordinated.

The exemplary knowledge organisation provides fast and efficient knowledge sharing capabilities, but is not handling disruptive changes in the organisational environment well. On the other hand the situational knowledge organisation is highly adaptable to changes, but requires more investments to continuously analyse the current settings.

The balanced theory show that it is necessary for an organisation to balance the different requirements and forces to create a setup in which the prevailing knowledge organisation type matches the applied SPI approach. This way the organisation can find the combination that balances the pros and cons from either of the approaches in a way that best fits the organisation's requirements.

In the case of SSE the organisation implemented a norm based approach to SPI, but to improve the knowledge sharing mechanisms the new process shifted the balance of the knowledge organisation towards the situational type.

10.2.2 New SPI Techniques

This thesis contributes with documentation of the application of a knowledge mapping technique and the conduction of a cultural analysis as techniques for conducting SPI. It shows how the knowledge mapping technique is a useful means for identifying SPI related improvements areas and further that a cultural analysis informs and aligns the transformation of improvement suggestions into an applicable process. Therefore, this thesis contributes to the SPI field by documenting that techniques from the KM fields can be utilised in a SPI context (referred to as F3 in Figure 10.1 on page 231).

My study introduces the knowledge mapping technique as an approach to identifying SPI improvement candidates. The technique combines theories from the KM literature concerning learning and organisational memory and introduces the notion of knowledge flows in a SPI context. The map is used in a SPI context to identify future improvement initiatives. Thus, the application of the technique shows how related disciplines contribute to SPI efforts when applied in a SPI context.

Further, my research provides evidence for the usefulness of conducting a cultural analysis as a SPI technique; the thesis describes how a cultural analysis technique inspired both by Schein (1973) and by Glaser & Strauss (1967) provides results which pro-actively are applied in the design process of new SPI initiatives. The analysis's results, a specification of the explicit and implicit values, were used to align the new process with the organisational practice and culture.

The application of grounded theory relied on my experience with an approach from a previous study (Kautz *et al.*, 2004). This experience helped the coding process of the gathered data. The coding process provided an efficient means for analysing the complex data sources collected during the initial part of the study. I recommend that SPI practitioners and researchers apply a grounded theory approach in similar scenarios to analyse complex unstructured data.

The adoption of a specific KM strategy for knowledge sharing is an example of how theories from the KM field contribute to the SPI field. My research shows how the project evaluation concept was valued as more efficient and effective by organisational members when the process was changed to be based on a personalisation strategy (Hansen *et al.*, 1999). The organisation's expert fora, the KNs, were actively integrated into the evaluation process and therefore they became the direct source for the organisational knowledge sharing.

The process shifted the organisation to a situational knowledge organisation by applying a personalisation based knowledge sharing approach. This shift is of especially interest and significance since the prevailing SPI approach in the organisation is a norm based approach, and as such the case of SSE is an example of SSE balancing the choice of SPI approach and knowledge organisation.

10.2.3 Rich Empirical Data from Practice

This thesis includes a detailed description portrayal of SPI practice. It presents empirical data describing the SPI related constructs of a high-maturity software organisation and provides a detailed description of the culture in such an organisation (referred to as F4 in Figure 10.1 on page 231).

The account based on rich empirical data can be of use for other research which needs case descriptions. Other studies of high maturity software organisations can reference these results since: "[...] explanations of particular phenomena derived from empirical interpretive research in specific IS settings, [...] may be valuable in the future in other organizations and contexts" (Walsham, 1995).

The empirical data includes details regarding how a Danish software company, which with 250+ employees is a small company in a global content, adopts the CMM model. My thesis contributes to the ongoing discussion concerning how well the CMM model fits in smaller companies outside North America and in companies not practising an US management culture. SSE is a Scandinavian company, and its management culture is less formal compared to large US companies; every employee is at maximum 4-5 levels below the owners of the company. The description of applications of the CMM in small organisations is, as argued in Chapter 2, in demand in the SPI field to provide understandings of how well normative models like the CMM scale. This study provides a documented case of the planning, managing, and implementation of maturity improvements in SSE and with its details about the SPI practice in an organisation of this type and size, makes a contribution to the SPI field's body of knowledge.

10.3 Methodological Contributions

My study provides methodological contributions concerning research practice beyond the SPI field to the information systems development and software engineering fields.

My study introduces an action research oriented approach, inspired by the collaborative practice research (CPR) framework (Mathiassen, 2002). Therefore my thesis provides empirical documentation regarding how to plan, control, and conduct a longitudinal study relying on close collaboration with a case company. Further, my research provides insights regarding how to design an intervention based collaboration by combining several analysis and intervention techniques (referred to as M1 and M2 in Figure 10.1 on page 231).

10.3.1 Documentation of Research Approach in a SPI Context

My research follows a research approach which relies on action research (Avison *et al.*, 1999), and I have directed this approach by applying the interpret/understand—design/support—intervene/improve framework from the CPR (refer to Figure 4.1 on page 82). I have shown how the knowledge mapping technique and the cultural analysis lead to an understanding, which facilitated the design of a new evaluation concept aimed at supporting the organisation. This concept was, in the pilot studies and the quality reviews, finalised to a directly applicable process ready to be implemented in the organisation.

This study confirms the applicability of the CPR action research approach within the SPI field, as it shows how the research approach leads to valuable contributions. The close collaboration and interaction with practice proved to be beneficial for reaching these results, as a thorough understanding of both software developers' and the SPI practitioners' tasks, problems, and functions is difficult to achieve without collaboration.

Methodologically, this thesis contributes to the SPI field with details of the research approach. The study's conduction of three successive research cycles, each focusing the study further by addressing successively more specialised questions, shows how the methodology controls a longitudinal research study with openly defined research questions which allow for an emergent research process.

10.3.2 Combination of Techniques

Three different research approaches are applied in each of the three research cycles; the first approach is a combination of off-site and on-site collaboration in which I, on-site, collected background material based on which I designed an analysis approach suitable for the actual problem off-site. In the first cycle this was the design of the knowledge mapping technique. I designed and prepared the technique off-site, and included participation and involvement from representatives from the organisation during the actual mapping session. The second cycle was an iterative trial and refine, experimental process concluded with the pilot studies. The third cycle was an on-site intervention which was based on the collaborate design of the evaluation process. This cycle was concluded by the quality reviews.

The study shows that combining different research methods and techniques into a suitable portfolio achieved relevant results. The flexibility of applying different data gathering techniques, analysis techniques, and intervention techniques in the three cycles, achieved the multiple results of this study. This flexibility would not have been possible if a detailed approach had already been developed during the initial phase. The cyclical nature of the chosen research design which in its course combined different approaches proved valuable to secure the continuity without losing the required rigidity.

This also shows that in an action research project as I performed it, it is beneficial, if not necessary to define the research questions open enough to allow the study to unfold according to both the situation found in practice and commensurate to the emerging scholarly and practical findings and achievements.

10.4 Conclusion

This study has contributed in all three parts of the A-F-M-framework: *A*) the interventions in the organisation have improved the practice of the company, *F*) the theoretical contributions to the SPI field have supplied new insights as to how theoretical concepts from the KM field can be integrated into the SPI field, and *M*) methodologically this study shows how complex organisational contexts can be researched by applying a suitable portfolio of analysis and intervention techniques.

I have shown how a longitudinal collaborative study has provided results internally in the case organisation by designing and aligning a new project evaluation process based on moving the organisation towards the situational knowledge organisation type, which facilitates a personalisation strategy to knowledge sharing and which actively involves the expert's networks of the organisation.

I have documented how theories from the SPI field integrate with theories from the KM field and I have pointed towards the emergence of a balanced theory of KM in SPI in which an equilibrium regarding an organisation's SPI approach and its knowledge type is central. Finally, this study has provided methodological contributions as to how a longitudinal action research inspired research approach can be managed and focused by implementing the CPR framework. This provides the basis for a multitude of results, as different analysis techniques could be brought into play in each of the research cycles.

My hope is that this research will help others, both practitioners and researchers, in their endeavour in the SPI field and beyond.

Appendix A

Initial Research Topics

A Establish common goals for the management and communication efforts in the organisation—across hierarchy and across organisational 'departments'.

B How to identify and collect (and share) the best 'best practices' in the organisation?

C Remove or reduce the impact from 'human errors' in projects. Establish common guidelines/processes for all projects and for all roles to make the projects less dependent on specific individuals.

D To establish (automatic) practices for collecting, analysing, and using (quantitative) data as managing guides or 'lessons learnt'.

E Improve the communication between the SPI project and the development projects. Strengthen the 'feedback'-cycle from the projects' practice.

F Establish a continuously ongoing education directly in the development projects. Avoid class room learning and establish practices for conducting situated practice learning directly in the projects.

G Establish a practice for continuous technology development, testing, and replacement to strengthen the innovation and change of technologies and tools.

H Change the focus from written documentation to learning. How is it possible to collect, analyse, and share experiences without the need of a large rigid set of document collection and storage?

Appendix B

Internal Events

03.02.2003	Initial meeting with SSE.
03.03.2003	SPK research project meeting.
12.03.2003	Steering committee meeting.
26-27.03.2003	Workshop for SPK project and involved organisations.
07.04.2003	Introductory course (intended for new employees).
	First interview with developer from development project.
	Meeting with three key staff from the SPI project.
08.04.2003	Informal chat with developers.
09.04.2003	Second interview with developer from development project.
	Third interview with developer from development project.
22.04.2003	Meeting with the SPI project about PFU process, and introduction to BM and related documentation.
23.04.2003	Fourth interview with PM from development project.
	Fifth interview with PC from the SPI project.
24.04.2003	Sixth interview with senior PM from development project.
12.05.2003	SPK research project meeting.
14.05.2003	Steering committee meeting.
24.06.2003	Steering committee meeting.
14.08.2003	SPK research project meeting.
26.08.2003	SPK research project meeting.

29.08.2003	Seventh interview with team manager from development project.
	Eight interview with team manager from development project (Test team).
09.09.2003	SPI project status meeting.
	MSG meeting.
15.09.2003	Steering committee meeting.
22.09.2003	Quality meeting about QPM with PM from the SPI project, BUD from BD BU, SPI project member, an internal pedagogical adviser, and representatives (PM and PQR) from development project.
	Studies of the PFU process in BM versions 3 and 4.
29.09.2003	SPI project status meeting. Meeting with external consultant, PM from the SPI project, and QPM responsible from the SPI project about QPM.
	Presentation of QPM Pilot.
06.10.2003	SPI project status meeting.
	Meeting with development project.
20.10.2003	SPK research project meeting.
28-29.10.2003	Workshop for SPK project and involved organisations.
03.11.2003	SPI project status meeting.
	Meeting with PC and PMs from development projects about mapping the BM activities to the projects' activities.
11.11.2003	Steering committee meeting.
	Creation of Knowledge Map (mapping session).
17.11.2003	Meeting with external consultant about introduction and diffusion of BM ver. 4.1 and QPM.
24.11.2003	On-site observations.
03.12.2003	Steering committee meeting.
	Presentation of new project evaluation concept.
08.12.2003	SPI project status meeting. Meeting with BUD from BD BU about new project evaluation concept.
	Adjusting new project evaluation concept to SSE lingo.

15.12.2003 SPI project status meeting.

Meeting with PM from the SPI project about new project evaluation concept.

14.01.2004 SPK research project meeting.

15.01.2004 MSG meeting, presentation of new project evaluation concept.

28.01.2004 Meeting with BUD from BD BU about KN/KL initiative introduction.
Meeting with PFU responsible about new project evaluation concept.

Meeting with PM from development project about new project evaluation concept.

29.01.2004 Meeting with PM from SPI project about plan for implementing new project evaluation concept.
Ninth interview with senior PM from development project.
Tenth interview with developer from development Project.

Eleventh interview with BUD from Defence BU.

19.02.2004 Twelfth interview with developer from development project.
Thirteenth interview with PM from development project.

Fourteenth interview with BUD from Key Accounts BU.

20.02.2004 Fifteenth interview with PM from development project.
Sixteenth interview with BUD from Products BU.

Seventeenth interview with developer from development project.

15.03.2004 SPK research project meeting.

03.05.2004 Meeting with PM from development project about project debriefing techniques/practices.
First pilot study of new project evaluation concept (in development project).

Meeting with (new) PFU responsible from the SPI project about new project evaluation concept and KN/KL.

24.05.2004 Meeting with PFU responsible, reviewing results from first pilot study of new project evaluation concept.

Status meeting with PM from the SPI project.

25.05.2004 Meeting with PM in development project, introduction an briefing of second pilot study.

09.06.2004 First part of second pilot study (in development project).

18.06.2004	Second part of pilot study (in development project). De-briefing and evaluation of second pilot study with PFU responsible.
24.06.2004	Steering committee meeting, presentation of pilot studies.
26.10.2004	SPK research project meeting.
14.01.2005	SPK research project meeting.
23.02.2005	SPK research project meeting.
24-28.02.2005	Project evaluation process work camp.
03-04.03.2005	Project evaluation process work camp.
10-15.03.2005	Project evaluation process work camp.
11.03.2005	Steering committee meeting, presentation of status of new project evaluation process.
07.04.2005	Project evaluation process meeting.
20.04.2005	Project evaluation process meeting (on-line).
21.04.2005	Project evaluation process meeting (on-line).
16.05.2005	Project evaluation process meeting (on-line).
17.05.2005	Project evaluation process meeting (on-line).
18.05.2005	Project evaluation process meeting (on-line).
23.05.2005	External quality review of new project evaluation process.
31.05.2005	SPK research project meeting.
06-08.06.2005	Project evaluation process work camp.
21.07.2005	Internal quality review of new Project evaluation process.
25.08.2005	SPK research project meeting.
28-29.01.2006	SPK symposium - ending SPK project.

Appendix C

External Events

03.2002	SSE achieves CMM level 3 compliance.
08.04.2003	Inauguration of SSE's new facilities.
29.06.2003	SPI project employee leaves SSE.
29.09-03.10.2003	External consultant visiting SSE to present results from off-site assessment of Business Manual 4.0.
09.2003	SPI project receives help from a development project because it cannot handle all the Business Manual 4.0 deployment tasks.
03.11.2003	New (external) employee hired into the SPI project.
28.11.2003	Every project supposed to comply to Business Manual 4.0.
11.2003	SSE is awarded "Entrepreneur of the Year"*.
26-30.01.2004	Preparing CMMI level 4 assessment, the SPI project education.
03.2004	Employee responsible for the Project Follow Up process leaves SSE.
05.2004	SSE achieves CMMI level 4 compliance (after week of assessment in April). First Scandinavian company to achieve CMMI level 4 compliance.
01.2005	28 of 360 employees dismissed. First cut-downs in 20 years†.
02.2005	A 'sales' department is established.
03.2005	Key employees (PC and responsible for QPM) leave the SPI project to participate in development projects.

03.2005	Reduced turnover -€2.000.000[‡].
05.2005	CMMI level 5 assessment postponed to avoid "stressing" the organisation. New estimate Nov. 2005.
09.2005	New general manager in SSE.
10.2005	New PM in the SPI project.
11.11.2005	SSE achieves CMMI level 5 compliance[§].
12.2005	Key employees (BUD from BD BU and (former) PM from the SPI project) leave SSE.
02.2006	Increased profit despite heavy investments in organisational development[**].

[*]http://www.ey.com/global/Content.nsf/Denmark/pm_eoy_landsvinder_241103
[†]http://www.jp.dk/arkiv:aid=2846868
[‡]http://systematic.dk/UK/About+Us/News/Continued+Profit+Despite+Decline+in+Turnover.htm
[§]http://systematic.dk/UK/About+Us/News/World+Class+Maturity.htm
[**]http://www.jp.dk/arkiv:aid=3535782

Appendix D

Interview Guides

D.1 Version 1, Project Staff

About you

- What is your educational background?
- How long have you been employed at SSE?
- What is your function at SSE?

About your project

- Describe your current project...
- Project size, staffing, expected duration...
- Project purpose...
- Is this a typical SSE project? And why not?
- How is the project organised?
- Describe the project from the beginning to the end...
- Which tools and techniques are used in the project?
- What is the current status of the project?
- How has the project flowed until now?
  - The processes?
  - The project plan/deadlines?
- Is your project a typical SSE project?

- Describe a typical working day (for you)...

About BM, PDP, Project's Status Report's (PSR) role in projects

- What is the purpose of the BM and PDPs?
  - Describe how your project uses the BM and PDP...
  - Do you in this project use the BM and PDP differently than normally?
  - What do you see as the strengths and weaknesses of the BM and PDPs?
  - What could be improved and how?
- What is the purpose of the PSR?
  - Describe how your project uses the PSR....
  - Do you in this project use the PSR differently than normally?
  - What do you see as the strengths and weaknesses of the PSR?
  - What could be improved and how?
- How do you, apart from this, document your project?
- How would you describe is the relationship with other parts of SSE?
- How would you describe the relationship with customers/suppliers/others?

About Knowledge and experience gathering

- What is the purpose of the PFU?
- Describe how the PFU is conducted/used...
- What are the strengths and weaknesses of the PFU (use PFU template)?
- How do you (or your project) use...
  - The internal IT knowledge base?
  - The metric/measurement systems?
- Do you know of other formal knowledge sharing mechanisms/systems/possibilities?
- What is the (purpose/task of the) PC?
  - How did the PC intervene in your project? How did you use the PC?
  - Is this the typical way of using the PC's services?
  - Do you use the PC's services optimally?
  - What do you get from the PC? What do you give to the PC?

- Apart from this, how does the knowledge/experience sharing work in your project?
  - What is working well?
  - What could be improved?
  - Are there any differences between this project and others?
  - Between the employees?
  - Between the projects?
- What is working well?
- What could be improved?

About the SPI project

- How do your project utilise the SPI project's services
- Which strengths/weaknesses are there in this co-operation?
- Which roles facilitates the contact with the SPI project?
- Which roles (in the SPI project) are directly involved?
- What difference has the CMM (level 3) meant?
- What still needs improvements?
- What possibilities/expectations do you see/have to SPI in SSE in the future?

D.2 Version 1, Process Controller

About you

- What is your educational background?
- How long have you been employed at SSE?
- What is your function at SSE?

About the projects

- Describe a typical SSE project...
- Project size, staffing, expected duration...
- Project purpose...
- How is a typical SSE project organised?
- Describe a project's life from the beginning to the end...
- Which tools and techniques are used?

About BM, PDP, Project's Status Report's (PSR) role in projects

- What is the purpose of the BM and PDPs?
  - Describe how projects use the BM and PDP...
  - What do you see as the strengths and weaknesses of the BM and PDPs?
  - What could be improved and how?
- What is the purpose of the PSR?
  - Describe how your project uses the PSR...
  - Do you in this project use the PSR differently than normally?
  - What do you see as the strengths and weaknesses of the PSR?
  - What could be improved and how?
- How do projects, apart from this, document their work?
- How would you describe is the relationship with other parts of SSE?
- How would you describe the relationship with customers/suppliers/others?

About Knowledge and experience gathering

- What is the (purpose/task of the) PC?

- Which meetings do you have with projects?
- What happened on the last meeting?
- Was this the correct thing to happen?
- What do you get from the projects? What do you give to the projects?
  - Is this working as it should?
- What is the purpose of the PFU?
- Describe how the PFU is conducted/used...
- What are the strengths and weaknesses of the PFU?
- How do the projects use...
  - The internal IT knowledge base?
  - The metric/measurement systems?
- Apart from this, how does the knowledge/experience sharing work in your project?
  - Formally or informally?
  - Between the employees?
  - Between the projects?
  - Between the projects and the SPI project?
- What is working well?
- What could be improved?

About the SPI project

- What is the SPI project's primary function?
  - The SPI project's goals?
  - On a long term/on a short term?
- What are the daily tasks?
- How do the projects use the SPI project's services?
- Which strengths/weaknesses are there in this co-operation?
- Which roles facilitates the contact with the SPI project?
- Which roles (in the SPI project) are directly involved?
- What difference has the CMM (level 3) meant?
- What still needs improvements?
- What possibilities/expectations do you see/have to SPI in SSE in the future?

D.3 Version 2, Generic

About you

- What is your educational background?
- How long have you been employed at SSE?
- What is your function at SSE?

About the project management during the last year

- Which changes have been explored during the last year?
  - With regard to Project Management?
  - With regard to the change from CMM to CMMI?
  - With regard to QPM?
  - With regard to the change from CMM Level 3 to 4?
  - With regard to the use of BM and PDP?

About Knowledge and experience gathering

- What is the purpose of the PFU?
- Describe how the PFU are conducted/used...
- What are the strengths and weaknesses of the PFU?
- How do you (or your project) use...
  - The internal IT knowledge base?
  - The metric/measurement systems?
- Do you know of other formal knowledge sharing mechanisms/systems/possibilities?
- What is the (purpose/task of the) PC?
  - How did the PC intervene in your project? How did you use the PC?
  - Is this the typical way of using the PC's services?
  - Do you use the PC's services optimally?
  - What do you get from the PC? What do you give to the PC?
- Apart from this, how does the knowledge/experience sharing work in your project?
  - What is working well?
  - What could be improved?

  - Are there any differences between this project and others?
  - Between the employees?
  - Between the projects?

- What is working well?
- What could be improved?
- Knowledge Networks / Knowledge Leaderships...
  - Expectations/possibilities...
  - Wishes...
  - Requirements (for success)...

About the SPI project

- How do your project utilise the SPI project's services?
- Which strengths/weaknesses are there in this co-operation?
- Which roles facilitate the contact with the SPI project?
- Which roles (in the SPI project) are directly involved?
- What still needs improvements?
- What possibilities/expectations do you see/have to SPI in SSE in the future?

Appendix E

Process Documentation

E.1 The Final Milestone Review Process

Conduct Milestone Review

Purpose

The Milestone Review purpose is twofold:

- Ensure project reflections by collecting experiences, lessons learned, good practices and reusable assets from previous activities and setting up critical success factors (actions) for the next period

- Consider relevant recommendations useable across the organisation based on lessons learned and experiences within the project

Milestone Review ensures that both the project and the organisation learns from project's experiences and thereby avoids wasting resources learning the same lessons the hard way.

Task description

Task	Description	Who?
1	Prepare Milestone Review	Project quality responsible
2	Present project status	Project quality responsible
3	Feedback from and Follow up on actions identified at the last Milestone Review	Project quality responsible, Points of Contact
4	Identify lessons learned	Project team
5	Perform root cause analysis	Project team
6	Determine project actions	Project team
7	Propose organisational recommendations	Project team
8	Document Milestone Review	Project quality responsible
9	Approve Milestone Review Report	Project manager
10	Forward organisational recommendations to relevant Knowledge Networks and/or SPI team if appropriate	Points of Contact
11	Forward the Milestone Review Report to the Internal Auditor for registration and compliance	Project quality responsible

E.2 The Final Milestone Review Procedure

- 1.1

Procedure for Milestone Review - $Revision: 1

CMM

Søren Frichs Vej 39
DK-8000 Aarhus C
Gothersgade 14
DK-1123 Copenhagen K
Tel.: +45 8943 2000
Fax: +45 8943 2020
sse@systematic.dk
www.systematic.dk

1 General Information

This document describes procedures for how to plan, execute and document Milestone Reviews (MR). Milestone reviews are executed every quarter or at important milestone/increments.

Responsible: Project Quality Responsible (PQR) or other project role assigned to the Milestone Review Process.

Asset References

The following assets are referenced in this document

ASSET	DTS Number	Revision
[TPL#Milestone Review Report]	SSE/96282/TPL/015	Current from SSE menu
[GDL#Guidelines for Milestone Review]	SSE/96282/SLI/XXX	XX
CAR	SSE/	XX

Purpose and Scope

The Milestone Review purpose is twofold:

- Ensure project reflections by collecting experiences, lessons learned, good practices and reusable assets from previous activities and setting up critical success factors (actions) for the next period
- Consider relevant recommendations useable across the organisation based on lessons learned and experiences within the project

Milestone Review ensures that both the project and the organisation learns from project's experiences and thereby avoids wasting resources learning the same lessons the hard way.

2 Procedures

Prepare Milestone Review

Responsible: PQR

Purpose: To assure a high quality review by inviting the right participants and allowing them to prepare for the Milestone Review.

Execute this procedure in order to arrange a Milestone Review

1. Invite relevant stakeholders to a milestone review. The following stakeholders should be considered:
   - Project Manager
   - Team Leader
   - Project Team members
   - Knowledge Networks
   - SPI team
2. Arrange a three hour meeting in a room with a large whiteboard
3. Prepare project status, e.g. by collecting:
   - Status reports
   - Balanced Scorecard
   - Effort, schedule and milestones
   - Risk status
   - Actions identified at last Milestone Review
   - Quantitative data
4. Prepare a milestone time line based on important/critical milestones in the project. Address input from above at the time line as appropriate
5. Draw a Milestone Review Report (MRR) and put in under configuration management [TPL#Milestone Review Report]

Present Project Status

Responsible: PQR

Purpose: To provide the participants of the MR with an overview of the project's progress and achievements, major events, and other relevant information. By focusing on matters only concerning the reviewed period the participants' minds are focused onto relevant issues from this period instead of on matters ongoing in the project at the moment.

Execute this procedure at the Milestone Review

Estimate: 25 minutes

6. Explain why the MR is conducted. What triggers the MR.

7. Brush up project member's memory by drawing a time line with important/critical milestones on a whiteboard. The time line equals the Milestone Review period.

8. Give a short briefing based on project status, e.g. project's balanced scorecard, status reports, effort, schedule, risks etc.

Feedback from and Follow up on actions identified at last Milestone Review

Responsible: PQR, Points of Contact

Purpose: Provide feedback from Knowledge Networks and/or SPI team about status/results from previous organisational recommendations. Identify relevant lessons learned candidates based upon experiences from actions identified at last MR.

Execute this procedure at the Milestone Review

Estimate: 25 minutes

9. Follow up on actions identified at last MR (See). What has been achieved and how?

10. Follow up on recommendations given to the organisation (Knowledge Networks/SPI) as a result of the last MR (See). What has been the outcome of the recommendations?

Identify Lessons Learned

Responsible: Project team

Purpose: To suggest relevant lessons learned/experiences gained from the reviewed project period.

Execute this procedure at the Milestone Review

Estimate: 35 minutes

11. Conduct a ten minutes brainstorm session. Milestone participants write down their proposals for major lessons learned. Use differently coloured Post-It notes for positive/negative lessons

12. Summarise the outcome of the brainstorm. All notes are placed on the whiteboard, while each writer gives a short summary/explanation as each note is placed. Relate notes to subjects on the time line if possible

13. Group the notes. Two persons group the notes and while doing this they comment so all participants are able to follow the argumentation for selecting actual groups

14. Identify suitable headings for the groups of notes

15. Summarize and point out the most important headlines for each group by placing votes (e.g. four votes per project member)

16. Pick headlines (groups) with most votes and proceed with root cause analysis. Top four is selected for further analysis

Perform Root Cause Analysis

Responsible: Project team

Purpose: Further analysis of critical/important headings with the purpose of finding root causes and actions to eliminate these.

Execute this procedure in small groups

Estimate: 35 minutes

17. Divide project members into two groups and address two headlines to each

18. Identify root causes on selected headlines and place these in fishbone diagrams (notes on lessons learned are used as input)

19. Identify actions to eliminate root causes

Determine Project Actions

Responsible: Project team

Purpose: On the basis of the root cause analysis suggest actions to be taken in the coming project period to avoid negative effects/repeat positive

Execute this procedure at the Milestone Review

Estimate: 30 minutes

20. Present results from group work. Both groups draw their root cause diagrams on whiteboards and each group selects a spokesperson to present their root causes and action proposals

21. Discuss the actions identified. After each presentation, feedback (if any) is given from all participants

22. Agree on actions and document these in the Milestone Review Report (see)Draw a Milestone Review Report (MRR) and put in under configuration management [TPL#Milestone Review Report]

23. Treat actions as change management issues

Propose Organisational Recommendations

Responsible: Project team

Execute this procedure at the Milestone Review

Purpose: Post mortem analysis on the project milestone review, in order to identify recommendations with relevance to the organisation.

Estimate: 30 minutes

24. Walk through milestone review with organisational impact in mind. Issues to consider:
    - Positive and negative Lessons Learned
    - Root causes analysis
    - New actions identified at this Milestone Review
    - Effect of actions from previous Milestone Reviews

25. Identify organisational recommendations (if any)

26. Assign responsibility of organisational recommendations to individual project members (Points of contact).

27. Document organisational recommendations in the Milestone Review Report (MRR) and push these into relevant Knowledge Networks or SPI

Document Milestone Review

Responsible: PQR

Purpose: To document the MR in the MRR thus allowing for following up upon actions and for capturing relevant lessons learned.

Execute this procedure during/after the Milestone Review

28. Document the Milestone Review in the drawn Template (see)

Approve Milestone Review Report

Responsible: PM

Execute this procedure after the Milestone Review

29. Approve the Milestone Review Report. Project management treats and the suggestions as changes

Forward organisational recommendations to relevant Knowledge Networks and/or SPI

Responsible: Points of contact

Execute this procedure after the Milestone Review Report is approved

30. Forward the previously selected organisational recommendations (see) to the relevant Knowledge Networks and/or SPI team. Each Point of Contact (see) forwards relevant recommendations to hers/his Knowledge Network/SPI team.

Forward the Milestone Review Report to the Internal Auditor for registration and compliance

Responsible: PQR

Execute this procedure after the Milestone Review Report is approved

31. Forward Milestone Review Report to Internal Auditor and participants from the Milestone Review

E.3 Proposed Milestone Review Report

SYSTEMATIC software engineering a/s

Conduct Milestone Review Report

Prepared for

PreparedFor1

PreparedFor2

PreparedFor3

by

Systematic Software Engineering A/S

Frichsparken

Søren Frichs Vej 39

DK-8000 Århus C

Contract Number

ContractNumber

Approved by:	Project Management	Date	Internal QA	Date

Table of Contents

Guidelines

Conduct Milestone Review

The steps described in [PRO068 Milestone Review]]are involved in conducting a milestone Review.

The Milestone Review purpose is twofold:

- *Ensure project reflections by collecting experiences, lessons learned, good practices and reusable assets from previous activities and setting up critical success factors (actions) for the next period*
- *Consider relevant recommendations useable across the organisation based on lessons learned and experiences within the project*

Milestone Review ensures that both the project and the organisation learns from project's experiences and thereby avoids wasting resources learning the same lessons the hard way.

Structure of the MRR

The MRR consists of 7 sections:

Section 1:	*This section.*
Section 2:	*General Information identifying the project and the evaluation period covered by this MRR.*
Section 3:	*Follow up on actions identified at last Milestone Review*
Section 4:	*Lessons Learned*
Section 5:	*Root Causes*

Section 6:	*New Project Actions*
Section 7:	*Organisational Recommendations*

Writers guide

All sections marked with (M) are mandatory and must be filled according to the instructions in the section.

All sections marked with (O) are optional and may be filled according to the instructions in the section.

Unless explicitly noted, only data for the Milestone Review period should be used.

Sections 2 - 6 concern the project specific experiences and actions, and section 7 is focussed towards providing the rest of the organisation with relevant recommendations that will improve the internal processes.

General information (M)

Participants: ______________________

____

____

Submitted by: ______________________

Project: ______________________

Date of Session: ______________________

Covers the period: From: __________ To: __________

Type of milestone conducted:

__ Delivery to Customer __ Delivery from Customer

__ Delivery to Sub-contractor __ Delivery from Sub-contractor

__ Inter-group __ Internal

__Other: ______________________

Feedback from and Follow up on actions identified at last Milestone Review:

To make sure that the follow up actions are effective in this section of the MRR are documented the outcome of previous actions.

Follow Up on Actions

Document task [9] "Follow up on actions identified at last MR. What has been achieved and how?"

Action	Outcome/achievements

'Lessons learned':

Document task [11-15] "Conduct a ten minutes brainstorm session. Milestone participants write down their proposals for major lessons learned. Use differently coloured Post-It notes for positive/negative lessons, Summarise the outcome of the brainstorm. All notes are placed on the whiteboard, while each writer gives a short summary/explanation as each note is placed. Relate notes to subjects on the time line if possible, Group the notes. Two persons group the notes and while doing this they comment so all participants are able to follow the argumentation for selecting actual groups, Identify suitable headings for the groups of notes, Summarize and point out the most important headlines for each group by placing votes (e.g. four votes per project member)"

List the "Lessons Learned" prioritised after which were voted most important.

	Heading	Subject (What's on the note)
1		
2		
3		
...		

(Consider photographing whiteboards to supplement documentation)

Root Causes:

To document the complete process of identifying relevant issues regarding the project's progress this section documents the break-down of the top prioritised "lessons Learned".

Document tasks [20-21] "Present results from group work. Both groups draw their root cause diagrams on whiteboards and each group selects a spokesperson to present their root causes and action proposals, Discuss the actions identified. After each presentation, feedback (if any) is given from all participants"

Subject:	Headline or group of lessons learned
ID:	MR05-1/1
Observation:	Lessons learned
Root Cause:	
Recommendation:	We recommend these actions

(Consider photographing whiteboards to supplement documentation)

New Project Actions:

Document tasks [22-23] "Agree on actions and document these in the Milestone Review Report, Treat actions as change management issues"

Actions that should be initiated in project	Responsible	Start date
...		

Organisational Recommendations:

Follow Up on Previous Recommendations

Document task [10] "Follow up on recommendations given to the organisation (Knowledge Networks/SPI) as a result of the last MR. What has been the outcome of the recommendations?"

To verify that the organisational recommendations are useful document the outcome of previous recommendations

Recommendation	PoC	Outcome/achievements

New Recommendations

Document task [25-27] "Identify organisational recommendations (if any), Assign responsibility of organisational recommendations to individual project members (Points of contact), Document organisational recommendations in the Milestone Review Report (MRR) and push these into relevant Knowledge Networks or SPI"

The Points of Contacts are responsible for forwarding the relevant information regarding the recommendation including the cause for the recommendation, the necessary context etc. Provide in this table only the "heading" of the recommendation.

Recommendation	PoC	Relevant Knowledge Network/SPI

Appendix F

List of Publications

The following list includes the publications co-authored by the author of this thesis during the study.

Hansen *et al.* (2003a)[†] Hansen, B., Jacobsen, D., & Kautz, K. 2003a. Information Systems Development Methodologies in Practice. *In: International Conference on Information Systems Development (ISD).*

Hansen *et al.* (2003b) Hansen, B, Kautz, K., & Jacobsen, D. 2003b. Systems Development Methodologies in Practice. *In: Proceedings of the 26th IRIS Conference.*

Hansen *et al.* (2004a) Hansen, B., Rose, J., & Tjørnehøj, G. 2004a. Prescription, Description, Reflection: The Shape of the Software Process Improvement Field. *International Journal of Information Management*, 24(6), 457-472.

Hansen *et al.* (2004b)[*] Hansen, B., Rose, J., & Tjørnehøj, G. 2004b. Prescription, Description, Reflection: The Shape of the Software Process Improvement Field. *In: Proceedings of the UKAIS Conference 2004.*

Kautz *et al.* (2004) Kautz, K., Hansen, B., & Jacobsen, D. 2004. The Utilization of Information Systems Development Methodologies in Practice. *Journal of Information Technology Cases and Applications*, 6(4), 1-20.

Hansen & Kautz (2004a) Hansen, B. H., & Kautz, K. 2004a. Knowledge Mapping: A Technique for Identifying Knowledge Flows in Organisations. *In: Proceedings of the 27th IRIS Conference.*

Hansen & Kautz (2004b) Hansen, B. H., & Kautz, K. 2004b. Knowledge Mapping: A Technique for Identifying Knowledge Flows in Software Organisations. *Pages 126-137 of:* Dingsøyr, T. (ed), *Proceedings of Software Process Improvement, 11th European Conference (EuroSPI 2004).* Lecture Notes in Computer Science, no. 3281. Heidelberg, Germany: Springer, for EuroSPI. ISSN 0302-9743.

Hansen & Kautz (2005a) Hansen, B. H., & Kautz, K. 2005a. Analysing Knowledge Flows as a Prerequisite to Improve Systems Development Practice. *In:* Bartmann, D, Federico, R., Kallinikos, J., Avison, D., Winter, D., Ein-Dor, P., Becker, J., Bodendorf, F., & Weinhardt (eds), *Proceedings of the 13th European Conference on Information Systems.* ibi Research an der Universität Regensburg. ISBN: 3-937195-09-2.

Hansen & Kautz (2005b)[†] Hansen, B. H., & Kautz, K. 2005b. Grounded Theory Applied—Studying Information Systems Development Methodologies in Practice. *In: Hawaii International Conference on System Sciences (HICSS) 38.* Hilton Waikoloa Village, Hawaii: IEEE Computer Society, for HICCS.

Hansen & Nørbjerg (2005) Hansen, Bo H., & Nørbjerg, J. 2005. Codification or Personalisation a Simple Choice? *In:* Munkvold, B. E., & Rolland, K. (eds), *Proceedings of the 28th Information Systems Research in Scandinavia Conference (IRIS).*

Kautz & Hansen (2008) Kautz, K., & Hansen, B. H. 2008. Mapping Knowledge Flows. *Chap. 6, pages 89-102 of:* Nielsen, P. A., & Kautz, K. (eds), *Software Processes & Knowledge.* Aalborg, Denmark: Software Innovation Publisher.

[*]Awarded "Best Paper" [†]Nominated "Best Paper"

Bibliography

Aaen, I., Bøttcher, P., & Mathiassen, L. 1998. The Software Factory: Contributions and Illusions. *Pages 736–750 of:* Baets, W. R. J. (ed), *Proceedings of the 6th European Conference on Information Systems (ECIS)*, vol. 2.

Aaen, I., Arent, J., Mathiassen, L., & Ngwenyama, O. 2001. A Conceptual MAP of Software Process Improvement. *Scandinavian Journal of Information Systems*, **13**, 81–102.

Abrahamsson, P. 2001. Rethinking the Concept of Commitment in Software Process Improvement. *Scandinavian Journal of Information Systems*, **13**, 69–98.

Abrahamsson, P. 2002. Commitment Nets in Software Process Improvement. *Ann. Softw. Eng.*, **14**(1-4), 407–438.

Abrahamsson, P., & Kautz, K. 2002a. Personal Software Process—Classroom Experiences from Finland. *In: Proceedings of the Seventh European Conference on Software Quality.*

Abrahamsson, P., & Kautz, K. 2002b. The Personal Software Process—Experiences from Denmark. *In: Proceedings of the 28th EUROMICRO Conference.*

Ahern, D. M., Clouse, A., & Turner, R. 2001. *CMMI Distilled: An Introduction to Multi-discipline Process Improvement.* SEI Series in Software Engineering. Addison Wesley.

Andersen, I. 1990. *Choosing Organisational Sociological Methods: a Combination Perspective (In Danish: Valg af organisationssociologiske metoder: et kombinationsperspektiv).* Samfundslitteratur.

Arent, J. 2000. *Normative Software Process Improvement.* Ph.D. thesis, Aalborg University, Aalborg, Denmark.

Arent, J., & Nørbjerg, J. 2000. Software Process Improvement as Organisational Knowledge Creation—a Multiple Case Analysis. *In: Proceedings of the 33rd Hawaii International Conference on System Sciences.*

Argyris, C. 1993. *Knowledge for Action—a Guide to Overcoming Barriers to Organizational Change.* San Fransico, USA: Jossey-Bass.

Argyris, C., & Schön, D. 1974. *Theory in Practice: Increasing Professional Effectiveness.* San Francisco, USA: Jossey-Bass.

Avison, D., Lau, F., Myers, M., & Nielsen, P. A. 1999. Action Research. *Communications of the ACM*, **42**(1), 94–97.

Avison, D., Baskerville, R., & Myers, M. 2001. Controlling Action Research Projects. *Information Technology & People*, **14**(1), 28–45.

Bach, J. 1994. The Immaturity of the CMM. *American Programmer*, **7**(9), 96–98.

Bach, J. 1995. Enough About Process: What We Need are Heroes. *IEEE Software*, **12**(2), 96–98.

Bansler, J., & Bødker, K. 1993. A Reappraisal of Structured Analysis: Design in an Organizational Context. *ACM Transactions on Information Systems*, **11**(2), 165–193.

Basili, V., & Caldiera, G. 1995a. *The Experience Factory Strategy and Practice.* Technical Report CS-TR-3483, UMIACS-TR-95-67. University of Maryland.

Basili, V., & Caldiera, G. 1995b. Improve Software Quality by Reusing Knowledge and Experience. *Sloan Managemnet Review*, **(Fall)**, 55–64.

Basili, V., Caldiera, G., & Rombach, H. D. 1994a. The Experience Factory. *In:* Marciniak (1994).

Basili, V., Caldiera, G., & Rombach, H.D. 1994b. The Goal/Question/Metric Approach. *In:* Marciniak (1994).

Baskerville, R., & Pries-Heje, J. 1998 (10-13 December, 1998). Managing Knowledge Capability and Maturity. *Pages 175–196 of:* Larsen, T. J., Levine, L., & DeGross, J. D. (eds), *Proceedings of the IFIP WG 8.2 and 8.6 Joint Working Conference on Information Systems: Current Issues and Future Changes*.

Bem, D. J. 1995. Writing a Review Article for Psychological Bulletin. *Psychological Bulletin*, **118**(2), 172–177.

Bhandari, I., Halliday, M., Tarver, E., Brown, D., Chaar, J., & Chillarege, R. 1993. A Case-Study of Software Process Improvement During Development. *IEEE Transactions on Software Engineering*, **19**(12), 1157–1170.

Bilotta, J. G., & McGrew, J. F. 1998. A Guttman Scaling of CMM Level 2 Practices: Investigating the Implementation Sequences Underlying Software Engineering Maturity. *Empirical Software Engineering*, **3**(2), 159–177.

Birk, A., Dingsøyr, T., & Stålhane, T. 2002. Postmortem: Never Leave a Project Without It. *IEEE Software*, **May/June**, 43–45.

Bollinger, T. B., & McGowan, C. 1991. A Critical Look at Software Capability Evaluations. *IEEE Software*, **8**(4), 25–41.

borsen.dk. 2006 (June). *About the Gazelles (In Danish: Om Gazellerne)*. http://borsen.dk/1097. Accessed June 2006.

Brodman, J. G., & Johnson, D. L. 1994. What Small Businesses and Small Organizations Say about the CMM. *Pages 331–340 of: Proceedings of the 16th International Conference on Software Engineering*.

Brown, J. S., & Duguid, P. 1991. Organizational Learning and Communities-Of-Practice: Toward a Unified View of Working, Learning, and Innovating. *Organization Science*, **2**(1), 40.

Brown, John Seely, & Gray, Estee Solomon. 1995. The People Are the Company. *Retreived from http://www.fastcompany.com/magazine/01/people.html August 2008*, **1**.

Börjesson, A., & Mathiassen, L. 2003. Making SPI Happen: the IDEAL Distribution of Effort. *In: Proceedings of the 36th annual Hawaii International Conference.*

Bødker, Keld, & Pedersen, Jesper Strangaard. 1991. *Workplace Cultures: Looking at Artifacts, Symbol and Practices.* Lawrence Erlbaum Associates, Publishers. Chap. 6, pages 119–136.

Campbell, M. 1995. Tool Support for Software Process Improvement and Capability Determination: Changing the Paradigm of Assessment. *Software Process Newsletter, IEEE Computer Society*, 12–15.

Charitou, C. D., & Markides, C. C. 2003. Responses to Disruptive Strategic Innovation. *MIT Sloan Management Review*, **44**(2), 55–63.

Checkland, P. 1999. *Systems Thinking, Systems Practice.* West Sussex, UK: John Wiley and Sons.

Checkland, P., & Holwell, S. 1998. Action Research: Its Nature and Validity. *Systemic Practice and Action Research*, **11**(1), 9–21.

Christensen, C. M., Johnson, M. W., & Rigby, D. K. 2002. Foundations For Growth. *MIT Sloan Management Review*, **43**(3), 22–31.

Conradi, R., & Dingsøyr, T. 2000. Software Experience Bases: A Consolidated Evaluation and Status Report. *Pages 391–406 of:* Bomarius, F., & Oivo, M. (eds), *Procedings of the Second Int'l Conf. on Product Focused Software Process Improvement.* LNCS 1840. Springer Verlag.

Cook, S. D. N., & Brown, J. S. 1999. Bridging epistemologies: The generative dance between organisational knowledge and organisational knowing. *Organisational Science*, **4**, 381–400.

Curtis, B. 1994. A Mature View of the CMM. *American Programmer*, **7**(9), 19–27.

Cusumano, M. A. 1989. The Software Factory: A Historical Interpretation. *IEEE Software*, **6**(2), 23–30.

Davenport, T. H., & Prusak, L. 1998. *Working Knowledge - How Organizations Manage What They Know*. Boston, USA: Harvard Business School Press.

Deck, M. 2001. Managing Process Diversity While Improving Your Practices. *IEEE Software*, **18**(3), 21–27.

DeLillo, D. 1971. *Americana*. Penguin.

Deming, W. E. 1982. *Out of the Crisis*. Cambridge, Mass.: Productivity Press.

Diaz, M., & Sligo, J. 1997. How Software Process Improvement Helped Motorola. *IEEE Software*, **14**(5), 75–81.

Dingsøyr, T. 2001. *Knowledge Management in Medium-Sized Software Consulting Companies*. PhD, Unipub Publisher.

Dion, R. 1992. Elements of a Process-Improvement Program. *IEEE Software*, **9**(4), 83–85.

Dion, R. 1993. Process Improvement and the Corporate Balance Sheet. *IEEE Software*, **10**(4), 28–35.

Edgar-Nevill, V.M.A. 1994. Evaluation of the SEI Software Capability Model Within an Information Systems Context; in Pursuit of Software Quality. *Pages 263–278 of:* Brebbia, C. A., Ross, M., & Staples, G. Stapleton, J. (eds), *Software Quality Management II. Managing Quality Systems*, vol. 1. Computer Mechanical Publications.

El-Emam, K., Goldenson, D., McCurley, J., & Herbsleb, J. 2001. Modelling the Likelihood of Software Process Improvement: An Exploratory Study. *Empirical Software Engineering*, **6**(3), 207–229.

Fayad, M. E., & Laitnen, M. 1997. Process Assessment Considered Wasteful. *Communications of the ACM*, **40**(11), 125–128.

Fitzgerald, B. 1998a. An Empirical Investigation into the Adoption of Systems Development Methodologies. *Information and Management*, **34**(6), 317–328.

Fitzgerald, Brian. 1998b. An Empirically-Grounded Framework for the Information Systems Development Process. *In: Proceedings of ICIS (International Conference on Information Systems).*

Frederiksen, H. D., & Mathiassen, L. 2002. Diagnosing Metrics Practice in a Software Organisation. *In:* Harindranath, G., Wojtkowski, W.G., Zupancic, J., Rosenberg, D., Wojtkowski, W., Wrycza, S., & Sillince, J.A.A. (eds), *New Perspectives on Information Systems Development: Theory, Methods, and Practice.* Kluwer Academic.

Frederiksen, H. D., & Rose, J. 2003. The Social Construction of the Software Operation: Reinforcing Effects in Metrics Programs. *Scandinavian Journal of Information Systems*, **15**, 23–28.

Gasston, J., & Halloran, P. 1999. Continuous Software Process Improvement Requires Organisational Learning: An Australian Case Study. *Software Quality Journal*, **8**(1), 37–51.

Glaser, B. G., & Strauss, A. L. 1967. *The Discovery of Grounded Theory - Strategies for Qualitative Research.* New York, USA: Aldine De Gruyter.

Goldenson, D. R., & Herbsleb, J. D. 1995. *After the Appraisal: A Systematic Survey of Process Improvement, its Benefits, and Factors that Influence Success.* Technical Report CMU/SEI-95-TR-009. Software Engineering Institute (SEI).

Haley, T. J. 1996. Software Process Improvement at Raytheon. *IEEE Software*, **13**(6), 33–41.

Hansen, B., & Jacobsen, D. 2002. *Systems Development Methodologies in Practice—A Case-Study (In Danish: Systemudvilkingsmetoders anvendelse* *i Praksis—et casestudie).* M.Phil. thesis, Copenhagen Business School, Frederiksberg, Denmark.

Hansen, B., Jacobsen, D., & Kautz, K. 2003a. Information Systems Development Methodologies in Practice. *In: International Conference on Information Systems Development (ISD).*

Hansen, B., Kautz, K., & Jacobsen, D. 2003b. Systems Development Methodologies in Practice. *In: Proceedings of the 26th IRIS Conference.*

Hansen, B., Rose, J., & Tjørnehøj, G. 2004a. Prescription, Description, Reflection: The Shape of the Software Process Improvement Field. *International Journal of Information Management*, **24**(6), 457–472.

Hansen, B., Rose, J., & Tjørnehøj, G. 2004b. Prescription, Description, Reflection: The Shape of the Software Process Improvement Field. *In: Proceedings of the UKAIS Conference 2004.*

Hansen, B. H., & Kautz, K. 2004a. Knowledge Mapping: A Technique for Identifying Knowledge Flows in Organisations. *In: Proceedings of the 27th IRIS Conference.*

Hansen, B. H., & Kautz, K. 2004b. Knowledge Mapping: A Technique for Identifying Knowledge Flows in Software Organisations. *Pages 126–137 of:* Dingsøyr, T. (ed), *Proceedings of Software Process Improvement, 11th European Conference (EuroSPI 2004).* Lecture Notes in Computer Science, no. 3281. Heidelberg, Germany: Springer, for EuroSPI. ISSN 0302-9743.

Hansen, B. H., & Kautz, K. 2005a. Analysing Knowledge Flows as a Prerequisite to Improve Systems Development Practice. *In:* Bartmann, D., Federico, R., Kallinikos, J., Avison, D., Winter, D., Ein-Dor, P., Becker, J., Bodendorf, F., & Weinhardt, C. (eds), *Proceedings of the 13th European Conference on Information Systems.* ibi Research an der Universität Regensburg. ISBN: 3-937195-09-2.

Hansen, B. H., & Kautz, K. 2005b. Grounded Theory Applied—Studying Information Systems Development Methodologies in Practice. *In: Hawaii*

International Conference on System Sciences (HICSS) 38. Hilton Waikoloa Village, Hawaii: IEEE Computer Society, for HICCS.

Hansen, Bo H., & Nørbjerg, J. 2005. Codification or Personalisation—a Simple Choice? *In:* Munkvold, B. E., & Rolland, K. (eds), *Proceedings of the 28th Information Systems Research in Scandinavia Conference (IRIS)*.

Hansen, M. T., Nohria, N., & Tierny, T. 1999. What's Your Strategy for Managing Knowledge? *Harvard Business Review*, **77**(2), 106–116.

Hedberg, B. L. T. 1981. How Organizations Learn and Unlearn. *Pages 3–27 of:* Nyström, P. C., & Starbuck, W. H. (eds), *Handbook of Organizational Design vol. 1*. Oxford: Oxford University Press.

Herbsleb, J., Carleton, A., Rozum, J., Siegel, J., & Zubrow, D. 1994a. *Benefits of CMM-Based Software Process Improvement: Initial Results*. Tech. rept. Software Engineering Institute, Pittsburgh, PA, USA.

Herbsleb, J., Zubrow, D., Siegel, J., Rozum, J., & Carleton, A. 1994b. Software Process Improvement: State of the payoff. *American Programmer*, **7**(9), 2–12.

Herbsleb, J. D., & Goldenson, D. R. 1996. A Systematic Survey of CMM Experience and Results. *Pages 323–330 of: Proceedings of the 18th International Conference on Software Engineering*.

Herbsleb, J. D., & Grinter, R. E. 1998. Conceptual Simplicity Meets Organisational Complexity: Case-study of a Corporate Metrics Program. *In: Proceedings of the 1998 International Conference on Software Engineering: Forging New Links*.

Hofstede, Geert. 1981. Culture and Organisations. *International Studies of Management and Organizations*, **X**(4), 15–41.

Hollenbach, C., Young, R., Pflugrad, A., & Smith, D. 1997. Combining Quality and Software Improvement. *Communications of the ACM*, **40**(6), 41–45.

Holmqvist, M. 2003. A Dynamic Model of Intra- and Interorganizational Learning. *Organization Studies*, **24**(1), 95–123.

Huber, G. P. 1991. Organizational Learning: The contributing Processes and the Literatures. *Organization Science*, **2**(1), 88–115.

Hughes, B., & Cotterell, M. 2006. *Software Project Management*. 4 edn. Berkshire, UK: McGraw-Hill.

Humphrey, W. S. 1988. Characterizing the Software Process. *IEEE Software*, **5**(2), 73–79.

Humphrey, W. S. 1989. *Managing the Software Process*. Reading, MA, USA: Addison Wesley.

Humphrey, W. S. 1995. *A Discipline for Software Engineering*. 1 edn. SEI Series in Software Engineering. Reading, Massachusetts, USA: Addison-Wesley Publishing Company.

Humphrey, W. S. 1997. *Managing Technical People—Innovation, Teamwork, and the Software Process*. Software Engineering. Pittsburgh, USA: Addison Wesley.

Humphrey, W. S. 1998. Three Dimensions of Process Improvement. Part I: Process Maturity. *CrossTalk—The Journal of Defense Software Engineering*, **5**(2), 1–7.

Humphrey, W. S. 2002. Three Process Perspectives: Organizations, Teams, and People. *Annals of Software Engineering*, **14**(1-4), 39–72.

Humphrey, W. S., Snyder, T. R., & Willis, R. R. 1991. Software Process Improvement at Hughes Aircraft. *IEEE Software*, **8**(4), 11–23.

Iversen, J. 2000. *Data-driven Intervention in Software Process Improvement*. Ph.D. thesis, Aalborg University, Aalborg, Denmark.

Iversen, J., & Mathiassen, L. 2003. Cultivation and Engineering of a Software Metrics Program. *Information Systems Journal*, **13**(1), 3–19.

Iversen, J., Nielsen, P. A., & Nørbjerg, J. 1999. Situated Assessment of Problems in Software Development. *ACM SIGMIS Database*, **30**(2), 66–81.

Johnson, D. L., & Brodman, J. G. 1995. Realities and Rewards of Software Process Improvement. *Software process—Improvement and Practice*, **1**(1), 35–47.

Johnson, D. L., & Brodman, J. G. 1996. Realities and Rewards of Software Process Improvement. *IEEE Software*, **13**(6), 99–101.

Juran, J. M., & Gryna, F. 1988. *Juran's Quality Control Handbook*. 4th edn. New York: McGraw-Hill Book Company.

Kautz, K., & Hansen, B. H. 2008. Mapping Knowledge Flows. *In:* Nielsen & Kautz (2008).

Kautz, K., & Nielsen, P. A. 2004. Understanding the Implementation of Software Process Improvement Innovations in Software Organizations. *Information Systems Journal*, **14**(1), 3–22.

Kautz, K., & Thaysen, K. 2001. Knowledge, Learning and IT Support in a Small Software Company. *Journal of Knowledge Management*, **5**(4), 349–357.

Kautz, K., Hansen, H. W., & Thaysen, K. 2000. Applying and Adjusting a Software Process Improvement Model in Practice: the Use of the IDEAL Model in a Small Software Enterprise. *In: Proceedings of the 22nd International Conference on Software Engineering*.

Kautz, K., Hansen, B., & Jacobsen, D. 2004. The Utilization of Information Systems Development Methodologies in Practice. *Journal of Information Technology Cases and Applications*, **6**(4), 1–20.

Kautz, K. H., Thaysen, K., & Vendelø, M. T. 2002. Knowledge Creation and IT Systems in a Small Software Firm. *OR Insight*, **15**(2).

Kelly, D. P., & Culleton, B. 1999. Process Improvement for Small Organizations. *Computer*, **32**(10), 41–47.

Kohutek, H. J. 1996. Reflections on the capability and Maturity Models of Engineering Processes. *Quality and Reliability Engineering International*, **12**(3), 147–155.

Konrad, M., Chrissis, M. B., Ferguson, J., Garcia, S., Hefley, B., Kitson, D., & Paulk, M. 1996. Capability Maturity Modeling at the SEI. *Software Process—Improvement and Practice*, **2**(1), 21–34.

Kuhn, T. S. 1962. *The Structure of Scientific Revolutions*. Chicago, USA: University of Chicago Press.

Kuvaja, P. 1999. BOOTSTRAP 3.0—A SPICE1 Conformant Software Process Assessment Methodology. *Software Quality Journal,*, 7–19.

Kuvaja, P., & Bicego, A. 1994. BOOTSTRAP—a European Assessment Methodology. *Software Quality Journal*, **3**(3), 117–127.

Kuvaja, P., Similä, J., Krzanik, L., Bicego, A., Saukkonen, S., & Koch, G. 1994. *Software Process Assessment & Improvement—The Bootstrap Approach*. Blackwell Publisher.

Kuvaja, P., Palo, J., & Bicego, A. 1999. TAPISTRY—A Software Process Improvement Approach Tailored for Small Enterprises. *Software Quality Journal*, **8**(2), 149–156.

Lanzara, G. F., & Mathiassen, L. 1985. Mapping Situations Within a System Development Project. *Information & Management*, **8**(1), 3–20.

Laporte, C., & Papicco, N. 1998. Software and Systems Engineering Process Development and Integration at Oerlikon Aerospace. *Software Process Newsletter*, **11**, 10–17.

Larsson, S, & Kolb, P. 2002. Software Process Improvement at ABB. *Civil Engineering*, **150**(6), 46–49.

Levinthal, D., & March, J. G. 1993. The Myopia of Learning. *Strategic Management Journal*, **14**(Winter Special Issue: Organizations, Decision Making and Strategy), 95–112.

Levitt, B., & March, J. G. 1988. Organizational Learning. *Annual Review of Sociology*, **14**, 319–340.

Liebowitz, J., & Beckman, T. 1998. *Knowledge Organization*. Boca Raton, USA: St. Lucie Press.

Lyytinen, K., Mathiassen, L., & Ropponen, J. 1998. Attention Shaping and Software Risk–A Categorical Analysis of Four Classical Risk Management Approaches. *Information Systems Research*, **9**(3), 3.

Madsen, S., & Kautz, K. 2002. Applying System Development Methods in Practice—The RUP Example. *In: Proceedings of the International Conference on Information Systems Development (ISD)*.

March, J. G. 1991. Exploration and Exploitation in Organizational Learning. *Organization Science*, **2**(1; Special Issue: Organizational Learning: Papers in Honor of (and by) James G. March), 71–87.

Marciniak, J. J. (ed). 1994. *Encyclopedia of Software Engineering*. West Sussex, UK: John Wiley & Sons, Inc.

Mathiassen, L. 2002. Collaborative Practice Research. *Information Technology & People*, **15**(4), 321–345.

Mathiassen, L., & Pourkomeylian, P. 2003. Managing Knowledge in a Software Organisation. *Journal of Knowledge Management*, **7**(2), 63–80.

Mathiassen, L., Pries-Heje, J., & Ngwenyama, O. 2002. *Improving Software Organizations: from Principles to Practice*. Redwood City, CA, USA: Addison Wesley Longman Publishing Co., Inc.

Matsumoto, Y. 1981. SWB System: A Software Factory. *Pages 305– 318 of:* Hunke, H. (ed), *Software Engineering Environments*. North-Holland.

Matsumoto, Y. 1987. A Software Factory: An Overall Approach to Software Production. *Pages 155–178 of:* Freeman, P. (ed), *Tutorial Software Reusability*. Washington, D.C., USA: EEE Computer Society.

Miles, M. B., & Huberman, A. M. 1994. *Qualitative Data Analysis: an Expanded Sourcebook*. 2nd edn. Sage Publications.

Mintzberg, H. 1983. *Structures in Fives: Designing Effective Organizations*. Prentice-Hall International Editions. New Jersey, USA: Prentice-Hall.

Mintzberg, H. 1990. Strategy Formation: Schools of Thought. *In:* Fredrickson, J. W. (ed), *Perspectives on Strategic Management*. New York, USA: Harper Business.

Ngwenyama, O., & Nielsen, P. A. 2003. Competing Values in Software Process Improvement: An Assumption Analysis of CMM from an Organizational Culture Perspective. *IEEE Transactions on Engineering Management*, **50**(1), 100–112.

Nielsen, P. A. 2003. *Software Processes and Knowledge (In Danish: Software Processer og -Viden)*. Terms of Reference for the SPK project.

Nielsen, P. A., & Kautz, K. (eds). 2008. *Software Processes & Knowledge*. Aalborg, Denmark: Software Innovation Publisher.

Nonaka, I. 1994. A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, **5**(1), 14–37.

Orwell, G. 1949. *Nineteen Eighty-Four*. Martin Secker & Wartburg Ltd.

Paulk, M. C., Curtis, B., Chrissis, M. B., & Weber, C. 1993. *Capability Maturity Model for Software ver. 1.1*. Technical report CMU/SEI-93-TR-24. Software Enginering Institute.

Paulk, M. C., Weber, C., Curtis, B., & Chrissis, M. B. 1995. *The Capability Maturity Model: Guidelines for Improving the Software Process*. Reading, MA, USA: Addison Wesley.

Paulk, M. C., Curtis, B., Chrissis, M. B., & Weber, C. V. 1996. *The Capability Maturity Model for Software*. Tech. rept. Carnegie Mellon University, Software Engineering Institute.

Polanyi, M. 1966. *The Tacit Dimension*. London, UK: Routlege and Kegan.

Pries-Heje, Jan, Nørbjerg, Jacob, Aaaen, Ivan, & Elisberg, . Thomas. 2008. The Road To High Maturity. *In:* Nielsen & Kautz (2008).

Pulford, K., Kuntzmann-Combelles, A., & Shirlaw, S. (eds). 1995. *A Quantitative Approach to Software Management: the AMI Handbook*. Boston, MA, USA: Addison-Wesley Longman Publishing Co., Inc.

Quinitas, P., Lefrere, H., & Jones, G. 1997. Knowledge Management: A Strategic Agenda. *Long Range Planning*, **30**(3), 385–391.

Quinn, J. B., Anderson, P., & Finkelstein, S. 1996. Managing Professional Intellect: Making the Most of the Best. *Harvard Business Review*, **74**(2), 71–80.

Rapoport, R. N. 1970. Three Dilemmas in Action Research. *Human Relations*, **23**(6), 499–513.

Reifer, D. J. 2002. The CMMI: It's Formidable. *The journal of Systems and Software*, **50.**, 97–98. Guest editor's corner.

Saiedian, H., & Chennupati, K. 1999. Towards an Evaluative Framework for Software Process Improvement Models. *J. Syst. Softw.*, **47**(2-3), 139–148.

Schein, E. 1973. *Professional Education*. New York, USA: McGraw Hill.

Schultz, M. 1990. *Culture in Organisations (In Danish: Kultur i Organisationer)*. Handelshøjskolens Forlag.

Shapiro, C., & Varian, H. R. 1999. *Information Rules - A strategic Guide to the Network Economy*. Boston, USA: Harvard Business School Press.

Snyder, W. M., & Cummings, T. G. 1998. Organization Learning Disorders: Conceptual Model and Intervention Hypothesis. *Human Relations*, **51**(7), 873–893.

SSE. 2002. *Intellectual Capital Report 2002*. Systematic Software Engineering, http://systematic.dk/sseweb/downloadfile.aspx?id=8.

SSE. 2004a. *Annual Report 2002-2003 (In Danish: Årsrapport 2002-2003).* Systematic Software Engineering, http://systematic.dk/sseweb/downloadfile.aspx?id=131.

SSE. 2004b. *Intellectual Capital Report 2004*. Systematic Software Engineering, http://systematic.dk/sseweb/downloadfile.aspx?id=140.

Strauss, A., & Corbin, J. 1998. *Basics of Qualitative Research*. London, UK: SAGE Publications.

Swan, J., Newell, S., Scarbrough, H., & Hislop, D. 1999a. Knowledge Management and Innovation: Networks and Networking. *Journal of Knowledge Management*, **3**(4), 262–275.

Swan, J., Scarbrough, H., & Preston, J. 1999b. Knowledge Management? The Next Fad to Forget People. *Pages 668–678 of:* Pries-Heje, J., Ciborra, C., Kautz, K., Valor, J., Christiaanse, E., Avison, D., & Heje, C. (eds), *Proceedings of the 7th European Conference on Information Systems (ECIS-99), Copenhagen, Denmark*. AIS.

Tiedeman, M. J. 1990. Post-Mortems-Methodology and Experiences. *IEEE Journal on Selected Areas in communications*, **8**(2), 176–180.

Walsh, J. P., & Ungson, G. R. 1991. Organizational Memory. *The Academy of Management Review*, **16**(1), 57–91.

Walsham, G. 1995. Interpretive Case Studies in IS Research: Nature and Method. *European Journal of Information Systems*, **4**, 74–81.

Weber, Herbert. 1997. *The Software Factory Challenge*. Amsterdam, Netherlands: IOS Press.

Webster, J., & Watson, R. T. 2002. Analyzing the Past to Prepare for the Future: Writing a Literature Review. *MIS Quartely*, **26**(2), xiii–xxiii.

Wenger, E. 1998. *Communities of Practice*. New York, USA: Cambridge University Press.

Wenger, E. 2000. Communities of Practice and Social Learning Systems. *Organization*, **7**(2), 225–246.

Whitman, Michael E., & Woszczynski, Amy B. 2003. *The Handbook of Information Systems Research*. Idea Group Inc (IGI).

Wiegers, K. 1999. Software Process Improvement in Web Time. *IEEE Software*, **16**(4), 78–86.

Wohlwend, H., & Rosenbaum, S. 1994. Schlumberger's Software Improvement Program. *IEEE Transactions on Software Engineering*, **20**(11), 833–839.

Wright, S. 1999. *http://www.pogner.demon.co.uk/mil_498/*. MIL-STD-498.

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