MEANS FOR INTERNAL KNOWLEDGE REUSE IN PRE-DEVELOPMENT – THE TECHNOLOGY PLATFORM APPROACH

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ABSTRACT
Effective knowledge sharing within the R&D department is important to build and benefit from a company's portfolio of technologies. This paper presents challenges with accessing and sharing knowledge during pre-development, and elaborates on the potential of using a wiki and checklists as supporting tools. A wiki demonstrator for collecting knowledge about technologies was developed and received very positive response from the interviewees at a case company.
The study was conducted as part of a research project about how a technology platform framework can increase the leverage of technology development efforts through increased reuse and strategic investments. The framework is intended to be used as a basis for technology development and when designing and configuring new products. New challenges arise for technology platforms compared to traditional product platforms as they support reuse on a higher abstraction level.

Keywords: Technology Development, Technology Platform, Pre-Development, Wiki, Maturity Checklists

1 INTRODUCTION

1.1. Product centric platforms
In this research paper, the term platform is used to describe the reusable assets connected to a product or a technology. This includes the technology development process where the underlying product technologies are developed and the production process where the product is manufactured. Hence, the term product platform as defined by Robertsen and Ulrich [1] is representative for how the term is used in this paper.
Traditional research regarding product platforms focuses on the economy of scale for manufacturers of consumer goods. The main idea is to spread the cost of product development over a wide range of products that share the same sub systems and components (internal leveraging). It is also possible to increase the product offer to the market (external leveraging). However, all businesses do not have a product offering suitable for sharing components across product families; the reuse has to be found elsewhere. For example, suppliers of custom and small series can find this economy of scale as they create and reuse knowledge on a higher abstraction level than components. Technology Platforms have been developed to meet the challenges regarding a diverse product portfolio where components cannot be reused [2].

1.2. The aero engine industry
An aircraft engine is a multi-technology, multi-component product involving high costs and intensive engineering. The complex nature of the aircraft engine is similarly reflected in the multi-tiered, multi-player aircraft engine industry. Unlike the traditionally-tiered buyer-seller model, the aircraft engine industry is characterized by six interdependent groups: the airlines, the airframes, the certification agencies and professional bodies, the government-funded laboratories and universities, the risk and revenue sharing partners, and the suppliers [3].
The industry is characterized by low volumes and long development times in order to fulfill legislation and safety requirements. This makes the industry conservative by nature. The tradition of developing military aircraft and engines (as a traditional basis for producing civilian engines) led to a business model where defense contracts pay for the complete product development. With a higher focus on civilian aircraft and cost reduction, this business model has been abandoned. Hence, it is important to

be more efficient in product development and find means to spread the development cost over a larger quantity of products.
The main business processes concerned in this work are the technology development process, the product development process, and the production development process (often called process development).
The technology development process concerns the development and commercialization of new technologies. Risk and revenue sharing partners often use technologies as assets when negotiating collaboration and risk/revenue sharing; hence, the great focus on technology.
The product development process (sometimes referred to as New Product Development) concerns the development of a new jet engine, where different stakeholders are responsible for different parts according to the organization described above.
Finally, process development concerns the development of the manufacturing system and its supply chain. This involves factory and resource planning.
In previous research at the case company, a technology platform concept has been presented. With the framework set, a large work regarding the details and the implementation of the technology platform is ongoing. This framework is further described in chapter 4.

1.3. Process and system support for collaboration

The implementation of a technology platform work procedure is both an information management and an organizational issue. The information represented in the platform needs to be continuously updated and available. There must also be an organizational support and encouragement for capturing and reusing that information. Information management in this context concerns both the information and communication systems and interaction with the user.
There are several ways to implement a technology platform and make it accessible through IT systems. Of particular interest for this research was the use of Web 2.0 technologies (such as wikis and blogs) since they deliver an interactive and collaborative environment, enabling social interaction and collective intelligence [4].
The scope of this paper is to investigate the process needs and IT support needed for a technology platform-based work procedure in technology development. The paper will also discuss possible implications regarding the subsequent product and process development. The following research questions are to be answered within this research paper:

What are the organizational needs regarding knowledge reuse in pre-development?
This question aims to discover the new processes needed to support a technology platform work procedure with more reuse of knowledge earlier in the development phases. This includes the processes that drive the technology, product, and process development. Focus is on how to set up the earliest phases, which are currently not supported much by either process or IT support.

Which tools and procedures can be adapted to support internal knowledge reuse in pre-development?
This question aims to identify clear tools and procedures that can be used to implement the technology platform within the organization. Web 2.0 solutions have shown a great potential to solve knowledge management difficulties and there are also tools from the quality assurance field and lean product development that can be assessed and used in this context.

2. METHODOLOGY

This qualitative case study was conducted as a part of a research initiative that started in 2007 about the implementation of a platform approach at one particular company. The case company, Volvo Aero Corporation is a wholly owned subsidiary of AB Volvo. Its main operations are located in Sweden, but it has subsidiaries in Norway and the USA. The case company develops and produces components for aircraft, rocket and stationary gas turbine engines that possess high-technology content, in cooperation with the world's leading manufacturers. It acts on the global market and its main operations are as a subcontractor supplying its customers with specialist components. The case company is a suitable company since it puts great focus on the development and marketing of technology. Further information about the platform strategies regarding the case company can be found in Berglund et al. [5].

This paper is based on research from technology development, product development and process development projects carried out at the company between autumn 2007 and autumn 2010. The data collection has been a combination of observations (attending meetings), semi-structured interviews (lasting for about two hours, focused on reuse and platforms), workshops and presentations at the participating company.
The project is now in a phase where the overall platform framework has been decided and the platform framework processes and tools are being designed. This paper is hence to a large extent prescriptive and focused on solution concepts mainly suggested by the researchers.
Specifically for this paper an interview study was performed during autumn of 2010. In total 12 people were interviewed regarding their view on a technology platform processes, tools and IT-support. The interviewees were working in the development organization as technology developers, manufacturing method owners, or managers from either the project or line organization. The interviews lasted on average 1h 30 minutes. All interviews were recorded and transcribed. The transcriptions was also read and corrected by the interviewees. The results from the interviews form the basis for the result chapter, while the previous studies are reflected over in the following discussion chapter.
Further, a demonstrator, presented in chapter 4.3, was developed and shown to the interviewees in order to get feedback on a potential IT solution for technology information. The demonstrations where held late during the interviews so that their answers where not influenced by them.

3. FRAME OF REFERENCE

3.1. Platform aspects

Product platforms are recognized as offering a number of advantages in the marketplace as well as within the organization. As a result, researchers have studied and proposed suitable frameworks, methods, and mathematical tools to assist in the selection of the platform elements within different industries. They are summarized by Simpson [6], Simpson et al. [7], Jose and Tollenaere [8] and Yang et al. [9].
Standardization and modularization in design and production are key to realizing the internal leverage of platforms. Techniques for implementing standardization and modularity for resources within organizations are discussed in a number of publications including Baldwin and Clark [10] and Ericsson and Erixon [11].
In an overview paper regarding technology platforms, Jolly et al. [12] found that a technology platform represents the development of a set of technological competencies or capabilities that map onto a wide variety of market opportunities. It concerns the reuse, deployment, and configuration of existing technology assets within a new context.
The technology platform captures assets (physical and non-physical) of a platform unlike a product platform [12]. Technologies within a technology platform can then be combined to develop new products and product lines. A well-known example of a company that uses a technology platform to yield innovations is 3M. Their core strength is derived from technology platforms such as adhesives, abrasives, and vapor processing.
Meyer and Lehnerd [14] discuss the generic capabilities that are shared between product platforms, and refer to them as building blocks. They divide these into four categories of which two, product technologies and manufacturing processes, are similar to technology platforms. The other categories, consumer insights and organizational capabilities, are outside the scope of a technology platform.
The process that mainly drives the technology platform is the technology development process. An example of a normative process model is the stage gate process developed by Cooper [15], named the technology development (TD) Stage-Gate model. The different gates include defined criteria to assess the potential value of the technology as well as e.g. its characteristics or associated cost and risk. NASA Technology Readiness Levels (TRL) [16] are often used to indicate the maturity of such technology development [17].

3.2. Knowledge management

As a research subject, knowledge management comes very close to the intent of a technology platform.
New technologies can provide opportunities to exploit new markets and create a foundation for a firm’s success, thereby creating a platform for a firm’s business. Kim and Kogut [18] argue that

technology platforms represent the coincidence of market and technological opportunities and that this usually happens when markets are not yet well-defined. As technologies age, they argue, market opportunities are filled. In the sense of platform thinking, the knowledge of a firm can be considered as owning a portfolio of options, or platforms, on future developments [19]. The knowledge of the firm can be seen as relatively observable. Examples of tangible representations of this knowledge include operating rules, manufacturing technologies, and customer data banks. Know-how in turn is more intangible, and is the accumulated practical skill or expertise that allows one to do something smoothly and efficiently [20]. Knowledge can also be intangible in the sense that it is embedded in the organization's structure, its systems and procedures, the work place organization and tools, the working traditions and practices, the management style and philosophy and the decision-making, planning and control procedures [21]. Patriotta [22] presents the knowledge-based view of the firm, and emphasizes firm-specific, difficult-to-imitate assets as a source of sustainable competitive advantage. Some of the most valuable assets of an organization are often hidden and invisible to its owners, managers and other stakeholders. These assets are the knowledge possessed by individuals and the organization's knowledge assets, which include its technology assets [21]. This knowledge needs to be managed, and can be a foundation or a platform for building new knowledge and creating value. In order to identify opportunities for managing the knowledge, critical knowledge functions that contribute most significantly to the success factors of the business must be identified [21].

3.3. Information systems and technologies

Traditionally, PDM and ERP systems have been used in the manufacturing industry to manage product and production information. These systems are continuously developed to incorporate more and more functions [23]. The system supplier also incorporates Web 2.0 solutions to complement their existing software suites. It has also been shown by Malmqvist [24] that PDM systems are relatively flexible and can be used for data management purposes they were not initially designed for. The classic object-oriented approach makes virtually any use possible.

However, in a comparison with modern Internet-based communities and sites, the traditional IT system seems rigid and old fashion. In the field of knowledge management, several Web 2.0 solutions have been presented to show a great potential, e.g. for fostering collaboration and interaction in dispersed workgroups [25].

Specifically, Walthall et al. [26] show that wikis are relatively easy to use, although they lack in several important functions regarding the integration of graphics, meta data and management options. However, this is related to the specific solution/supplier you choose to work with.

As presented in Schneckenberg [25], there are fundamental differences between Web 2.0 solutions and traditional IT systems. Traditional IT systems can be compared to the hierarchical pyramid structure, and the flat pancake structure can be represented by the dynamic Web 2.0 technologies. He further proposes that the new flexible Web 2.0 solutions can increase corporate efficiency when knowledge and decision-making capabilities can be made on a lower organizational level.

3.4 Lean influences in product and technology development

Lean product development is a hot topic in product development. There are several tools presented in the lean literature that can be used for early development and to assure risk e.g [27]. Common features are that the tools are often physical (walls and boards) and very easy to use. The lean movement has led to a shift in many industries towards lightweight solutions since the rigid IT solutions are difficult to master. In the context of this work, especially the use of checklists and guidelines to manage and assure corporate knowledge is interesting as an alternative to rigid PDM or ERP systems.

4. THE PLATFORM FRAMEWORK

The technology platform framework, first presented in Berglund et al. [5], is designed around three major industrial capabilities regarding process, product, and technology development (Figure 1).

4.1 Description of the framework

The framework contains definitions of the core platform and the related components. The core platform, consisting of a product platform, a production platform and a technology platform, contains the high value reusable assets of the company. The product platform contains product families and design concepts that are the basis for the case company's products, while the process platform contains

the production methods and concepts configured and used in the factories. This framework leaves non-reusable assets outside the platform, such as manufactured components, machines in the factory and immature technologies.
The base of the current platform framework is the technology platform. The product and production concepts are created from known and reusable technologies. The mapping within the platform from technology towards product and production concepts is one of the great challenges of this research project. The platform is also believed to help the synchronization of product development and production by giving a process support for these parallel development processes.
Each part of the platform has its "platform owner" that corresponds to a high organizational belonging. Hence, the management of product development is also the owner of the product platform.

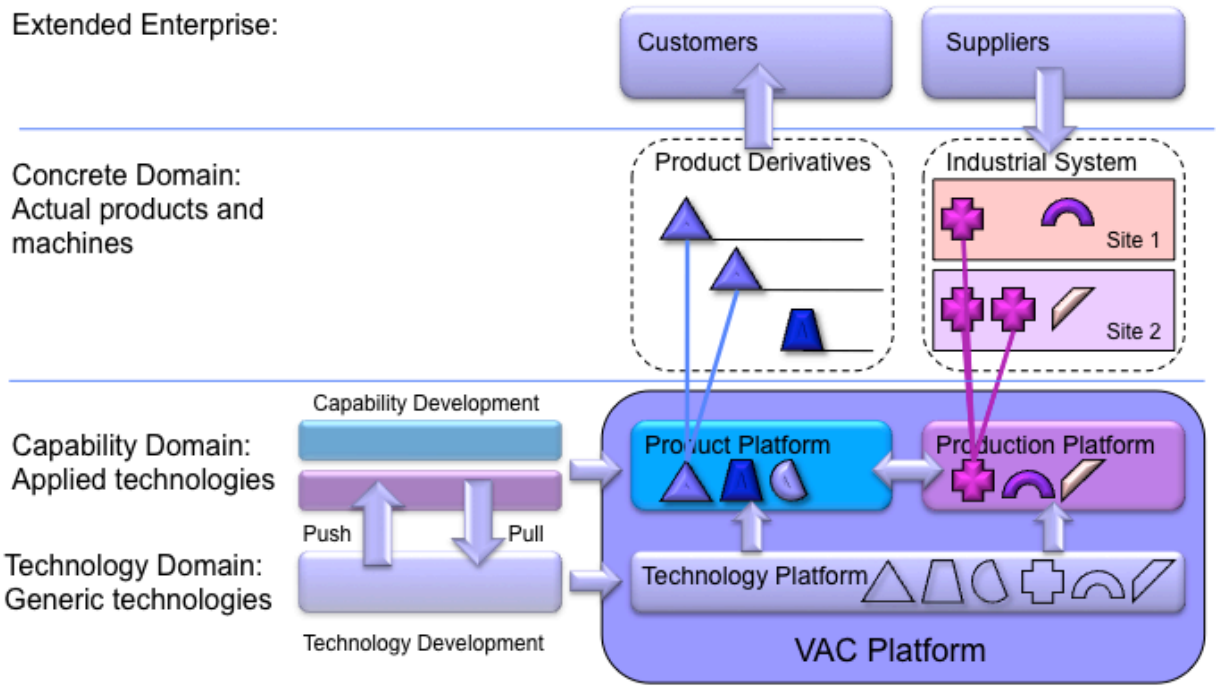

Figure 1. The technology platform framework utilized at the case company

4.2 Perceived benefits from the platform approach

The platform needs to contribute business value by incorporating knowledge from other domains in order to increase performance and reduce manufacturing costs.
A key function of the platform is to better predict and manage production and product development over time. If you can more accurately predict when a new technology is going to be mature, you can with higher certainty market and potentially exploit the advantages of this technology earlier. This way of working will reduce risk both in prediction and in actual implementation since technologies can be mature and tested in different applications. The platform can also be used to group key technologies and market them towards customers. Other important processes that are supported are gap analyses (to find and reduce research gaps), prioritizing development projects, and spreading new knowledge internally to other projects and development groups.

4.3 The wiki demonstrator

A local wiki-based website was set-up by the authors on a laptop as a hypothesis on how the technology platform could be embodied in order to gather and display knowledge on technologies. A wiki is a website structure consisting of an indefinite collection of pages where any registered user can add or edit pages in an in-built editor. The best-known example is Wikipedia, which is an encyclopedia that has grown organically from small contributions of information from users worldwide. The main ways of finding information in a wiki are through links between pages and an efficient search engine. A version tracker is normally present to prevent information loss from misusage. The wiki format was chosen for this demonstrator mainly based on its ability to give multiple authors an easy tool for sharing their knowledge and experience. A framework for the content was set up by creating a top-node page called "Technologies" linking to four pages with technology

categories called “Manufacturing methods”, “Design solutions”, “Engineering methods” and “Test & control methods”. These four pages contained links to pages about technologies identified at the case company with information in the order of two to four A4-pages. The three page levels are illustrated in Figure 2 with the third level containing proposed headings for a manufacturing method. Only a few pages were filled with information to illustrate the concept.

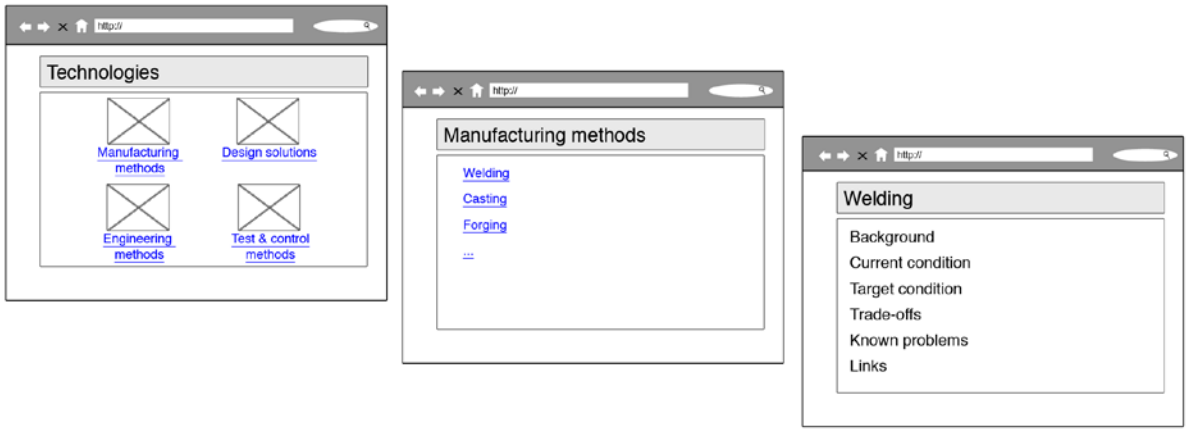

Figure 2. Page levels in the wiki demonstrator

5. RESULTS

This chapter presents the findings from the interviews sectioned according to the themes of the interview guide. A summary is found at the end of the chapter.

5.1 Perceived benefits of implementing a technology platform

The recent introduction of the platform framework at the case company means that it is still in its infancy, and all the interviewees had high expectations on the positive effects it would bring to cost efficiency, risk reduction and shorter development lead-time. The product and production platform have come further in their implementation than the technology platform. The overlap between the three platforms (product, production and technology) was commonly mentioned, but while most welcomed the distinction, others perceived technologies as inseparable from the product and production platforms. There were two main arguments for why a separate technology platform was needed. The first was that technologies should be developed as generic capabilities to prepare for reuse in multiple products, and the second was that development costs often need to be shared to justify investments in promising novelties. By fulfilling these two purposes, it was argued, the technology platform could feed the other two platforms and support planning to increase efficiency and synchronization of development.

5.2 Current modes of accessing knowledge

The interviewees had different needs regarding the availability of technology information. Some of the managers said they seldom searched for that kind of information personally, but indicated that it was important for them to be updated and knowledgeable to be able to assess the relevance and accuracy of decisions taken by designers. Designers, on the other hand, were often faced with questions regarding the standard procedures and recommended ways of solving design issues, such as setting tolerances or understanding implications of design choices on manufacturability and cost. Employees working with technology development and product planning were typically interested in following the most recent activities on immature technologies and examining the current possibilities and limitations with existing technologies. Examples of such situations were when advances in technologies are used as input to concept generation for future products or when new concepts pose new challenges for manufacturing methods. There existed a variation of means to access this type of information, and the sources stated as most often used were meetings with experts, seminars and informal discussions with colleagues. Some considered finding the right person to ask straightforward while others found it

cumbersome. Most interviewees agreed that the process was quicker when you had personal contacts within the company.
Interviewees working in later phases of product development talked more about accessing detailed information about other products to gain from earlier experiences and avoid rework on solving similar problems. Examples include finding specifications on tolerances for drilling holes or getting a cost estimate on a design feature. Specifications collected in a web-based library were mentioned as an important source of such information, but also documents that they or their colleagues had available from earlier projects. Since project teams included members from different departments, another common method was to ask the most relevant representative in one's product development project who either had the answer or otherwise could find someone who had. Several interviewees commented that the amount of general information sought decreased as the development progressed, in favor of more details about the product and design standards.
In the beginning of new projects there is a requirement that lessons learned from relevant earlier projects are reviewed to gain from that experience. However, the interviewees pointed out that the technical lessons from projects were difficult to incorporate in new projects. There were several theories for why, the prominent one being that the lessons learned are written after the project is closed and hence focusing more on project management issues rather than on technical issues.

5.3 Current modes of sharing knowledge

The most common modes of sharing knowledge within projects and departments were by discussions, meetings or emails. They also used shared folders in a web-interface for their working files, and to notify colleagues of important updates in those folders it was common to send an email with a link to the new or updated document. Reports and specifications that are reviewed and approved are filed to a document management system. The system was however considered more of an archive than a place for publishing documents
Some interviewees used seminars to share knowledge and inform others about the progress and discoveries in their projects. One of the interviewees commented that the company is small enough to gather the most important stakeholders for a seminar if there was something important they wanted to share. There were several statements about the lack of a place to publish general information about technologies. The main means for publishing new technologies internally is by publishing electronic reports. Some interviewees demanded easier, ways to make knowledge available in the organization, since the process of writing a full report is time consuming. Some interviewees knew that a wiki was being tested for sharing experiences and informal information at the company, and one of them had participated in a small project to add information about products in that wiki. The creator of the wiki was another interviewee who explained that it was meant for collecting experiences and opinions about process descriptions and instructions for how to design different parts and features.

5.4 Attitudes toward using Web 2.0 solutions for sharing knowledge

Before showing the wiki-demo, the interviewees were asked about their experience of Web 2.0 solutions, which was explained to them as collaborative web applications such as wikis, blogs and forums. Most of them used Wikipedia to find information in their spare time and some also at work, and about half of them knew about the internal wiki mentioned earlier. Few of them had contributed to any wikis; one had added information to Wikipedia and two had added information to the internal wiki as part of their work tasks. One of the interviewees had an internal blog about a large ongoing product development project and most of the others knew about it and read it regularly, even if they were not directly connected to the project. The most common answer to why they read the project blog was that it was an important project to the company, which made it interesting to follow and the events would have ripple effects on most people's work. Other blogs that were followed by a handful of respondents was the blog of the company's CEO and that of an external consultant who reported on news in the industry. Discussion forums were mentioned by some as valuable when searching for a solution to a problem outside work, mostly by finding the discussions of others through general search engines such as Google. Only one of the respondents mentioned having taken an active part in forum discussions.
When asked about the potential of using such tools internally at the company, about half of the respondents were slightly positive and the other half was fully positive. A typical statement by the first group was "Why not?", while an example from the latter was "We must use them more to stay competitive". The benefits mentioned were improved search ability, a tool for sharing knowledge and

an area for getting in contact with others having similar problems as one-self. A couple of interviewees said that their current work would benefit from being published in an internal wiki as a way to reach out more effectively and get feedback through commenting functionality. Some thought that blogs could be useful for spreading news from departments and smaller projects as well, but concerns were raised that reading too many blogs would just steal time from ordinary work.
None of the interviewees were negative to Web 2.0 solutions in general, but a few comments on the risks and limitations of such tools were made. First of all there were large differences in attitude towards the usefulness of the non-reviewed type of information in a wiki. Some were concerned that the reader could see the opinion of one as a company guideline and that the wiki-pages would serve better as a complement for information about less critical things. Others regarded it as particularly useful to be able to view others' opinions and experiences on e.g. the use of manufacturing methods or simulation. Most of the interviewees agreed that it would be good or even necessary to have owners of the important pages who could review the information regularly to maintain the quality. One interviewee suggested that the possibility for employees to edit pages could be disabled and instead let them post ideas for updates in the comments section. The internal wiki that was in use had a disclaimer published in the header stating that the validity of the information was not guaranteed and that it was not an acceptable source of information for decisions. This was in line with the interviewees' thoughts on the correct way to use a wiki for business purposes, and most of them commented that references and links would be the best way to provide access to reviewed information.
Currently most reports and project folders at the company have restricted access, and employees must apply for permission to view them. A common worry during the interviews was that while many of the benefits of a wiki would come from its openness, it would increase the risk of information leaks. The most common thing that the interviewees perceived as unsuitable for publishing on an internal wiki was the "core knowledge" of the firm as that was its source of competitiveness. This statement was often followed by a comment that such information was perhaps not possible to write down anyway. Other common things that were regarded as unsuitable to publish too openly were contracts, manufacturing costs and strategic plans. Some suggested that the wiki should be as open as possible, while some would prefer to see a few permission groups, e.g. based on the content necessary for one's work or by separating consultants from employees.
One of the reasons for the current restrictions in access to information is that the company's customers are competitors and must be able to trust that knowledge does not leak between them. The interviewees believed that it would be possible to filter information from customer secrets so that the knowledge gained could be used by the organization. The reason given for why it was not done so now was that project members had no time for it unless they were instructed to create such filtered documentation and given additional resources for its purpose. When asked whether they thought it would be worth the additional resources, the answer from most was that they were not sure, but that it could be worth it in the long run.
When shown the wiki-demo, all interviewees were either positive or very positive to being able to access information on the technologies in the company portfolio in a wiki-format. The search function, completeness (many technologies listed) and the explanatory type of information were the most appreciated benefits of the demo. There were comments that this would be good as the first instance to find information, with sub-pages or links that help them find more details if needed. A few interviewees thought it best to have only technologies under development represented in the wiki since the mature technologies were better represented with reviewed formal documents and standards that can be used as the basis for decisions. Most of the respondents however did not reflect upon there being a problem with having mature technologies represented in both systems. Another benefit commonly mentioned was that by having the technologies explained in general terms, it is easy to get an insight into areas that are peripheral to one's work, which in the long run can raise the general knowledge of the employees and be especially valuable for the newly employed.

5.5 Summary

The main findings of each topic in this chapter are summarized in Table 1.

Table 1 Summary of results from the interviews

Topic	*Comments on current condition*	*Wishes for target condition*
Technology platform thinking	Platform thinking is being established in the company Focus is shifting from single product business cases towards a platform thinking General information is sought more in early stages of development	Technology investments are planned for a range of products to leverage development costs Bearer of knowledge upon which product and production platform development is based
Access to knowledge and information on technologies	Depends to some degree on personal network Time-consuming to find documents that you do not often use. No first point of contact for learning about technologies	Easy to find people with certain knowledge Effective search engines in document vaults Information available for both overview and details on technologies
Sharing knowledge and information on technologies	Work to publish standards and guidelines online Email and seminars are used at the initiative of individuals Rigid change management to current standards and guidelines	Possibility to also comment on standards and guidelines Placeholder needed for knowledge that does not fit in reports Technical lessons learned are written continuously during projects
Use of Web 2.0 solutions	There are a two well-known internal blogs (CEO and a large project) and a wiki is being rolled out.	Divergent opinions about project and department blogs Wikis have great potential for certain types of information, such as experiences, links and educational information

6. DISCUSSION

This chapter discusses the findings presented in the result chapter and solution concepts.

6.1 Organizational needs regarding knowledge reuse in pre-development

The interviewees considered the introduction of a platform framework as very important for increasing efficiency and responsiveness at the company. The need for having a technology platform was also clear, where potential benefits would be connected to shorter lead times when introducing a new technology as well as making new technologies visible within the organization. The attitude toward Web 2.0 solutions in general was positive with some reservations about e.g. validity of information and too extensive use of blogs. The proposed use of a wiki for information about technologies received a very positive response and several interviewees could see clear benefits for their own work.

6.2 Proposed solutions

There are several approaches to choosing which technologies that should be part of the platform and what processes and tools should be used for its embodiment. The results strengthen the hypothesis that a wiki based technology platform can provide the means for facilitating internal knowledge reuse at the case company. In addition, a checklist is suggested as a complementing tool to assess platform suitability and keep record of maturity for the technologies on a platform level.

Wiki

The wiki described in chapter 4.3 would support engineers and managers by:

- visualizing the technology portfolio
- improving accessibility of general technology information for self-education
- providing a forum for sharing experiences and knowledge
- helping to locate contacts and reports with detailed knowledge and information
- providing a reference material for evaluating the capabilities of the firm

To use a wiki as a database and versioning system for the future technology platform has both benefits and disadvantages, and the most important are listed in Table 2.

Table 2 Advantages and disadvantages with using a wiki for the technology platform

Advantages	*Disadvantages*
• Quick and simple to understand and start using • Information can be updated quickly • Automatic versioning • Versions (and previous editions) are relatively easy to track • Higher attention on technology owners / method owners • Requires clear ownership and "moderator" for each technology	• Not intuitive to see who has written what (is it a reliable source?) • Information looks more official than it is • Difficult to differentiate facts from opinions. • Requires new work procedures • Requires new roles and organizational structure

To summarize these points, it is relatively easy to get started with working with a wiki-based technology platform. However, as with many IT introductions the problem lies in the organizational adoption of a new way of working. The wiki concept can easily be integrated within the current intranet structure, which is beneficial from this point of view.
The disadvantages are mainly connected to how the traditional formalized IT systems at the company work. Engineers are not used to handle information that is not assured in an IT system and this may be a future problem regarding reliability. It is important to assign a "chief engineer" or moderator to each technology in order to give it reasonable validity within the organization.

Checklist

A checklist is tool commonly found in lean product development that can be used here to assess a technology's maturity. The checklist suggested in this paper should both act as an official document for communicating maturity of a technology platform element, e.g. for risk assessments during product planning, and to be used to justify investments in new technologies and position the technologies against strategic intents.
In this case the checklist will be the technology owners' main tool to assure the maturity of their technology and make sure that there is a low risk or risk awareness in the product development projects where it is used. This checklist could be connected to an already implemented TRL checklist that is used during technology development to assess the advancements made. It is however important that the technology checklist continue a bit further than the TRL checklist since the scope is slightly different. This means that the technology platform checklist must also contain checks in order to assure the platform compatibility and risk levels beyond TRL9, (the last TRL level in the TRL scale). In order to do this, the number of similar applications in production could be a good assessment of the uncertainties with using a technology. Checks regarding how the technology could be used in different contexts and in different applications would benefit the platform perspective. A prototype checklist has been developed in Excel and Figure 3 is an illustration of the content.

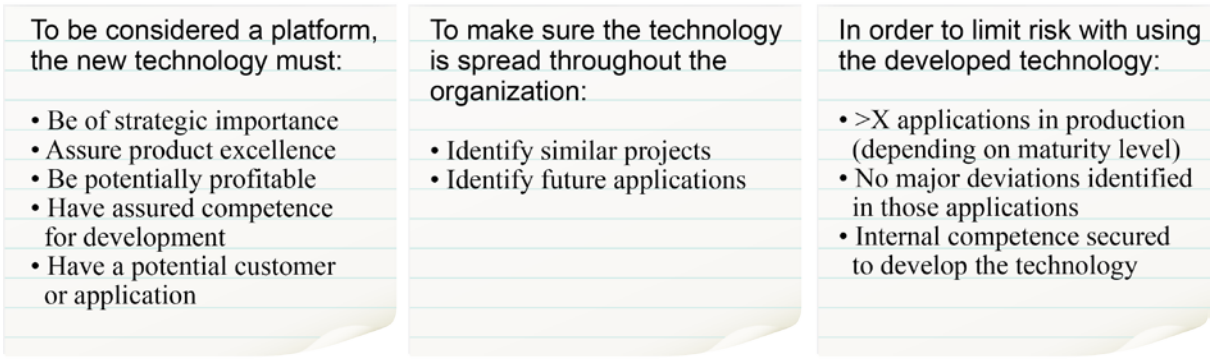

Figure 3 Illustration of the content of the checklist

6.3 Future work and considerations

The overall goal of the technology platform is to reduce risk and lead time, which leads to high quality products that are developed in a shorter time with fewer resources. On the technology development level the main purpose of a technology platform is to leverage the investments in technology

development and reap economies of scale by reducing variety, which makes it natural to seek solutions that increase reuse of technologies and foster development for reuse. The tools presented in this paper are designed to contribute to these purposes and as the wiki demonstrator received positive feedback, the next step will be to run a pilot to evaluate it in more detail. This will also make it possible to validate the approach in future research projects in other contexts. The checklist was developed after the interviews were held, but discussions with company representatives show that it has a high relevance, and it will be further evaluated through co-development and workshops with process managers at the company.

The wiki and the checklist are tools that require changes to current processes and responsibilities in the organization to be effective. Their design has an implicit suggestion of how to work with them, but the details will probably be important, as the ability to achieve the benefits of a technology platform is dependent on the reception of the tools with their users. The main preparations that need to be made at the case company before the introduction of the wiki and the checklist can be listed as:

- Decide what technologies should be made elements of the platform (e.g. which capabilities to be included and what maturity requirements that would be posed on a technology platform)
- New routines and incentives for projects to feed lessons learned to the wiki
- Choosing owners for each technology to maintain their checklist and wiki-page(s)
- New routines for documenting technology advancements in the wiki and the checklist
- Decision on the suitable types of content and detail level for the wiki, including how to filter confidential or redundant information
- Assess employees' willingness to publish their knowledge

While covering many of the purposes with a technology platform, the tools should not be regarded as its sole constituents. As an example, the undirected sharing of information in a wiki means that there is no guarantee that information will spread to those who need it. Likewise, the forthcoming studies will help reveal other additional efforts that may be important in introducing the technology platform.

7. CONCLUSIONS

This paper investigated means for internal knowledge reuse in pre-development at a case company. In particular, the need to access knowledge and ways to share knowledge about new and mature technologies was studied.

From the interviews performed, in conjunction with demonstrator development, concerns regarding the ability to support technology development and to access knowledge about the technologies were of main focus. Another key issue was to present information about technologies in a way that offered a good overview.

In the paper, two tools are suggested to support these issues: a technology platform wiki to share information regarding key technologies and reusability and a lightweight online checklist system to assure the maturity and platform compatibility of technologies. Included in the platform checklist is the process of pushing reuse of known and mature technologies internally in the organization..

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