Social PLM

an explorative study of the integration of social computing technologies in the product development

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Social PLM:

An explorative study of the integration of social computing technologies in the product development.

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I. Abstract

This master thesis explores a new development in Product Lifecycle Management, which combines the functionalities found in popular social networking sites in the context of the product development process. The business drivers, business values and software market of social PLM are researched.

Author's note: the conducted research presented in this report was conducted at the company Atos Origin SI-PBS-PLM-LIMS. For reasons of company confidentiality agreements, several segments have been omitted from this publicly-viewable version. The omitted segments are demarcated with an asterisk in the segment-title.

It must be emphasized that these omissions *do not* inhibit the reader's ability to understand the research presented here.

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Introduction

While taking a moment to reflect on daily life, we realize that we live interesting times. Never before in the history of mankind have ordinary people been able to access over as much information and knowledge, as we do today. It is obvious that the Internet is *the* enabler, but that implies that people must actively know what they are looking for, in order to find it. No, the *massive* amount of information is enabled by a specific version of the Internet, Web 2.0. Web 2.0 enables ordinary people to possess the tools to author new knowledge, share, discuss and passively discover new knowledge. The number of services on the Internet offering these tools was unheard of only a decade ago, Facebook, MySpace, Hyves, LinkedIn, YouTube, Blogger, Wikipedia etc, etc.

Remove the user-interface off of any of these services, and what is left are platforms for creating, communicating, sharing, collaborating and discovering. The presence of these platforms has a newfound setting, namely the product development process.

Product Lifecycle Management (PLM) systems have been the IT solution to manage the information of product development process, for the past three decades. There is nothing social about these systems; comprehensive product engineering data management applications, with numerous mechanisms to ensure the validity and integrity of each piece of product related information created and modified.

So, what does this new development in PLM, called Social Product Development have to do with PLM anyway? What does the enabling of social interactions, found in Web 2.0 services, have to do with the rigid and tightly controlled environment of PLM systems?, PLM Service Provider Atos Origin asked itself. This is the departure point for the research into social PLM.

This report is organized as follows: chapter 1-3 present the research context, the theoretical background and research questions. Chapters 4-8 present the investigations and findings into different aspects of social PLM. Translating these latest developments, into commercial implications for Atos Origin PLM, is presented in chapter 9 and 10. Finally, social PLM implications for the scientific PLM research and research conclusion are presented in chapter 11.

Note: chapter 9 and 10 contain business sensitive information that cannot be published in this public version of the TU/e.

1. Research context

1.1 PLM

Managing the product development process is for many industrial and manufacturing companies of competitive significance.
There are various perspectives through which one can view and arrange the product development process. In the scope of this proposal, the perspective of the Information Technology (IT) is chosen. Academic research focusing on the technical aspect of managing the product development process and product data is assigned to Product Lifecycle Management (PLM) discipline.
The concept of PLM can be broken down along two levels: a strategic and technological level. CIMdata[1], a renowned PLM consulting institution, offers the following definition of PLM:

"PLM is a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination and use of the product definition information."

From this definition, it is established that choosing to implement PLM has an impact on the business strategy. This is because PLM is meant to manage a company's product across its complete lifecycle, from conception to disposal or recycling of it (Batenburg, Helms, & Versendaal, 2005). Thus PLM enables product data to be created faster, which is subsequently managed as it transcends departmental boundaries as the product goes through the various product lifecycle phases.
The technology supporting this strategic vision of creation, usage and dissemination of product data, is realized by a set of solutions as shown in figure 1.
PLM is developed as a tool to enable product development engineers to adequately manage the product data, while shortening the development process. In order for PLM to obtain these end results, it delivers several underlying benefits.

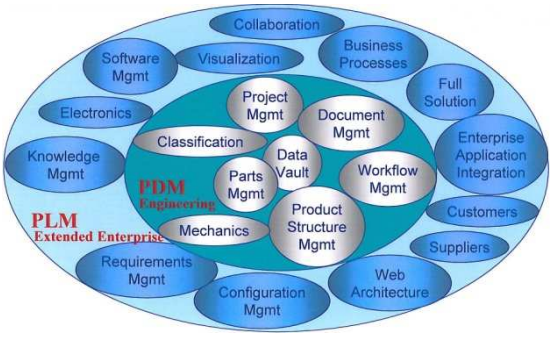


Figure 1: Functional modules of PLM system. Source: Atos Origin PLM

[1] Definition of PLM by CIMdata, *A Global Leader in PLM Consulting*: http://www.cimdata.com/plm/definition.html

1.2 Social computing

The recent advancements in Internet technologies have spawned interesting platforms and services on which individuals can communicate, share and collaborate. Examples of such platforms are numerous and can be used for everything from sharing pictures to editing documents, such as Twitter, Facebook, LinkedIn, MySpace, Hyves, Wikipedia and YouTube. These platforms and services are known as Web 2.0 or social computing.
An explanation for the strong emergence of the platforms above lies in the main principle of Web 2.0: "Build applications that harness *network effects* to get better *the more people* use them" (Levy, 2009). Further, Levy (2009) describes Web 2.0 as an *open architecture*, which aims to lower the bar for sharing and connecting ideas among users.
Social computing is typified by set of technologies:

- Wikis
- Blogs
- RSS
- Tagging
- Social Networks
- Instant Messaging

In the context of the enterprise, a similar emergence of social software platforms computing is observed. This emergence is either within companies, between companies and its partners or customers (McAfee, 2006). Within this organizational boundary, a different term is used, namely Enterprise 2.0. Enterprise 2.0 is essentially the use of the same Web 2.0 infrastructure and tools, implemented by organizations (Levy, 2009). Enterprise 2.0 emphasizes, more than Web 2.0, the collaborative aspect of these social computing platforms.

1.3 Business context

Atos Origin is a publicly-traded multinational IT Service Company, with headquarters based in Paris, France. The services of the Dutch branch of Atos Origin fall into three business units: Consulting, Systems Integration (SI) and Managed Operations (MO). The business unit SI houses the *practice* Package Based Solutions (PBS), where the *unit* Product Lifecycle Management-Laboratory Information Management Systems (PLM-LIMS) is located. The conducted research presented in this report was executed at this unit level of the enterprise, Atos Origin SI-PBS-PLM-LIMS, referred to as Atos Origin PLM from here forward.

The Product Lifecycle Management (PLM) unit of Atos Origin specializes in delivering broad scope of services to discrete-manufacturing industries relating to implementation or consulting to implement PLM systems (see section 6.5.1). The branch of business, in which Atos Origin PLM operates, is known as PLM Service Providers[2].

The branch of business in which Atos Origin PLM is active, emerged from the need of the manufacturing industry for specialized know-how when it came to the deployment of the actual PLM system. Next to actual deployment of PLM systems, PLM Service Providers are also active in helping manufacturing

[2] Source: Gartner Industry Research: *A Guide to Choosing PLM Service Providers*. Publication date: 15/12/2009. ID Number: G00172218.

industries in defining the scope of PLM deployment, enabling business change and managing these changes. According to Gartner Research, the expertises of PLM service providers arise from the lack of the in-house expertise, insufficient internal resources or political issues at the manufacturing industries.

1.4 Will it blend[3]?

The subject of PLM and social computing may seem completely unrelated, if not for one common theme: *collaboration*.

As noted above, the strong suit of PLM is the management of product data across the lifecycle of the product. The current form of collaboration that PLM supports, is primarily the storage of data and presentation of data (data vault), the management of access privileges to documents, assigning tasks to the different product development engineers (workflow management and project management) (Bryan & Sackett, 1997) (Kovacs, Le-Goff, & McClatchey, 1998) (Gascoigne, 1995). This all is focused on the formal aspect of collaboration; who gets access to what, and what they are allowed to modify.

Taking a broader context on collaboration, it becomes obvious that collaboration involves much more than assigning tasks and access rights to product development engineers. A general definition for collaboration, states that collaboration is a recursive process between people or organizations, where the parties work on common goals by sharing knowledge, learn and build consensus (source: Wikipedia[4]).

The academic PLM literature notes several research projects that aim to enhance the current, formal state of PLM, to include more elements of this general definition of collaboration in PLM. Some examples are the addition of Web applications to PLM (Huang, Lee, & Mak, 2001). Another is the development of virtual workspaces where groups can create and share knowledge in a product development setting (Tomek & Giles, 2008). These authors make the case for their research, but the technologies they propose are not as widely implemented as social computing technologies.

An extensive literature search for the intersection of social computing and PLM systems did not produce any results. Perhaps there is a reason for this void; there seems to be an obvious contradiction when juxtaposing social computing and PLM. Social computing is not about selecting a tool based on pre-determined criteria, but about allowing multiple tools to jointly co-evolve. These multiple tools enable new patterns of interaction to form, and destabilize as needed to reform in new and contextually appropriate ways (Levy, 2009). This free form of collaboration is in stark contrast to PLM, where quality assurance and conformance to specifications concerns of the product data form the basis for viewing and authoring rights. Another possible cause for the gap in the literature is the novelty of the topic. Society at large is only now starting to adopt social computing (i.e. social networking websites) in a mainstream fashion.

Regardless the reason for this gap, arguing for the augmentation of the collaboration aspect of PLM to accommodate more social interactions amongst product development engineers would be an entertaining philosophical question, would it not already be taking place in the market of PLM systems.

[3] Reference to the popular YouTube video series, where the presenter puts various not-blend-able objects into a blender, and asks "Will it blend?" Source: http://www.youtube.com/user/blendtec

[4] Definition of Collaboration. Source: http://en.wikipedia.org/wiki/Collaboration

It is this integration of social computing in PLM systems that is causing companies to ask if they change the way that they look at PLM systems. One such company is Atos Origin PLM.
The following paragraph will explain more on Atos Origin PLM and why this integration may be of value to it.

1.5 Research trigger: Social Product Development

During a workshop provided by a PLM partner, Atos Origin PLM was introduced to the concept of Social Product Development. On a separate conference, the same partner along with several other partners announced that they are working on introducing product development systems that incorporate the networking tools offered by Web 2.0 technology. These announcements came around the end of the summer of 2009 (See: Appendix A).

The subject about "social" Internet tools is nothing new. The last couple of years have seen the emergence of social networking sites, such as Facebook, LinkedIn, Hyves, MySpace, Ning and many more. Other social sites are microblogging tools (e.g. Twitter, FourSpace, GoWalla), Wikis (WikiPedia is the most popular example), instant messaging (e.g. MSN Live Messenger, Microsoft Office Communicator), etc.
These web-based applications allow people to get in contact with each other, in an easy and asynchronous manner. Through the connections people establish, information can be shared with others. This information can be seen by a (select) group of people, who can then comment on it, thus creating a discussion. This same format of social activity can lead to collective problem-solving and idea-generation through open collaboration. Some of these tools are already being implemented by private companies, through specialized enterprise software. These systems are called Enterprise 2.0.
The widespread availability of these social tools is leading to PLM systems where these are integrated in them. Atos Origin PLM reckons that this "trend" will continue to develop, and wonders what the implications of it might be for the services it delivers.

1.6 Problem statement

PLM systems are by nature complex, consisting of various functional business solutions (see figure 1), often delivered by multiple PLM vendors. This inherent complexity of these modules means that the implementation of these systems at customer firms often requires more knowledge than is found in a user-manual. For this Atos Origin PLM must often make the decision whether to invest in training of its engineers, when certain modules of a PLM solution have undergone an update. Trainings and acquirement of system knowledge represent a certain throughput time before the organization can take ownership of new system knowledge.
The topic of Social Product Development knows no direct precedent at Atos Origin PLM. Prior to this report, internal discussions at Atos Origin PLM raised the question whether or not research should be conducted into the developments of Social Product Development. Unfamiliarity and curiosity on this subject formulated the problem statement below.

The problem is thus stated as follows:
Do developments, such as Social Product Development, present a business opportunity for Atos Origin? If so, what actions should the organization take to take to develop this business?

2. Theoretical background

PLM, or product lifecycle management, is the most recent definition used for a set of information technology (IT) solutions aimed at helping companies that produce product engineering data, to manage this in more efficient and effective manner. Product Lifecycle Management systems (the successor of Product Data Management) evolved over time to help solve several themes of business problems discrete manufacturing industries faced during product development. Resolving these business problems often makes the difference in obtaining and/or maintaining competitive advantage. The terminology PLM has been introduced recently, and is an extension of its predecessor Product Data Management (PDM).

2.1 PDM drivers

PLM has its origins in the '80's of the last century, which saw discrete manufacturing firms struggling with efficiency problems in their product development process (Liu & Xu, 2001). This efficiency was related to managing the flood of engineering product data resulting from the use of computer aided solutions (Bryan & Sackett, 1997). At the time, obtaining competitive advantage was contingent on how efficient product development engineers could locate product data. Locating product data could take up to 80 percent of product development engineer's time (Gascoigne, 1995).

Customer demands for more bespoke products (functionally and aesthetically), resulted in manufacturers replacing single products, with a flexible range of products (Kumar & Midha, 2001). The offering of product ranges consequently leads to even higher amounts of product data to manage.

Next to the efficient handling of product data, increasing competition and customer demand forced manufacturing industries to look for ways to realize ever shorter development cycles. Along with the rise of the Internet, and thus to ability to more easily connect across great distances, outsourcing became a popular method to reduce the product development time by granting external suppliers the task to co-develop and/or produce specific components. The trend of production outsourcing to external suppliers can be as high as 50 to 80 percent of all components produced by original equipment manufacturers (OEM's) (Smparounis, Mavrikios, Pappas, Xanthakis, Viganò, & Pentenrieder, 2008). Combine this need to outsource with the proliferation of the Internet, and the outcome is companies that are outsourcing from all over the world (Ming, Yan, Lu, & Ma, 2005). The involvement of more actors in the development process placed further emphasis on assuring access to product data, but also on the consistency and integrity of the data. The latter is often referred to as the matter of the "Single source of truth".

As the environmental pressure drive manufacturing industries to find more efficient and effective ways to develop products, a paradigm shift has taken place (Ming, Yan, Lu, & Ma, 2005). The shift from mass production, to concurrent engineering and virtual enterprises, has consequences on the information systems supporting the development process. As the academic literature suggests, PLM is evolving into a distributed, open and intelligent system aimed at supporting collaborative product development (Han & Do, 2006).

2.2 PDM business values

In managing the product engineering data, engineering and manufacturing firms were able to achieve several benefits: the consistency and integrity of data, enabling the secure access to product data, achieving collaboration across organizational disciplines and product supply chain, resulting in the reduction of the product development cycle time and the time to market (see table 1). In reducing a product's time to market PDM became of strategic importance to various industries.

Bryan & Sackett (1997)	**Liu & Xu (2001)**	**Rouibah & Ould-Ali (2007)**
Reduce product lifecycle	*Interdisciplinary collaboration*	*Interdisciplinary collaboration*
Reduce environmental impact	*Reduced product development cycle time*	*Reduction of product development cycle time*
Reduce time to market	*Reduced complexity of accessing company information*	*Reduction of complexity of accessing company information*
Improve product quality	*Improved project management*	*Improvement of project management*
Improve flexibility of processes	*Improved lifecycle design*	*Improvement of collaboration in the supply chain*
Secure access to product lifecycle data	*Supply chain collaboration*	
Data consistency and integrity		
Concurrent process support		

Table 1: Benefits of PDM

2.3 From PDM to PLM

As business processes evolve to meet demanding market pressures, so must the information technology solutions that support their processes. PLM is an evolution of PDM (Batenburg, Helms, & Versendaal, 2005). While the focus of PDM was a pure data management problem in an organization's engineering department, PLM raises the subject of data management to a strategic business problem. Compared to PDM, the definition of PLM places emphasis on the availability of product data, information, knowledge across multiple organizations (extended enterprise) for the life of the product (concept to end of life) (Ming, Yan, Lu, & Ma, 2005).

2.4 Extending PLM

The academic literature goes on to showcase this evolution of PLM. Different types of technologies and academic disciplines have been proposed as extensions of PLM to further enhance and realize collaboration in the product development. One example is the development of synchronized Web applications to break down departmental boundaries and establish a form of collaborative data sharing (Huang, Lee, & Mak, 2001), (Liu & Xu, 2001), (Rouibah & Ould-Ali, 2007). Other researchers have proposed the implementation of Groupware systems that offer tools for group management, textual chat, brainstorming tools and audio & video capabilities (Tomek & Giles, 2008).

2.5 The social aspect

The extensions to PLM proposed in the academic research all have a common objective, facilitating the collaboration needed in product development by introducing some sort of collaboration platform. Where the original PLM drivers were focused on the technical aspects of the business process, the current drivers (collaborative platform and its technologies) seemed to be geared towards the needs of the knowledge workers involved. “Many years it was assumed that technical features were the most important ingredient to support an effective collaboration platform” (Pallot, Richir, & Samier, 2008).

The dominant paradigms of outsourcing of product development and extended enterprise, has placed an emphasis on collaboration in the product development process. With this emphasis on collaboration, the core of PLM, PDM, is not modified. Rather, technologies from other academic disciplines are applied around PDM, to organize the process of collaboration. Collaboration can be related to several factors, such as connecting geographically dispersed team members by means of Web-architecture applications (Huang, Lee, & Mak, 2001). Also to enhance the sense of proximity among team members, the application of groupware systems, such as virtual- and augmented reality systems or communication technologies is observed (Tomek & Giles, 2008) (Pallot, Richir, & Samier, 2008).

Web 2.0 is an open (Internet) architecture that allows users to share and connect ideas (Levy, 2009). According to Olmo, Aguilera, & García (2008) Web 2.0 is rapidly changing the face of collaborative work. From the perspective of collaboration in the context of PLM, this technology can be seen as an extension of previous research, but it has been seldom discussed in the academic literature.

3. Research

3.1 Research methodology

The concept of PLM and its scope of academic research are limited. PLM is a relatively new concept that was hardly addressed in scientific literature, according to Batenburg, Helms, & Versendaal (2005). As the body of knowledge on PLM grew in the past decade, it did so in a particular direction. Reviewing the literature on conducted scientific research on PLM, shows that much of the research efforts are invested in developing Web-based applications for the product data management (PDM) systems, and thus extending the reach of PDM and attaining the vision of the Extended Enterprise; the active sharing of product data information with partners, suppliers and contractors (Kumar & Midha, 2001) (Liu & Xu, 2001) (Colombo & Pierpaoli, 2002).

Given that research on supporting unstructured creative processes needed for product development is not discussed in scientific literature, this research developed an approach that consults a variety of sources of information which provide insight into social PLM. This approach is presented in figure 2.

The research approach defines several so-called focus areas; these are distinct areas of conducted research that are related to the subject of social PLM. Each focus area has contributes specific knowledge to this overall research.

- The *Social PLM drivers* attempt to determine the origin of the development behind social PLM.
- *Technology* will elaborate on the systems that comprise social PLM.
- *Supply-side of the PLM market* will analyze which PLM vendors are active with the development of social PLM and whether the PLM market will continue to develop in this direction.
- Further, *Demand-side of the PLM market* highlights the business values social PLM will provide to adopting engineering and manufacturing firms, but also to gather insight into their current challenges with their established PLM implementations.
- The final focus area, *Organization*, is concerned with the commercial implications social PLM can have for PLM service providers, such as Atos Origin PLM.

Given that each focus area has a specific objective, demands different types of research and sources of knowledge per focus area;

- *Social PLM drivers* employs information published by PLM experts (online reports and blogs), as well as academic literature to understand the shortcomings of PLM and the subsequent development of and need for social PLM.
- *Technology* utilizes the product information published on the social PLM systems by the PLM vendors, on the company websites and in the product whitepapers.
- *Supply-side of the market* will conduct a market research of the PLM market, by means of reports published by PLM market analyst companies such as Gartner Research, Forrester Research, CIMdata and Aberdeen Group.
- *Demand-side* of the market is interested in the validating PLM implementation and adoption challenges described in scientific literature, as well as uncovering the current use of social computing technologies at engineering and manufacturing industries. Uncovering information is done by means of several interviews held at two engineering and manufacturing firms. Further,

academic literature, market analyst reports, publishing by PLM experts and PLM vendor whitepapers are used to establish the business values of social computing technologies in PLM.

- *Organization* translates the social PLM development into possible commercial implications for PLM service provider Atos Origin PLM. This requires the identification of overlap between the subject of social PLM and the organization of Atos Origin PLM. Uncovering the characteristics of the PLM service provider was executed by means of a *focused-SWOT* methodology (Coman & Ronen, 2009), and by investigating the current services the company delivers, i.e. the Atos Origin PLM service portfolio.

Each focus area produces insights and argumentation on which the Partial Research Questions (presented below) can be answered. The Partial Research Questions will provide the basis on which the Main Research Question (presented below) is answered. Given that the PLM concept can be viewed from different perspectives, i.e. PLM vendors, the PLM users and the technologies, this research proposes the use of the CIMO-logic (Denyer, Tranfield, & Van Aken, 2008) as a means to establish the effect of social PLM on a specific perspective (see Appendix D for an explanation of the logic components). The use of CIMO-logic is supported as follows; social PLM is developed to support a specific business process in a distinct fashion, and is thus defined as a design proposition. CIMO-logic allows this design proposition to be decomposed in four elements as follows: a suggested type of intervention implemented in a problematic context to produce the intended outcome, through generative mechanisms.

3.2 Research scope

The research into social PLM has an exploratory character, for several reasons. The subject of social PLM has not been researched academically and offers no frame of reference for its origin, its uses and challenges. Understanding the subject requires explaining the empirical observations on social PLM with suitable academic literature.
Further, the concept of PLM is a comprehensive collection of various business solutions that contribute to the management of product engineering data throughout the lifecycle of the product. Whether social PLM supports the entire lifecycle of the product and its engineering data is not directly clear. At the time of the research, the concept of social PLM was recently introduced with few concrete practical examples. PLM vendors are still developing the technical solutions. Thus, understanding social PLM and its role in the product lifecycle, requires understanding of the similar technologies found in Enterprise 2.0 solutions. The limitations imposed by the academic and empirical sources result in asserting a broad exploratory character of the research.

From a technical perspective, PLM, PDM, social PLM, etc. are IT solutions developed to address a specific business problem. Given the exploratory nature of the research and since business requirements always drive the technology solutions (Ming, Yan, Lu, & Ma, 2005), it has little relevance to focus on the technical details that comprise social PLM, i.e. programming language, hardware requirements etc.

PLM and PDM (benefits, drivers, and challenges) are most often described from the perspective of manufacturing industries. Nowadays, PLM is being applied to new industries such as for example clothing and process industries (food and beverage). These newer industries do not correspond to the industry Atos Origin PLM serves, nor are the market dynamics of these industries in relation to PLM described in the academic literature. Thus, the scope of social PLM is limited to the discrete-manufacturing industries is convenient given the better understanding of their characteristics.

In summary, the research scope is limited to an exploratory analysis focusing on the business requirements that drive the social PLM developments in the manufacturing industry.

3.3 Research objective

The research conducted in this report is executed with two main objectives. First, little literature is presented on the presence of Web 2.0 in context of PLM. Stronger yet, no academic sources can be found that describe what the effects of social interactions, such as those enabled by social computing, can be on the management of structured product engineering data. Social computing has been mentioned as rapidly changing the nature of collaboration. The objective of the research presented here is to understand the emergence of social computing in PLM and its role in the development process of products.

Second, as noted by the research trigger, the interest to pursue the investigation into social computing in PLM (also referred to as social PLM from here forward) was suggested by the PLM service provider Atos Origin PLM. From its perspective, the research looks for areas where the development of social PLM overlaps with the business of Atos Origin PLM.

3.4 Main Research Question

Based on its popularity on the Internet, social computing (social networks, social media etc) may have arguably heavily influenced the patterns of modern societal interactions, which may also be true for the way products will be developed. In order to better understand the potential paradigm shift social computing is causing in product development, insight is needed on what part of the product development process this subject might be most prevalent. Also, how PLM systems are currently utilized in these parts of the development process and how social computing will affect it. In short, the central question of the research is related to the various aspects of PLM (the concept, systems, and users) and how these are/will be affected by the emergence of social computing. Thus, the Main Research Question is formulated as follows:

What is the impact of the integration of social computing in PLM for the product development process, PLM systems, PLM users and PLM suppliers?

This Main Research Question is divided into several Partial Research Questions (PRQ's). Reasoning being that PLM can be seen from various perspectives, e.g. as a concept, as a physical system supporting business processes and as a service sold by PLM Service Providers. Thus, grasping the impact of social computing in this context requires delving into the various related areas. The PRQ's formulated below address these various perspectives.

3.5 Partial Research Questions

Partial research questions formulated to help answer the main research question are as follows:

- **(PRQ.1) What factors are driving the development of Social Product Development? And, what aspects of the product development process does it aim to improve?**

This question is directed towards the business drivers behind social PLM, the dynamics that have led to the existence of Social Product Development.

- **(PRQ.2) How will social PLM affect the activities of product development process that are supported by PLM?**

It is important to understand whether social PLM is aimed at improving processes already supported by other PLM solutions, and how.

- **(PRQ.3) How do social networks enhance the product development process?**

The first offering of a social PLM solution, Social Product Development (see Appendix B), emphasizes the use of social networks in the enterprise. This question investigates what the role of social networks are in the product development process.

- **(PRQ.4) How should the social PLM system be positioned within the Enterprise Information system? And, with which other product-related systems does it interact?**

PLM systems almost always operate in conjunction with other enterprise information systems, ensuring the transfer of product data from design to subsequent downstream processes. How social PLM solutions will interact with other systems, is investigated by this PRQ.

- **(PRQ.5) What are the commercial implications of social PLM for PLM Service Providers, such as Atos Origin PLM in particular?**

This PRQ will focus on the business of Atos Origin PLM, find its overlap with social PLM in order to highlight possible business directions.

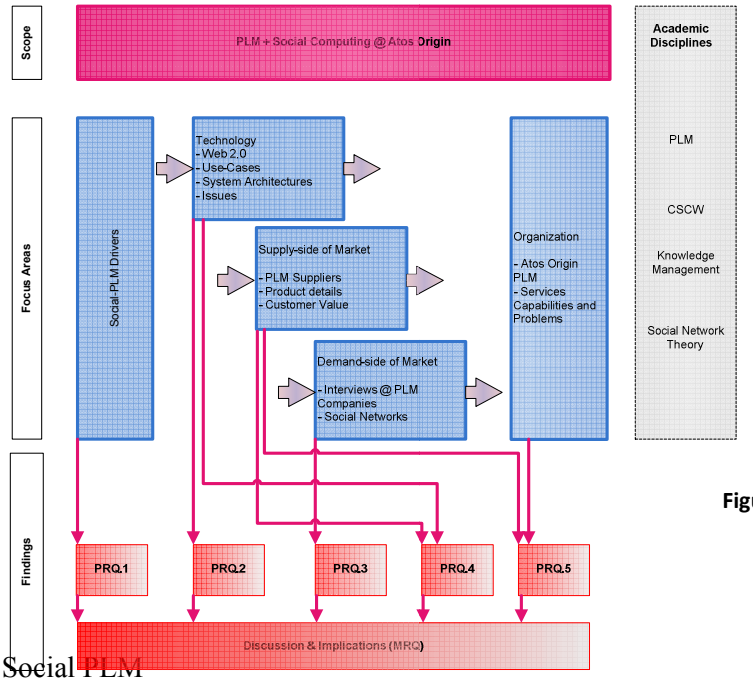


Figure 2: Social PLM research approach

4. Social PLM drivers

Scientific literature notes that the development of traditional PLM is caused by the following drivers:

- Rising customer demands
- Flexible product range
- Shorter product lifecycles
- Reduced product costs
- Increasing rate of innovation
- Faster product obsolescence
- Increasing product quality
- Dissemination of product data

Social PLM can be considered as a progression of the PLM development, with social PLM's focus being on the enhancement of the collaboration processes in product development. The PLM business drivers have remained unchanged, but interestingly the development of social PLM is not attributed to these traditional drivers. Research has shown that PLM vendors point to the drivers of Enterprise 2.0 technologies and the adoption of Web 2.0, in general, as reasons for social PLM development.

Social computing technologies can also be adopted by organizations not familiar with PLM (see Enterprise 2.0, in section 7.2.1). The business drivers for social computing technologies in the enterprise, is also deemed valid for explaining social computing in PLM. Enterprise 2.0 drivers are as follows (The 2.0 Adoption Council, 2009):

- productivity increase
- connecting globally dispersed project teams
- reinvention of corporate culture
- knowledge management and retention.

As can be noted, these Enterprise 2.0 drivers can be generally applied to any kind of industry and thus differ from the traditional PLM drivers. The general applicability of these drivers shows that the development of social PLM is not directly related to needs of engineering and manufacturing industries, thus social PLM is a result of *technology push*. In contrast, the scientific literature presents PLM development as *market pull*, since the need arises from manufacturing industries to enhance the efficiency in which product data is managed.

The technology push-character of social PLM is further evidenced by the second set of drivers mentioned by PLM vendors, namely the adoption of Web 2.0 technologies. Stronger yet, it is shown that the adoption of Web 2.0 is still limited (early adoption).
The number of enterprise social software vendors is growing (Enterprise 2.0; see section 7.2.1), thus implying that Web 2.0 technologies are becoming popular amongst enterprises. Closer inspection of this market shows that the market is dominated by a few large vendors of business-collaboration platforms which feature social computing technologies as one of its many functions. Thus, referring to the growth of the social software market as a sole indication of the increasing popularity of Enterprise 2.0 systems is a misrepresentation of reality.
Social computing technologies, or Web 2.0, are most commonly found on the Internet and developed with recreational objectives in mind, which has added to their popularity and adoption. One might think that enterprises can be skeptical towards Web 2.0's business values, given its recreational image, and regard it as hype. Findings from Gartner Research shows a categorization scale to index whether a technology can

be considered hype or not (the Hype Cycle), i.e. can the technology live up to the expectations of users. The Hype Cycle for Emerging Technologies[5] (see figure 3) positions Web 2.0 at the end of the "Through of Disillusionment" and the beginning of the "Slope of Enlightenment". Disillusionment occurs when the technology does not live up to the inflated expectations, and interest in the subject withers.
A technology lands on the "Slope of Enlightenment" when there is focused experimentation being done by an increasingly diverse range of organizations, resulting in "true understandings of the technology's applicability, risks and benefits". The state of experimentation can be confirmed by a review of social computing adopting enterprises, in which half of the adopting companies reviewed identify themselves as early adopters, i.e. users embrace the technology before mainstream (The 2.0 Adoption Council, 2009). These findings show that social computing technologies are losing their image as hype, with half of the adopting companies experimenting with the use of Web 2.0. However, these findings still show that the mainstream demand for social computing technology has not crystallized.
Lastly, social PLM vendor PTC mentions the product development engineers' acquaintance with Web 2.0 as a driver for the integration of social computing in PLM. PTC mentions that a reported 89% of engineers (i.e. customers) use Web 2.0 (Saitz, 2009). Figure 4 presents the so-called socio technographics ladder, which classifies the level of technology use from low (bottom) to high (top). The high percentage users mentioned by PTC is located in the "spectators"-rung of ladder, in other words users passively watch, read and listen to socially created content on the Internet. The portion of active Web 2.0 users ("creators"-rung of the ladder) is much smaller, i.e. users that author and publish content on the Internet.

Thus, PLM vendors present Enterprise 2.0 drivers and the seemingly increasing level of Web 2.0 as drivers for the development of PLM. It is shown here that these drivers do not reflect a pull from the market, rather a technology push from the PLM vendors.

[5] Gartner Research, Source: Gartner's 2009 Hype Cycle Special Report Evaluates Maturity of 1650 Technologies. http://www.gartner.com/it/page.jsp?id=1124212

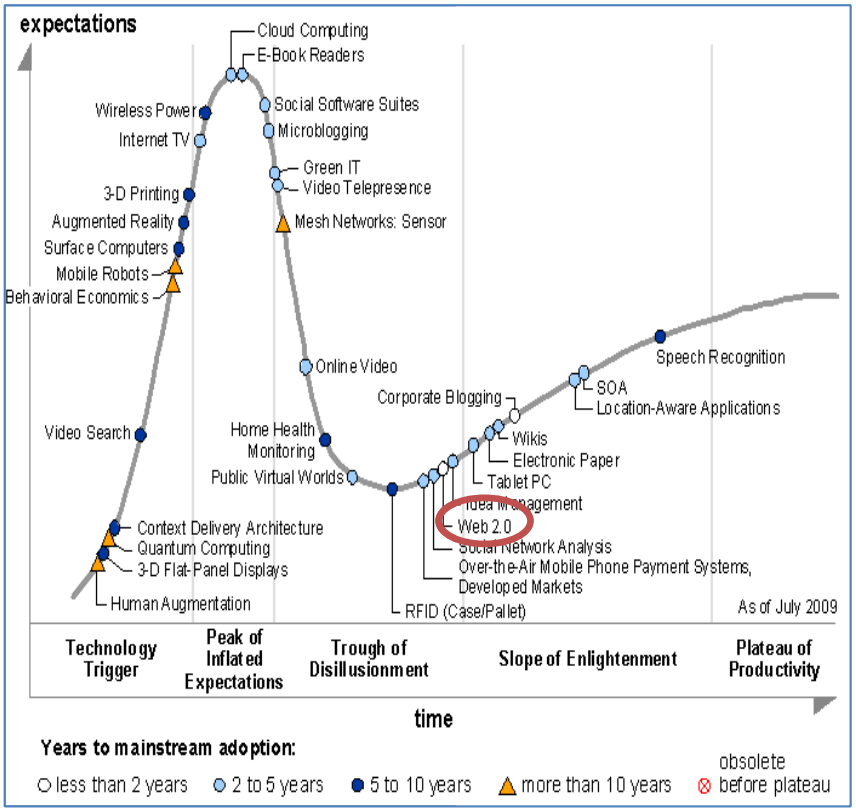


Figure 3: Gartner Research Hype Cycle. Source: Gartner Research, Inc. 2009

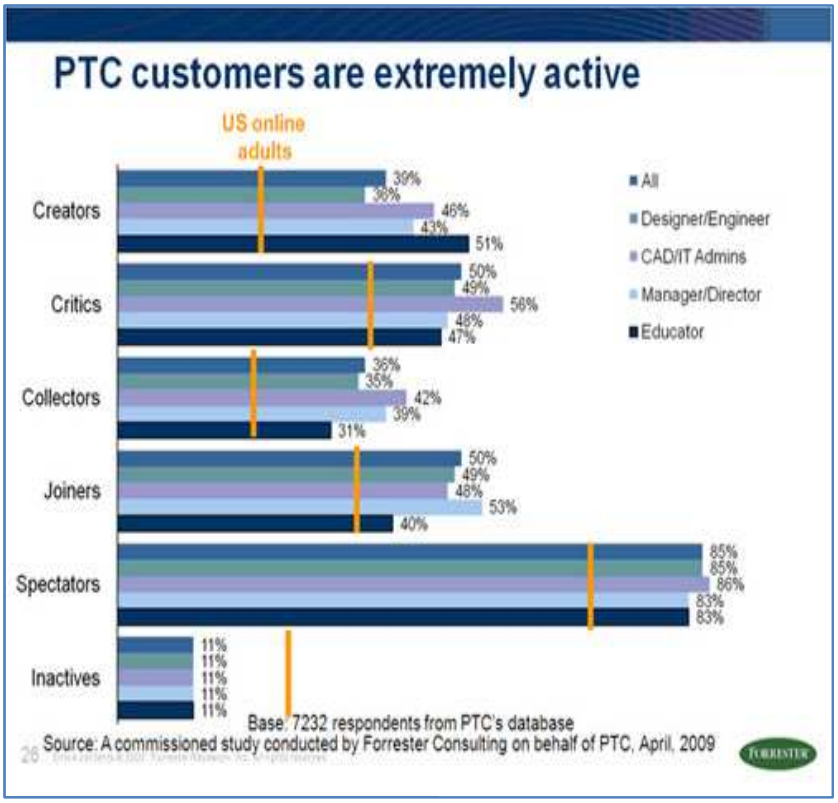


Figure 4: Socio Technographics ladder. Source: Forrester Research 2009

5. Social PLM market analysis

5.1Supply side PLM Market analysis

Product Lifecycle Management (PLM) software suppliers/vendors have expanded the scope of their software solutions over the past couple of decades. Whereas, PLM was originally destined to be used for the management of documents pertaining to the engineering department (also known as PDM), that is no longer the case. PLM is now rapidly expanding beyond engineering design to a broader range of business functions (CIMdata, 2009). Figure 5 visualizes this statement, where one can observe different PLM tools utilized at various stages of the product lifecycle.

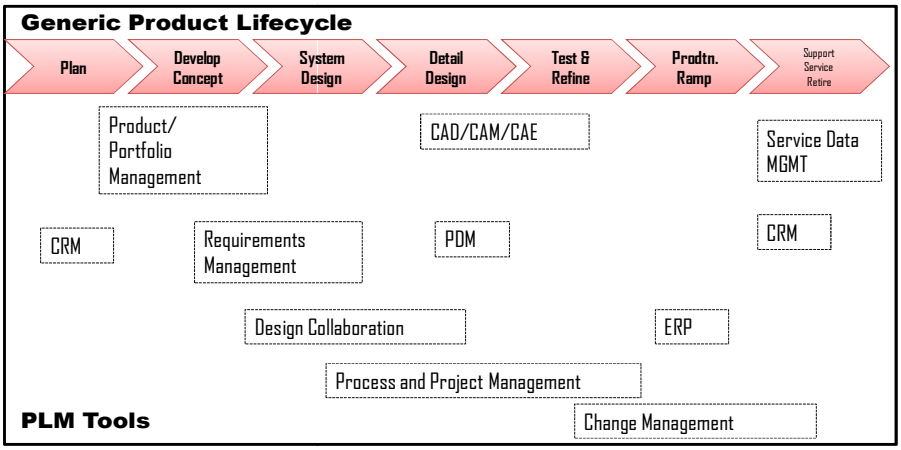


Figure 5: PLM tools in product lifecycle

5.1.1 PLM market Growth

The strategic importance of PLM continues to increase, as can be confirmed by the PLM software market figures. Market-experts predict PLM to grow from the $12.7 B dollar industry in 2007, to $20B-$24B in the year 2012 (AMR Research, 2008) (CIMdata, 2009).

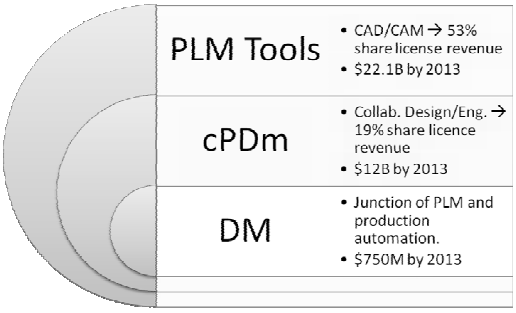


Figure 6: Main segments of the PLM software market

The forecasts become even more promising for PLM suppliers when one regards the fact that "new", non-traditional industries are adopting PLM. Factoring-in non-traditional industries such as food & beverage, retail & apparel, financial & investment services and government, the estimated PLM market will reach $36B by the year 2013. The *mainstream* PLM industries are currently responsible for the generating the lion's share of market revenue. .

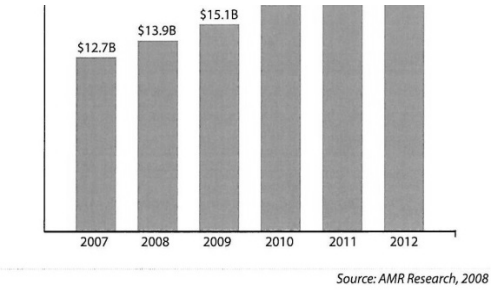


Figure 7: Growth of the PLM software market, Source AMR Research 2008

These are industries such as automotive, high-tech electronics and aerospace & defense

These industries have a long-standing history with PLM tools such as Computer-Aided Design (CAD) software. For 2010, the mainstream PLM market is expected to turn over $18B. Adding the non-traditional PLM industries, forming the *comprehensive* market, revenues are expected to reach an additional $9B, for total PLM market revenue of $27B.

Increasing demand for PLM software might seem as an incentive for PLM software vendors to expand the type of PLM applications portfolio. However, the segments of the PLM markets show that the growth is not related to demand for new PLM applications, but more demand for existing PLM applications.

PLM software market segments

The PLM software market is made up out of three main segments (see figure 6):

- **PLM tools**, set of technologies aimed at creating intellectual property authoring with tools such as mechanical computer-aided design (MCAD), computer-aided manufacturing (CAM).
- **cPDm** (collaborative Product Definition management), PLM applications help product development engineers to manage, disseminate, capture, visualize and collaborate on product-related engineering data. Belonging to this group of tools is Product Data Management (PDM), the most mature technology in PLM.
- Digital Manufacturing (**DM**), the junction where product engineering data and product manufacturing design meet. DM-applications aid the design of the production layout.

PLM market-experts reckon the PLM Tools segment to be the largest, based on software license revenue. The second largest are (cPDm) solutions. The Digital Manufacturing (DM) segment rounds up the PLM market. At an estimated $750M by 2013, this segment is the newest and smallest of them all.

As shown by the market figures, the growth of the PLM market is attributable to the demand increase of traditional PLM software solutions.

5.1.2 Discussion: Collaboration & innovation?

What about PLM software aimed at supporting creative processes needed for innovation? The current segments of the PLM software market does not explicit its support for such process.

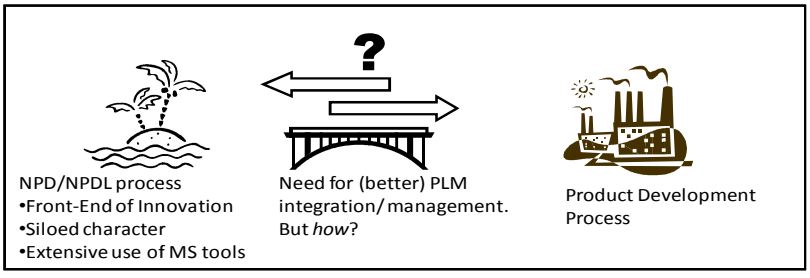
This is not surprising since PLM the best in situations where product structures are hierarchical in nature, their use in supporting the unstructured processes inherent in product development is somewhat limited (Kovacs, Le-Goff, & McClatchey, 1998). Thus, the use of PLM itself does not ensure the support of the innovation creation process. This last statement is supported by various sources, who state that the *front end of innovation is disconnected* from the rest of the product development process supported by PLM (Brown, What I learned: The Front End of PLM is Disconnected from PLM, 2009) (AMR Research, 2008). Front end refers to the idea generation process of NPD, which is subsequently followed by product feasibility, -development and –launch stages; of the so-called Development Funnel (Burgelman, Christensen, & Wheelwright, 2004).

Several reasons can be named for this apparent discontinuity in support of these processes. The front end of the product development new process (and launch), or NPD (NPDL), is characteristically a detached and unstructured process. NPD is a business process with highly uncertain outcomes (see section "Innovation and Knowledge" for more NPD process characteristics). The creative freedom necessary for idea-formation and –formulation means that a gated-process of PLM is not suitable in this front end.

Nonetheless, PLM-experts and market-analysts reckon that PLM must do a better job at integrating and managing the information created at this front end.

From the market figures, follows that the PLM software market is dominated by the sales of authoring tools, but none of these tools lend themselves for supporting the needs of product development engineers in the NPD process. Market-analysts call on the PLM vendors for more development of Customer Needs Management (CNM) applications, which is posited as the link between the creative front end and the rest of the development process. CNM applications are defined as tools to aide manufacturing firms to send validated product improvements and ideas through the phase-gate process for product portfolio analysis, feasibility determination, etc.

Developing applications aimed at managing the customer requirements may be steps in the right direction by the PLM vendors. But when it comes to connecting the front end to the rest of the PLM process, even CNM (by definition) still *does not* directly address the need of NPD in PLM; which is linking unstructured creative, free-form collaboration with the rest of the rest of product development process. This is where solutions such as Social Product Development will offer a solution and possibly bridge this disconnect (see pictogram below).



5.1.3 Social PLM vendors

Only a few big PLM software suppliers shape and control the PLM software market. The explanation behind this observation is the standard practice in PLM of acquisitions (acquisition and annexation of smaller software developing niche PLM solutions). The result is a supply-side of the PLM market seen below (see figure 8). This section will highlight the PLM software vendors that are undertaking the development of PLM solutions enabled by social computing technologies.

These same PLM vendors are categorized as PLM Mindshare Leaders (CIMdata, 2009), i.e. vendors responsible for generating the majority of the market revenues, and thought leadership (See figure 9).

From this set of PLM Mindshare Leaders, only three vendors are active in the realm of social PLM. There strategy towards the social PLM development is elaborated below.

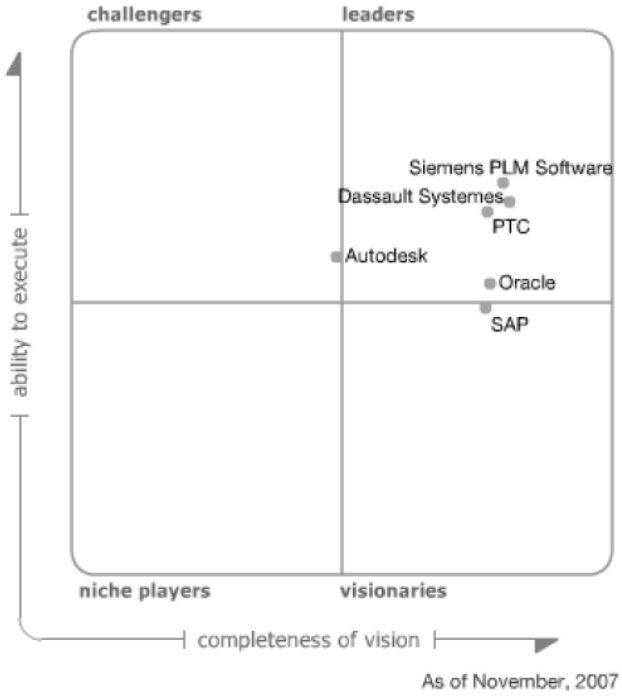


Figure 8: PLM vendor market positioning, source Gartner Research 2007.

Source: Gartner (November 2007)

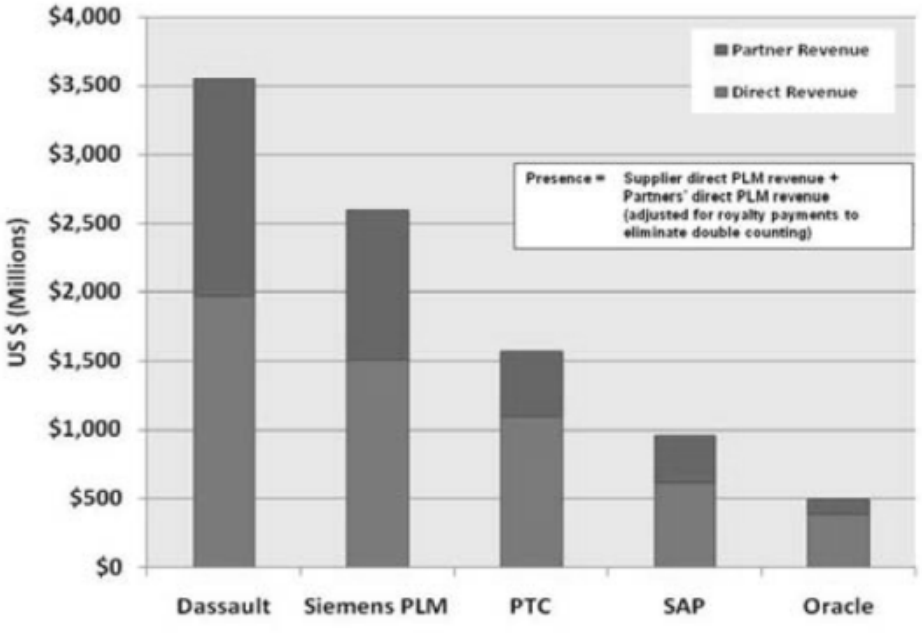


Figure 9: PLM Mindshare Leaders. Source CIMdata, 2009.

5.1.3.1 Parametric Technology Corporation (PTC): Social Product Development

The American-based company Parametric Technology Corporation (PTC) is the first PLM vendor to announce the inclusion of social computing technologies in a PLM product (See Appendix B).

PTC Windchill ProductPoint

The concept of joining social computing technologies and product development tools is named Social Product Development. The current Social Product Development solution on the PLM market is PTC Windchill ProductPoint. In late June 2010, PTC has announced to offer another Social Product Development solution, named Windchill SocialLink. Unfortunately, details are not available at the ime of this writing.

Partnership

Windchill ProductPoint is the result of a strategic partnership between PTC and Microsoft. By making extensive use of the social computing capabilities featured on the Microsoft SharePoint platform, PTC chose a favorable starting point. Microsoft's SharePoint platform is a popular business-collaboration platform with an immense installed-base (see section Social Computing Market, below), thus lowering the entry-barrier for manufacturing industries targeted by PTC with this latest offering. Also, PTC foregoes the in-house development of proprietary social computing technologies. Thus, PTC adheres to its strengths as a PLM software vendor, i.e. developing software applications that enable dissemination, management and collaboration of management structured product content. The partnership benefits for Microsoft are discussed in the Social Computing Market section.

Functionality

Windchill ProductPoint has several functionalities. Primary objective is the sharing and reusing of structured content (i.e. product engineering data), such as CAD-models. Second, Windchill ProductPoint interfaces with Microsoft Sharepoint platform and makes use of several key-features, such as document collaboration and social computing.

Thus, Windchill ProductPoint strives to offer SME's the ability to create, share and manage structured content, with the ease of an enterprise document management system.

Target market

Windchill ProductPoint is directed towards manufacturing industries that fall under the Small and Medium Enterprises (SME's) that are still making use of dispersed file-sharing protocols and local shared-drives to store and disseminate documents across project teams (OnWindows, 2010) (PTC, 2009) (PTC, 2010). The implicit assumption made is that these smaller organizations have no desire or do not make use of full-featured PLM systems, but use instead standalone CAD-systems to develop the product data. Further, PTC assumes that these target customers utilize some form of Enterprise Content Management (ECM) system, such as Microsoft SharePoint, since the aim of Windchill ProductPoint is to extend the capabilities of the SharePoint platform. In essence, Windchill ProductPoint interfaces PTC's CAD-solutions with Microsoft SharePoint, resulting in the Social Product Development target market being SME's with utilizing PTC Windchill CAD-applications and SharePoint.

Objective

The main emphasis of Windchill ProductPoint is the enhancement of product development collaboration. Since collaboration in the product development process is largely based on the sharing of knowledge and information, Windchill ProductPoint aims to provide sharing capabilities that IT-friendly and user-friendly

Windchill ProductPoint is positioned as an easy-to-deploy and easy-to-use application due to its use of familiar Microsoft-like layout. Offering product development engineers a familiar interface that functions like the file-based collaboration platform SharePoint, with the capabilities of a document management system that understands structured data, i.e. Windchill solutions.

5.1.3.2 Siemens PLM: Social Product Engineering

Siemens PLM Software

SIEMENS

Social Product Engineering

Siemens PLM Software calls its solution Social Product Engineering, and is meant to leverage the beneficial effects of social networks in the context of product development.

Siemens PLM integrates the social computing technologies into its *full-featured* PLM platform, Teamcenter PLM. The comprehensive PLM suite implies that this product development solution is aimed at larger enterprises.

Partnership

Similar to PTC's strategy, Siemens PLM entered into a strategic partnership with Microsoft. Unlike PTC, the partnership includes the integration of Microsoft technologies beyond the social computing technologies of SharePoint, but also with Office Communicator. With the latter allows the user to initiate communication with other users (e.g. Voice-over-IP telephony, conference calls, video-calls, instant messaging) from within the product development application.

Objective

The objectives of Social Product Engineering are multiple-fold. Siemens PLM aims to address the gap in the product development process mentioned earlier, by enabling Social Product Engineering to deal with product data across the complete range of the development process, and beyond the idea generation phase. Siemens expresses the vision of product development engineers forming product development communities, in the hope of speeding up internal project team collaboration.
Social Product Engineering aims to push social computing technologies to other downstream product development phases supported by PLM tools, such as the Change Management process. Product designs or design changes can be discussed making use of social communication technologies such as, instant messaging, video- and Voice-over-IP calls, Social Product Engineering enables management and project teams to discuss the changes. Thus, not only enabling collaboration within product development teams but also within the enterprise.

Target market

Siemens PLM Software positions Social Product Engineering as a full-featured PLM solution. With this positioning, Siemens PLM targets large engineering and manufacturing industries that use or have need for PLM. Siemens PLM's marketing describes pilot programs that have been executed at a multinational defense systems manufacturer, as to validate the features of the PLM solution.

5.1.3.3 Dassault Systèmes: Social Innovation

Dassault Systèmes (DS)
Dassault Systèmes (DS) is a French company, with core businesses established in 3D modeling and PLM solutions. DS's approach of socially-capable PLM solutions is unique in its vision of harnessing social interaction, within and outside the organization to generate solutions to product development issues. In other words, not only relying on customer insight input from product development engineers in the product development process, but procuring the involvement of the *actual customer* in the development process. DS calls this concept of product development *Social Innovation.* At the time of this research, this approach has not been developed past the conceptual stage.

Philosophy of Social Innovation

The philosophy behind the Social Innovation concept fits beautifully with the gap mentioned earlier, between the front end of innovation and the rest of the product development process. In a press release issued by DS (Dassault Systèmes, 2009), the DS president and CEO is mentioned noting that there is a "growing disconnect between consumer requirements and available products, between employees and their companies". Social computing technologies now offer means for businesses to adapt and narrow this gap.

Similar to PTC's Social Product Development, Social Innovation aims to provide means for people to connect in the product development process. Where Social Product Development places the emphasis on better product development collaboration *between* product engineers, Social Innovation envisions the involvement of *customers and employees* as active participants in the innovation process. DS envisions online services, through which these participants can connect and be presented with "ideas and virtual

experiences". The leveraging of social networks will be used to gather input from these partcipants. DS provides a simple example of the Social Innovation concept, in a video broadcasted by means of a popular social media platform[6]. Ironic.

Partnership

The driving force behind DS's Social Innovation, is a strategic partnership with the Enterprise Social Software company, blueKiwi Software. This partnership is much like PTC's own, where the PLM vendor acquires the rights to incorporate the social computing technologies developed by the partnering firm.
DS and blueKiwi Software partnership is focused on the progression of DS's current V6 PLM solution, delivering the company's "PLM 2.0" platform. Social Innovation is said to "deliver new and unique capabilities that connect users within their companies or with external online communities…create and share Intellectual Property and 3D experiences…use of common Internet tools" (Brown, 2009).

5.1.3.4 Conclusion PLM Market

A review of the PLM market and the PLM vendors indicates that PLM Mindshare Leaders have stayed true to their name and are expanding the concept of PLM. Three of these mindshare leaders have announced their already announced their social computing enabled solutions.

The review of PLM vendors shows that vendors have formed partnerships with organizations not related to PLM. These strategic partners are known as social software vendors. It is observed that the social computing features developed by these social software vendors, have been integrated in specific PLM applications (CAD), as well as supporting the full suite of applications.

It is shown that PLM systems do not support all parts of the product development process with the same level of adequacy. This seems to be the case for the so-called, front end of new product development. PLM vendors seemingly are addressing this chasm in the product development process with the offering of social PLM solutions. A PLM offering that offers a free-form collaborative environment enabled by social computing, while being supported by and connected to the structured content management abilities of PLM.

Below, further insight is presented into the vendors responsible for the developments of social computing. The following chapter will discuss the technologies involved in these systems, and how the systems are integrated.

[6]Dassault Systèmes' "Social Innovation in Plain English" :
http://www.youtube.com/watch?v=dXHxz0oVWTA

5.1.4 Social computing-market

Currently, PLM vendors employ social computing technologies developed by so-called *social software* vendors. Investigation into this market reveals that PLM partnerships, like those of Microsoft SharePoint and blueKiwi, are not commonplace. This is why further investigation is made below, into the underlying development of Microsoft's entrance into the PLM market.

Growth

Social software vendors focus on developing dedicated enterprise platforms that deliver these same social computing capabilities found on the consumer Internet. Forrester Research estimates the social software market to grow to $4.6B by the year 2013 (NewsGator, 2008). In this year alone (2010), Gartner Inc. expects the social software market to grow by 24.4% (Dassault Systèmes, 2009).

Overview

Market reviews by Gartner, Inc. (Gartner, Inc., 2009) and Forrester Research (Koplowitz, R., 2009) deliver convergent insights into the active vendors in the social software market (see figures 10 and 11, respectively).

The PLM market overview has already mentioned some social software vendors, namely Microsoft and blueKiwi Software. Based on the emergence of social computing in the consumer and enterprise markets and related growth of the social software market, further investigation in this market is reasoned as follows: if there are some social software vendors entering the realm of PLM, it is likely that other social software vendors will also make the transition.

Using the set of vendors shown in the figure 10, only the quadrants of the market where Microsoft and blueKiwi Software appear are chosen, in order to compare vendors with reasonably similar market positions.

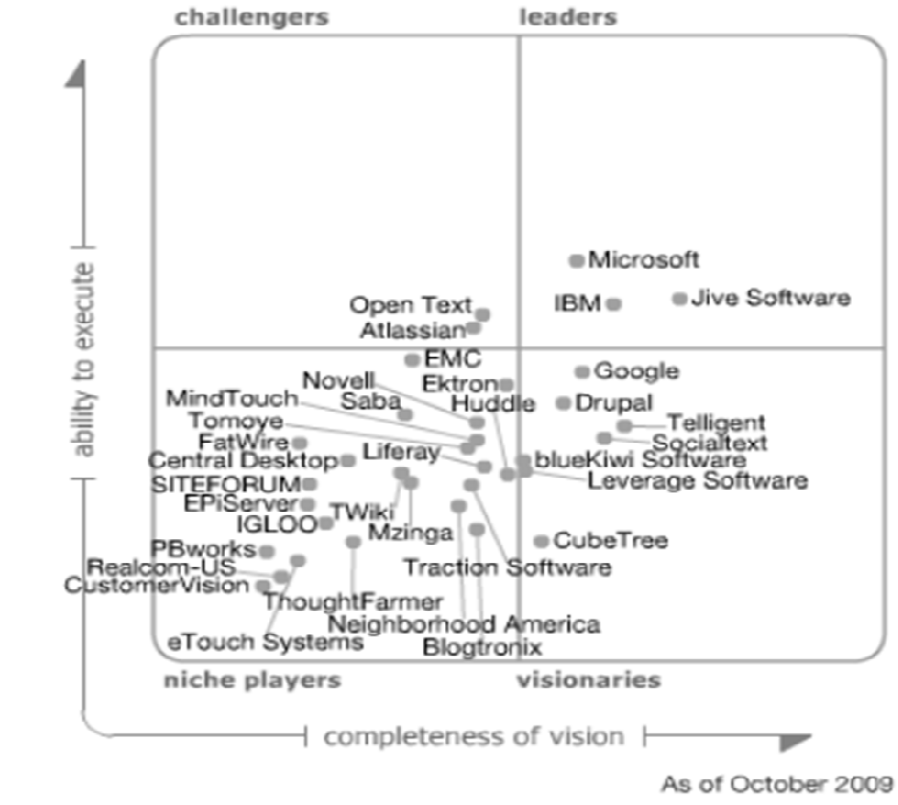
Appendix E presents an overview of the offerings of the social software vendors. The overview of the social software market turns up some interesting findings;

- Highly diverse market with vendors ranging from start-ups with local presence to multinational software vendors.
- The social computing capabilities of these vendors vary tremendously. From customer-specific engineered social computing solutions (blueKiwi Software,Telligent, SocialText), to full-featured collaboration platforms, incorporating all of the social computing technologies currently available (Microsoft, IBM Lotus and Novell).
- These products range from Software-as-a-Service (SaaS) Internet-based implementations, to implementations on dedicated servers on the customers' premises.

However, investigations into this diverse and dynamic market, has not yielded any partnerships for PLM integrations (Microsoft and blueKiwi are exceptions).

Viewing social PLM from the perspective from the social software market produces little insight into the dynamics that are driving the PLM integrations, even though these integrations are present. It is concluded that the observed PLM integrations are attributable to the initiatives of social software vendors, and not to any discernable market dynamics.

Microsoft's social computing involvement with two large PLM vendors warrants further investigation.



Source: Gartner (October 2009)

Figure 10: Magic Quadrant for social software market. Source: Gartner Research, 2009.

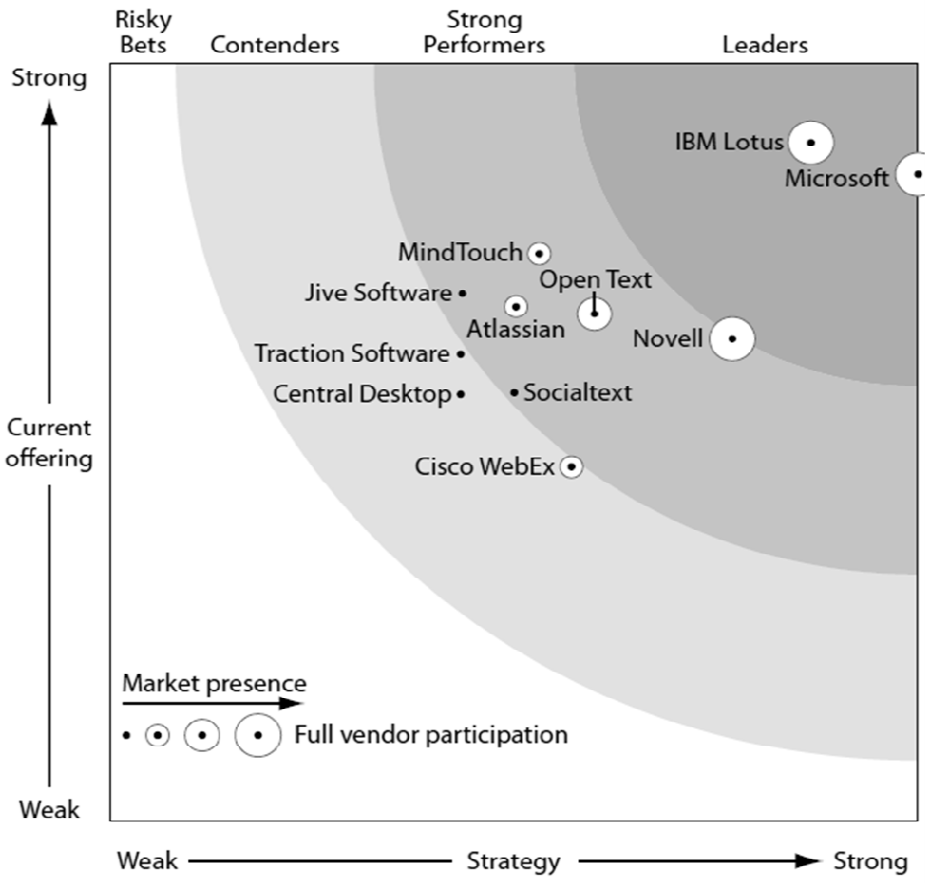


Figure 11: Forrester Wave for collaboration platforms. Source: Forrester Research, 2009

5.1.4.1 Microsoft Office SharePoint Server (MOSS)

The Microsoft Office SharePoint Server (MOSS) platform is more than social software. Next to social software, the platform occupies a prominent position as well in the enterprise content management (ECM) market[7]. Thus, this platform is an enterprise-wide document management and content collaboration platform transcending organizational disciplines, offering a variety of non-discipline specific functions. How can the integration in a process-specific platform, such as PLM, be explained?

Figure 12: the functionalities of MOSS

Social computing is one of user-experiences the platform offers, which has allowed it to gain massive adoption in the enterprise environment. MOSS boasts an installed-base of 100 million licenses at 17.000 companies worldwide[8] [9]. Even with widespread adoption, only a small portion of the MOSS' functions are utilized by enterprises, namely Collaboration and Portal (see figure 12). As part of Microsoft's Innovation Process Management (IPM) solution[10], Microsoft seeks to grow the MOSS business by integrating the MOSS platform with other discipline-specific solutions. Primary objective of this expansion is introducing enterprises with further Microsoft services, such as Business Intelligence and Analytics. Social computing in MOSS (found in the Collaboration-segment) is not the main driver for PLM integration; rather it is a low entry-barrier for services enterprise might use.

5.1.4.2 Conclusion Social software market

Reviewing the social software market reveals a diverse collection of vendors. The larger vendors (Microsoft, Novell and IBM) have offerings comprehensive enough to meet the demands of the enterprise environment. New or small vendors offer social computing applications with a limited focus.

From the larger vendors, only Microsoft has undertaken the initiative to integrate its social software (social computing technologies) into product development solutions. Investigation into this motive shows that Microsoft aspires to increase the utilization of the MOSS platform by leveraging its massive installed-base.

None of the smaller social software vendors have mentioned to have PLM-integration ambitions (blueKiwi excluded).

[7] Source: Magic Quadrant for Enterprise Content Management, Gartner, Inc. October 15, 2009.
[8] PTC Windchill ProductPoint presentation, 2009.
[9] Microsoft SharePoint presentation, *Winning on the Web: SharePoint as an Internet Medium*, 2009.
[10] Microsoft and Siemens PLM Alliance. Source:
http://www.microsoft.com/business/enterprise/alliancepartner/siemensplm.mspx

5.1.5 Supply side PLM market conclusion

The supply side of the PLM market shows that engineering and manufacturing are spending increasingly more on PLM applications and software licenses. Yet, this PLM market is dominated by a handful of vendors, the so-called PLM Mindshare Leaders.

Three of these PLM Mindshare Leaders are currently developing their social PLM solutions, by partnering with vendors of social software platforms. In contrast to the PLM market, the social software market is scattered with vendors of various sizes. In integrating the social computing features in their product development solution, the PLM vendors have chosen to partner with the largest social software vendor. Only one of PLM vendors has invested in a partnership with a smaller social software vendor, but the vision behind its social PLM concept is not yet definite.

6. Demand side PLM market analysis

The notion of social computing (i.e. enabling social interactions for product development), and PLM (i.e. a highly-structured system to store, manage and release product data) seem to conflict.Extracting the underlying capabilities from popular Web 2.0 social networking platforms and applying these to the enterprise environment (Enterprise 2.0), presents range of benefits can be observed.

This section highlights the values relevant abilities social interactions have for the product development process.

6.1Social PLM business values

This section will show that judging social computing tools by the existing popular examples of Web 2.0 (i.e. Facebook and Twitter), is a misconception.

The concept of social computing in PLM systems is a novel one. Concrete benefits from the actual PLM context are not mentioned. Social PLM business values noted by PLM experts originate from Enterprise 2.0. Applying these benefits to the realm of PLM does not undermine their validity, since product development engineers in the NPD process function as knowledge workers.

"Social Discovery" -- A prominent benefit of social computing in PLM is the subject of discovery. Discovery in relation to social computing is referred to as social discovery (Brown, 2009) (Brown, 2009). Social discovery happens when product development engineers can search for competent engineers or specific knowledge bases outside of their existing contacts, enabled by the Social PLM system. This Social PLM system is then used to make (initial) contact with the person of interest.
Social discovery is closely related to the theories of *weak and strong ties* in the Social Network Theory. The premise of *ties* is that the individual gathers knowledge through a social network. Product engineers interacting on a regular occurring basis are connected by so-called strong ties (Kijkuit & Ende, 2007). Strong ties are useful for the handling of formal processes.
The benefit of social discovery lies with the so-called weak ties. Weak ties present product development engineers with new (i.e. non-redundant) information. Discovering weak ties and making connections, allow product engineers to extract value from the details of a project, the engineers involved, or the references by these engineers.
The use of user-profiles enables social discovery. Enterprise knowledge workers utilizing user-profiles are able to find persons of interest, effective and efficiently. Social discovery shortens social and geographical distance between product development engineers, leading to the discovery of new knowledge and initiation of further collaboration with the persons of interest.

"E-mail bloat" –Electronic mail, or e-mail, is the primary form of communication in enterprise settings, but is not suitable for use in new product development process.
E-mail bloat happens when sending one message to multiple recipients triggers an event where the sender receives multiple responses. Especially the NPD, characterized by many designs and specifications uncertainties, collaborating product engineers communicating through e-mail, may experience *e-mail bloat* when communicating with multiple collaborators (OnWindows, 2010). Knowledge is strewn across inboxes and people making it challenging to maintain overview of the received information and avoid redundancy.

E-mail represents a *channel of communication* between sender and recipient. Knowledge shared through this channel, forms a knowledge base of a project but is not viewable or searchable by others. Nor is the knowledge stored centrally at the end of a project. Social computing presents a platform where product development engineers can express their challenges and share solutions. Knowledge is accessed for viewing by others, and stored on a central location.
Blogs and wikis are the social computing technologies suggested to enable this management of knowledge. Tags enable the categorization and retrieval of knowledge. RSS-feeds notify knowledge workers when information has been modified (i.e. new comments).

Knowledge drain – Knowledge drain (or Intellectual Property (IP) drain) occurs when the organization loses the tacit knowledge embedded in its knowledge workers, when these depart from the company and can negatively impact a company when the knowledge pertinent to an engineer is not transferred (Brandel, 2008). Engineering solutions developed by product engineers accumulate in time and is part of the organizational knowledge base. The current generation of PLM engineers is mentioned to retire in the coming years (OnWindows, 2010), creating a need to store this knowledge. It is also shown that the upcoming generation is well-adjusted to the use of social computing technologies (Web 2.0). Social computing technologies in the product development are presented an alternative for retaining the current specific product and process knowledge for future generation of engineers.

Development of new Intellectual Property (IP) – (Internet) Communities are one of the products of social computing. Common interests can motivate individuals to join a community and share information (i.e. experiences, tips, etc.) Social PLM proposes the potential of utilizing communities to contribute to the product development process (Brown, 2009). Outward-facing internet services enable customers and suppliers of the organization to engage in conversations that can generate new product ideas (i.e. "the voice of the customer").
Product communities extend the network of product development engineers beyond the organizational boundaries, and present almost similar benefits as social discovery. Communities can be accurate representations of target customers and social computing leverages the expertise provided by communities.

Increased productivity and knowledge management– Market pressures force engineering and manufacturing firms to optimize the internal business processes, the product development process in particular. The "traditional" form of collaboration – without social interaction – sees knowledge workers spending between 15-30% of the billable hours looking up information, and finding what they are looking for only 50% of the time (Socialtext, 2009). Current way of working at discrete manufacturing companies, make extensive use of e-mail, local- and shared hard drives to store and disseminate project documentation.
Social computing contributes to the organizational knowledge management efforts, by enabling sharing of tacit and explicit knowledge (i.e. project documentation) on a central location. Knowledge shared and stored in this central location is then accessible for use of future NPD teams. Future teams can learn from past efforts, whether or not the projects were executed successfully or were abandoned, and the reasoning behind the decisions.

6.1.1 Conclusion Social PLM business values

The concept of social computing integration in product development systems, presents several benefits. Social computing platforms aid the product development process on several fronts. The discovery of non-redundant information and generation of customer demand knowledge can be enhanced, and subsequently shared internally in the development team. Posting this information on a central location allows for easy finding and viewing for all engineers involved. Meaningful discussions ensue that are stored on central locations, accessible by future NPD teams.

In short, social computing in PLM aims to streamline the information flow among product development engineers. From the organizational perspective, social computing delivers shorter and more effective product development cycles, while ensuring that generated (tacit) knowledge is captured.

6.2 Social networks in the product development process

Social computing fosters interactions among users. This section shows that applying this notion in the product development process should result in improved shorter, more efficient and innovative product development cycles. This section focuses on social networks and what such networks trigger that have an impact on product development processes.

The prevailing view when considering the concept of social computing and its interactions is the perspective of social networks, but the concept of social networks is not new. Social networks exist long before the advent of the computer (Moreno, 1950), and modern-day Web 2.0. Social computing can thus be considered as the systemization of existing social networking dynamics.

Systemizing social networks, integrating them into PLM systems (as part of social computing), means that there must be advantages to do so.

6.2.1 Social network determinants

The Social Network Analysis (SNA) scientific discipline studies the phenomenon of social networks, and presents its values to product development. SNA literature show how market conditions ripple through industrial organizations, to invoke a reality where social networks are decisive for the innovative outputs of organizations. Innovation presented as a crucial element in fending off this pressure.

Social networks in the organizational context originated from restructurings in the industry, large-scale downsizing, vertical disaggregation and outsourcing (Batt & Purchase, 2004); companies reorganized themselves to focus on a smaller part of the process and/or product as a whole. Research show that manufacturing firms able to respond adequately to these pressures the competitive market thrive, as a premium is placed on speed, efficiency and quality in the product development process (Morton et al., 2004) and the strengthening of organizational product development capabilities is a necessity (Morton et al.,2006).

Thus, first firms restructured the organization in pursuit of speed and agility the market demands. Business networks emerged from these restructurings, through which they contribute knowledge and extract knowledge through network collaboration (Batt & Purchase, 2004).

Further, manufacturing industries must ensure to separate themselves from other similar competing industries, as market pressures drive the competitive climate of the contemporary marketplace (Morton et al., 2006). To pursue this differentiation, firms must constantly innovate to stay ahead (Lee, Wong, & Chong, 2005).

Market pressures shape the form of the organizations, which must then respond by forging collaborative ties with industries in order to strengthen their product development competences. In the end, innovation is needed to counter the competition.

Innovation is no longer conceived as a discrete event only involving the development of technical solutions, but also social interactions (Landry, Amara, & Lamari, 2002). Thus, market pressures trigger the need for innovation which is enhanced by social networks.

6.2.2 Innovation and knowledge

A firm's innovative performance is dependent on an effective front end[11]of the NPD process (Kijkuit & Ende, 2007), with at its heart is knowledge work (Pitt & MacVaugh, 2008). Knowledge acquisition is established as a determinant of innovation and production factor (Landry, Amara, & Lamari, 2002) (Bakker et al., 2006).
NPD activities are characterized as having ambiguous and complex non-repetitive tasks (Freel & De Jong, 2009). NPD team members' ability to disseminate the right knowledge successfully is directly related to the success of the NPD project.

Thus, the knowledge-based product innovation is a result of a NPD team's iterative, problem-solving, information processing abilities. Social networks support product development engineers in the NPD, by enabling information acquisition from multiple points of view, through which synthesis is achieved, also known as *creative abrasion* (Freel & De Jong, 2009). Creative abrasion is an important factor for producing innovations, due to the need for multidisciplinary approaches in complex product development processes (Lee, Wong, & Chong, 2005).
In conclusion, market pressures such as delivering products faster, cheaper and satisfying tougher demands trigger the need for innovation, and the social networks that create them. Competitive pressures further enforce the need to innovate. These simultaneous forces are known as the *manufacturing squeeze*. Responding to this squeeze, the new product development engineers develop network ties to acquire non-redundant knowledge from business networks. Internally, these social network ties function to disseminate knowledge and triggering creative abrasions, as engineers place the new knowledge in context and extract value from it. It is through this information processing process of disseminating knowledge and creative abrasions that product innovations emerge (see figure 13).
Note that the market pressures correspond to the traditional PLM drivers mentioned above.

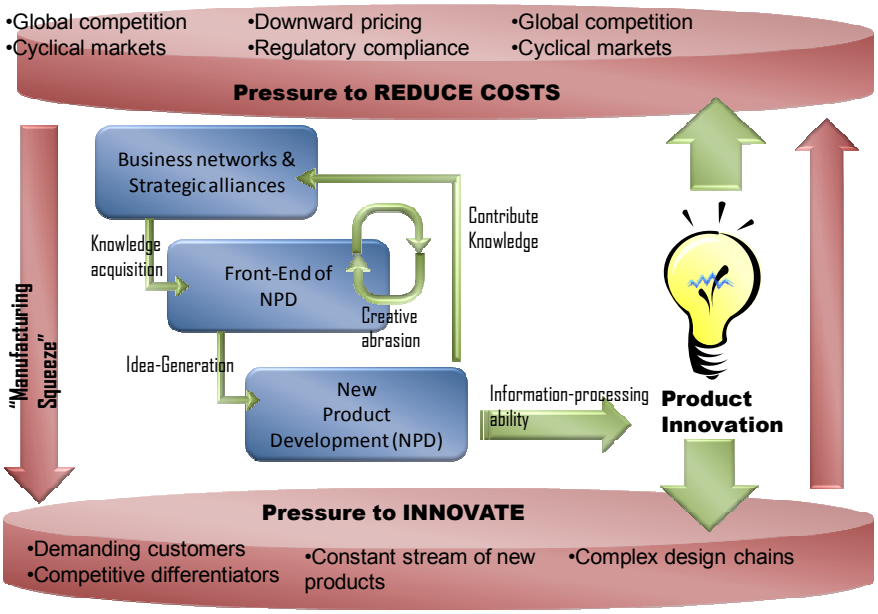


Figure 13: social network and product innovations

[11] Front End, according to Kijkuit & Ende (2007),is the part of NPD from where ideas are born and developed, up to the go/no-go decision for the project.

6.2.3 Social network mechanisms

The previous section has shown that social networks are important for product innovations in the NPD process. But what is it that social networks enable and facilitate?

Network ties give product engineers access to knowledge (i.e. ingredient for innovation) of others. Social capital (the stock of active connections engineers possess in their network) enables knowledge to be transferred from other resources, since it binds members of human networks and communities and make cooperative action possible (Landry, Amara, & Lamari, 2002). This reduces the time and effort needed to obtain knowledge, benefitting the NPD process.

Once knowledge is accessed and transferred in the NPD process, it must be processed internally and triggers other mechanisms. Product engineers need to be able to understand the knowledge, and is where social network ties enhance the mutual understanding of the knowledge bases of others (Kijkuit & Ende, 2007). Mutual understanding enables the use of a common language, resulting in subsequent sense making of the knowledge in the correct context by developing meaning of surrounding information and acting accordingly.

Finally, social networks aid NPD project teams to reach their shared goals by making necessary knowledge available to others and be able to jointly create new knowledge. (Bakker et al., 2006)

6.2.4 Conclusion Social networks in the product development process

This section has shown that firms rarely survive and thrive through their individual efforts (Batt & Purchase, 2004). Competing firms have a need to innovate, which depends on the collective expertise of others. Expert knowledge are embodied in networks and communities (Landry, Amara, & Lamari, 2002), and social networks become essential to access it.

Also internally to the NPD process social networks are crucial, since these processes are integrative and complex, requiring creativity that is more suitably handled by informal, decentralized structures (Lee, Wong, & Chong, 2005). Social networks can traverse organizational functions and divisions and facilitate the flow of information, enabling more rapid outcomes. Social networks are suitable for pursuing product development in dynamic market environments, given their capacity for managing change (Morton et al., 2006)

In summary, if the NPD process of a product developing- organization can be compared to an engine, informal, social networks are its fuel. Enabling the acquisition of non-redundant knowledge, helping engineers to make sense and extract value, and supporting NPD teams to achieve shared goals.

6.3 PLM-customer interviews

The social PLM business values have shown the proposed benefits social computing has for the engineering and manufacturing industry. Up to this point, social PLM values have been presented from the technology push-perspective of PLM vendors, omitting issues that might hinder the adoption of social PLM. Interviews were held at engineering and manufacturing companies to compensate for the lack of academic perspective of social computing use in industries involved in the development and manufacturing of products.

6.3.1 Target companies

Firms in the discrete manufacturing industry were chosen which possess implementations of PLM and business-collaboration platform MOSS. Investigative interviews deliver a better description of the actual uses, issues and perceptions of these systems in the organization. Two Atos Origin PLM customer companies, active in the discrete manufacturing industry, were approached.

In both companies there are mentions of globally dispersed project teams that must share information. Information can refer to project documentation or product-related data, each type having different methods in which they are managed.
The investigative interviews centered on subject of data management with regard to product data, collaboration and the current presence of social computing.

6.3.2 Issues in information management

Product-related data are stored in the product data management (PDM) PLM solution. The characteristics of PDM allow product data to be closely managed in order correspond to exact product specifications. The objective of the PDM is the controlled release of this information to other domains downstream, i.e. manufacturing and maintenance. PLM authoring tools (mechanical and electrical CAD solutions) are directly connected to the PDM system for storage, management and dissemination.
Access to the PDM system is limited to the internal product development engineers. Knowledge workers from other organizational disciplines can request to access the PDM system, but seldom happens given the unintuitive user interface of PDM. Direct access for co-developers to the PDM system, product engineers contributing to the product development process as a result of outsourcing, is a growing in order to shorten the lead time of the development cycle. Collaboration with co-developers happens by sending technical product documentation (TPD) taken off the PDM system.

Project data does not follow the same strict management procedures of PDM and also creates management issues. Project data are scattered across various local drives and shared drives. Document version management is left to the discretion of the author. Documents are disseminated by e-mailing the hyperlink (the URL of the Intranet location of the document) to the members of the project team. The effectiveness of this method is limited, since the hyperlinks become non-functional, if or when the author relocates of renames the document.

Both discrete manufacturing industries have implementations of enterprise-level business-collaboration platforms, which can be used for storage of project documents and also support the collaboration process. But interestly, its use as a means to collaborate and/or share project documentation is not officially enforced. This lack of enforcement results in knowledge workers not being familiar with the system and

often cannot find the location in which the documents are stored on the business-collaboration platform. Thus, the question of what to do with project documents at the end of a project still requires a definite solution.

6.3.3 Social computing?

Interviews both companies revealed that there was no official mention of actual implementation of social computing technologies in the product development process. Instant messaging (IM) technology is the social computing tool most commonly used for supporting social interaction amongst knowledge workers. The absence of social computing technologies in these organizations has several reasons.

The perception of use is an issue, when it is mentioned that there is little benefit having product development engineers authoring blogs and setting up user-profiles. This perception of social computing is likely related to the innovation creation context at the specific company, i.e. whether or not innovations originate within the organization. It is mentioned that current product innovations in this company's offering, are outsourced to co-developers. Once an innovation is developed product development translate these into feasible manufacturing processes. Outsourcing the (front end of) NPD tasks explains the lack of social computing technologies at the company, which support idea generation processes mentioned earlier.

Second, social PLM systems are based on the newest versions of PLM offerings. This raises the issue of legacy systems and data that result from the organic growth an organization. As organization evolve more information systems (CAD, PDM, ERP, WFMs) are employed to support the various processes. However, these systems are seldom delivered by a single vendor, resulting in a complex patchwork of systems that are integrated by use of bespoke software (see practical example, figure 14). The high costs and lead times to acquire and implement the systems can make companies reluctant to change, unless there are clear financial incentives to do so, by means of the returns-on-investment (ROI). Establishing a ROI is a concrete demand for the consideration of social computing adoption. Unfortunately, research shows that establishing a ROI is difficult even for enterprises that already have adopted social computing (The 2.0 Adoption Council, 2009).

6.3.4 Conclusion Interviews

The subject of implementing social computing technologies in the product development process was presented to two discrete manufacturing industries.

What resulted from these interviews is a view where not all information is treated equally, and each kind has its set of issues. PDM ensures the structured management of product-related data, but makes it difficult for knowledge workers from other disciplines to understand the PDM interface and locate the data. Allowing developers outside the PDM environment to access this data is also a challenge. Managing unstructured product development project documents do not follow the strict document management scheme of PDM, and are stored on various sources. This presents an issue when considering what do with the information after the project is concluded.

Social PLM can contribute in resolving the management product development project documentation, but the perception of its use is not well understood. From all the social computing technologies offered, only one has been officially adopted (e.g. IM). Further social PLM adoption can be hindered by issues such as the perception of the social computing and its added-value, legacy systems and establishing ROI's.

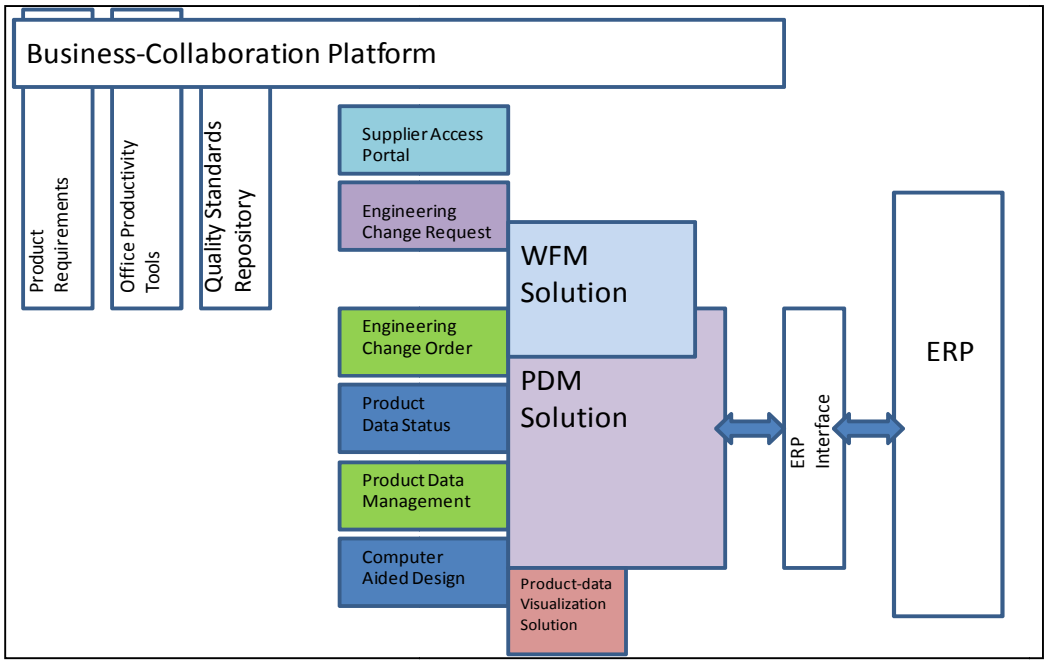


Figure 14: "Patchwork" of information systems

7. Technology

This section presents a deeper investigation of the technologies that comprise PLM. As mentioned above, Up to this point little is mentioned on the actual integration of social computing in PLM. This section will show that the integration of social PLM is a result of interfacing Enterprise 2.0 technologies (as features of business-collaboration platforms) with existing PLM solutions. The use of social PLM in the product development process is illustrated in a use-case scenario.

7.1 Web 2.0 & Enterprise 2.0 technologies

"Web" is the abbreviation of World Wide Web, the most popular application of the Internet based on universally-agreed technology standards. The current incarnation of the Internet has been named Web 2.0, indicating a new version of sorts[12] of technology standards/agreements which represents a profound change the user experiences. Technological developments of the Web 2.0 have lead to possibility of users sharing and collaborating with others. A feat heretofore not possible, without the technologies described below:

- Wikis
- RSS-feeds
- Presence detection
- Threaded discussions
- Blog
- Tagging
- Ratings
- User-profiles

A detailed elaboration of these technologies is presented in Appendix F.

7.2 Current integration of social computing in PLM

Scientific PLM literature offers tools limited insight into social PLM, with one example of the offering of wikis and blogs presented by Pallot, Richir, & Samier (2008). The example is developed on a bespoke theoretical architecture, with limited practical applicability.

From the PLM vendors' publications it is found that the integration of social computing in PLM happens by way of business-collaboration platforms. In order to understand how social computing is implemented in social PLM offerings, such as Social Product Development and Social Product Engineering, it must first be understood how Web 2.0 is implemented business-collaboration systems, also known as Enterprise 2.0.

7.2.1 Enterprise 2.0

The application of Web 2.0 in the enterprise environment to enhance organizational productivity is referred to as Enterprise 2.0. Just as Web 2.0, Enterprise 2.0 enables sharing and collaboration but now among enterprise users.

McAfee (2006) presents the acronym SLATES to describe the comprising technologies of Enterprise 2.0 platforms: Search, Links, Authoring, Tags, Extensions and Signals. The correspondence of SLATES and Web 2.0 technologies are presented in the table below. Further elaboration on SLATES is presented in Appendix H. As

As table 2 shows, the majority of Enterprise 2.0 tools are an exact replica of the Web 2.0 tools found on the Internet.

[12] […] There are **no set standards** for Web 2.0, it is characterized by building on the existing Web server architecture and using services. Source: Wikipedia, http://en.wikipedia.org/wiki/Service-oriented_architecture

SLATES (Enterprise 2.0)	Corresponding Web 2.0 technology
Search	-
Links	-
Authoring	Wikis, blogs
Tags	Tags, Tag cloud (see figure 15)
Extensions	Ratings
Signals	RSS-feeds, Presence detection

Table 2: Enterprise 2.0 vs. Web 2.0

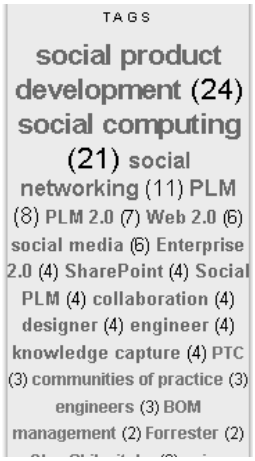


Figure 15: Tag cloud

7.2.2 Business-collaboration platforms and social computing

Business-collaboration platforms focus on two functions: enable enterprise to centrally manage, store and disseminate unstructured enterprise information (document management platform). And, enable knowledge workers to work together on documents, in order to achieve common business goals and increase business productivity (collaborative content management systems).

Document management platforms, otherwise known as Enterprise Content Management (ECM) systems have long been the core function of business-collaboration systems. The emergence of social computing placed emphasis on the development of the collaborative content management system, as to enhance collaboration and sharing across organizational disciplines to achieve common goals. This can be evidenced by the example of Microsoft SharePoint business-collaboration platform, which mentions that three of its nine functions relate to social computing[13].

The presence of Enterprise 2.0 technologies in these business-collaboration platforms, deliver the following functionalities:

- Develop a personal social networks (Search),
- Social tagging (Links and Tags),
- Develop dynamic knowledge repositories (wikis), share latest developments through blogs (Authoring),
- Published on a personal profile (Signals).

The added-value of business-collaboration platforms are support and track of project workflows, and task management. Social computing technology breaks away from this transactional view of project management. Business-collaboration platform vendors posit social computing as a tool to help knowledge workers to communicate changes occurring in the market, by sharing relevant information quickly and

[13] Microsoft SharePoint 2010, Evaluation Guide, Beta version. Source: www.sharepoint2010.microsoft.com

informally. Thus, social computing implemented in these platforms is meant as an information dissemination mechanism, to redirect problem-solving efforts, generate ideas and develop solutions, leading to potential innovations demanded by the dynamic market circumstances.

7.2.3 ECM and PLM

Mentioned above, PLM solutions aimed at enabling engineering and manufacturing industries to respond to dynamic correspond to the Customer Needs Management solutions of PLM. Social computing adds to the functionality of this class of PLM solution, and this section will elaborate on its integration in PLM. Although research has not generated explicit evidence on how this integration is executed, inferences are made here based on the technical properties of PLM and business-collaboration (ECM) systems.

Both ECM and PLM maintain a separate database system, given the different information formats managed, respectively unstructured vs. structured. Given that both systems operate independently, social computing functions in PLM is the result of integrating both systems by means of an application programming interface (API) or "middle system" (see figure 16).

This "middle system" configuration is proposed, since the nature of PLM system does not allow it to support and store unstructured, informal information such as blogs and user profiles. Second, the purpose ECM is to store all types of unstructured content[14] found in project workflows and task management. Social computing in PLM, by means of these business-collaboration platforms, is meant to enable product development engineers to share and collaborate on either product data knowledge (found on PLM) and/or project documentation (found on ECM).

By describing social computing technologies, enabled by business-collaboration platforms as a system in the middle of the ECM and PLM, the product development (collaboration and sharing) functionalities described by the PLM vendors, can be realized. The hypothesized integration is presented in figure 16 with dotted-lines.

[14] Source: Magic Quadrant for Enterprise Content Management, Gartner, Inc. October 15, 2009.

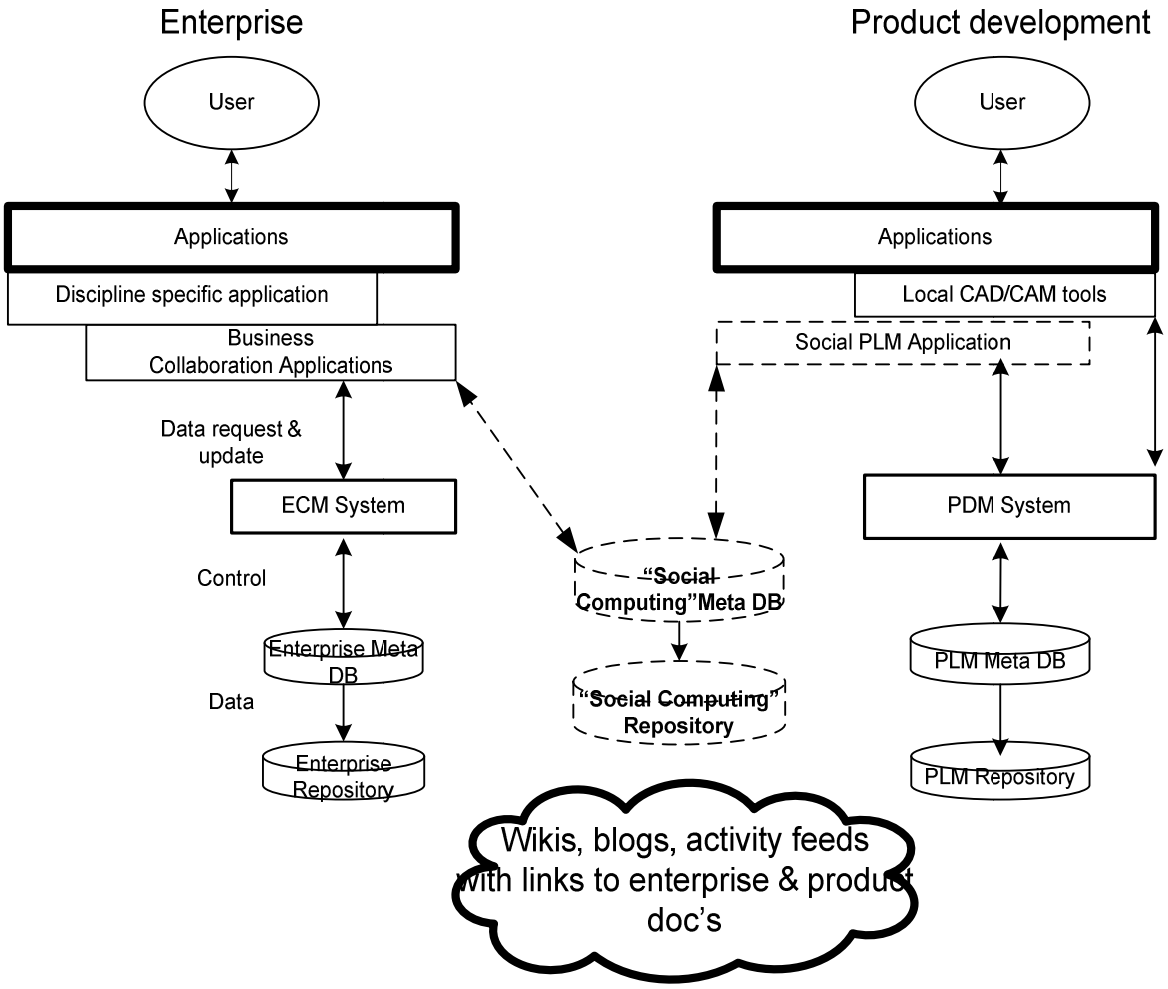


Figure 16: Functional view of social computing in PLM

7.2.4 Social PLM in product development process

Envisioning how social PLM is utilized and enhance the product development process is presented here. The use-case scenario stems from practical examples presented by Siemens PLM Software (Social Product Engineering) and PTC (Social Product Development).

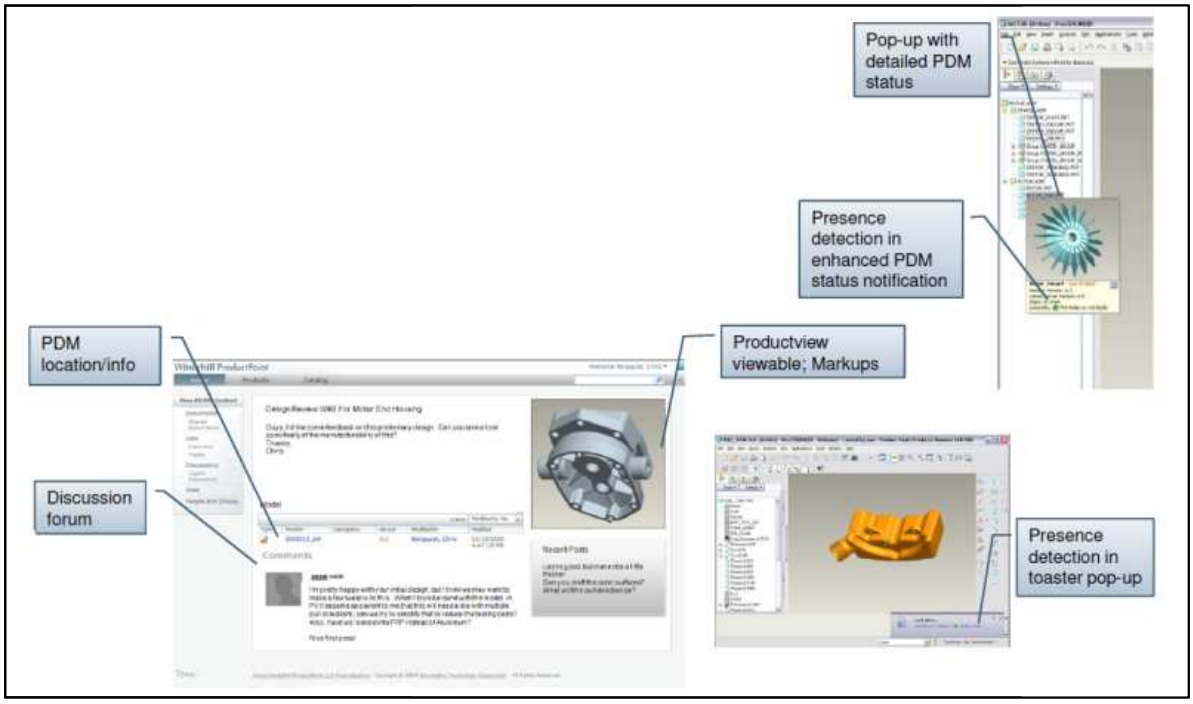
Use-case scenario: collaborating on product design changes.

Figure 17 presents actual screenshots of the social PLM solutions, PTC Windchill ProductPoint and Siemens PLM Software Social Product Development, respectively.

In this use-case scenario, specifications of existing product designs are modified to meet customer demands. The social PLM solution allows product engineers to create a dedicated profile page of the product, on which the product design in question is visualized and collaboration will occur. Engineers can post technical product documentations (TPD's) and other project documentation (stored on the PLM and ECM respectively) to this page, by adding hyperlinks (tagging).
Engineers can add other available engineers to the collaboration process by making use of presence-detection, or search for an engineer by means of user-profiles. Presence-detection automatically announces the availability of engineers already added to the collaboration process.
Once available, instant messaging (IM) enables a conversation on the tasks between engineers, which stored centrally allows viewing by other engineers at a later time.
Comments on the design improvements and/or proposals are placed on the product page, triggering further discussions and comments. Insights gathered from these discussions can be gathered and added to a dynamic knowledge repository on the product (wiki).

Web 2.0 tools utilized	
	Ratings
	User-profiles
✓	Tags
	RSS-feeds
✓	Chat messaging
	Blogs
✓	Wikis
✓	Presence-detection

In summary, this vision of social PLM vendors depicts how social computing can impact the development process, by means of the business values mentioned earlier such as social discovery and knowledge management, and resolving product development issues such as knowledge retention and potential e-mail bloat.



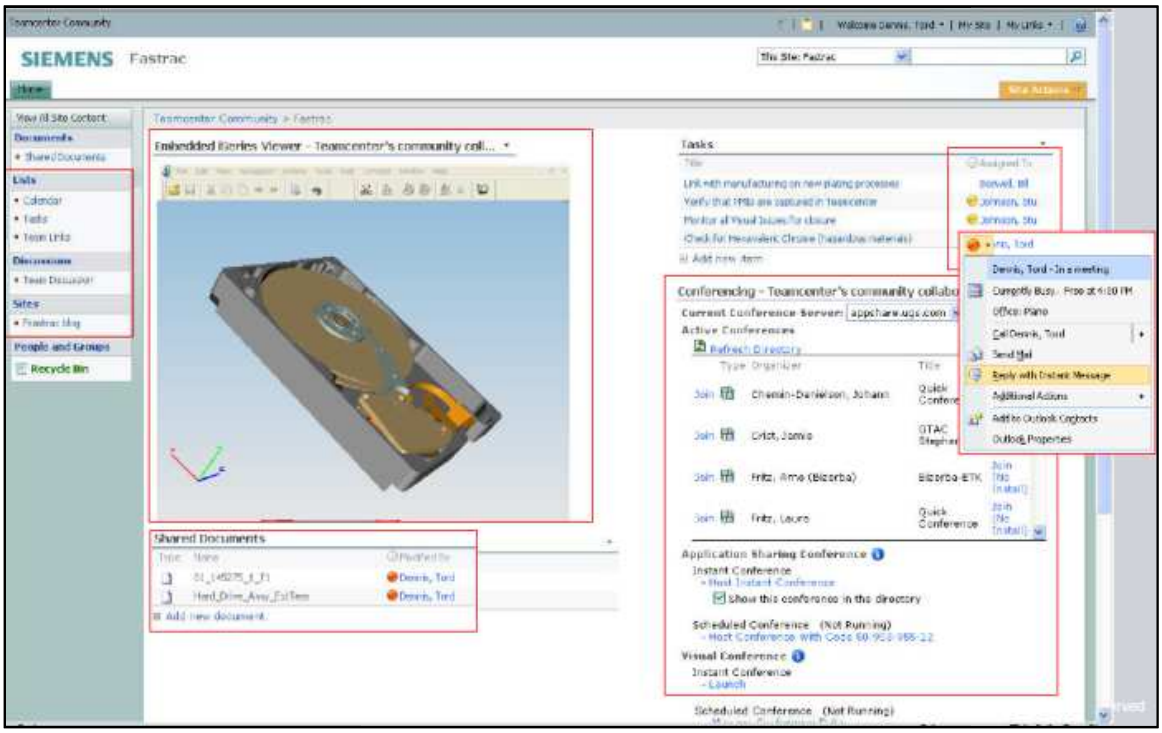


Figure 17: Screenshots of Windchill ProductPoint and Social Product Engineering

8. Overall conclusion Focus Areas

Chapters 4-7 presented the research findings of each focus areas in detail. Using this generated insight, this chapter will answer the partial research questions (PRQ's) presented in section 3.5.

(PRQ.1) What factors are driving the development of Social Product Development? And, what aspects of the product development process does it aim to improve?

Social Product Development is the concept name introduced by a PLM vendor to describe the concept of implementing social computing features in product development solutions.
Social Product Development presents:

- a free-form collaboration space,
- enhanced with social computing technologies,
- enabling engineers to visualize, collaborate on and share product-related knowledge,
- supporting the social interactions necessary for the new product development process, to acquire, process, disseminate product-related information,
- and, stored in a central location, facilitating knowledge retention and retrieval.

The drivers of social PLM, e.g. Social Product Development, are shown to be generalized business challenges related to Enterprise 2.0 and apparent increase in Web 2.0 adoption.
The Enterprise 2.0 generalized drivers, the limited practical applications by early adopters (Hype Cycle) and low-level of acquaintance of Web 2.0 by product development engineers (socio technographics ladder), show that social PLM is a result of technology-push.

(PRQ.2) How will social PLM affect the activities of product development process that are supported by PLM?

PRQ.2 is interested in what part of the product development process social PLM affects. Research findings show that social PLM is the most applicable at, a part of the product development process seldom supported by PLM at all; the front end of the NPD process. Collaboration tools which connect the product idea generation phase of NPD and the rest of the product development process, have been largely neglected in the overall development of the PLM discipline. The main focus of PLM development has been on the development of authoring tools (PLM Tools) and data management solution (cPDm). Those PLM solutions handle structured product definition data, which subsequently accompanies the product throughout its lifecycle.
However, the generative processes behind these structured data are ideas and insights from product development engineers, customers or knowledge workers from other disciplines. Social PLM offers tools to support these unstructured collaboration processes. It is these unstructured collaboration processes that can generate product innovations, and by employing social computing these can be achieved more efficient and effectively, contributing to the firm's competitiveness.
Lastly, social PLM functions as a knowledge repository for accumulated innovation knowledge; loosely coupled ideas and concepts are stored and can be of potential value in future product applications.

(PRQ.3) How do social networks enhance the product development process?

Applying social networks – the commonest social computing technology recognizable for the uninitiated – in the product development process are beneficial in producing innovations, since social networks enhance the collaboration on and sharing of knowledge by invoking several mechanisms.

Social networks enable the development of weak ties amongst product development engineers, which are useful in discovering and accessing to non-redundant information faster. The transfer knowledge over these ties is dependent on the social capital product development engineers have accumulated in their networks over time. Social networks support NPD teams to process new knowledge by enabling the development of mutual understanding, creative abrasion and sense making within these teams.

Social networks enlarge the ability of NPD teams to acquire and process knowledge faster, enabling product innovations.

(PRQ.4) How should the social PLM system be positioned within the Enterprise Information system?

Findings show that the current social computing technologies in PLM, form part of a business-collaboration platform. Business-collaboration platforms are not discipline-specific systems, offering a variety of enterprise-wide document-management and –collaboration functions (ECM); enabling the sharing of product engineering data, as well as other enterprise information, such as project documentation. Business-collaboration platforms transcend organizational disciplines, and allow product development engineers to share and collaborate within the project team and with knowledge workers beyond.

Thus, social computing technologies are not an integral part of the PLM solutions but interact with these solutions from within the business-collaboration platforms.

Figure 18 visualizes the product development Enterprise Information System of a generic engineering and manufacturing firm. PLM and ECM deal with structured and unstructured data, respectively. To the far left of figure, the product development authoring tools (PLM Tools) are presented. These tools have access to the social computing technologies provided by the business-collaboration platform. Using these interfacing tools, product development engineers can create, share and collaborate on product-related content (stored in PLM) or unstructured project documentation (found in ECM). Social computing is thus presented as an interacting layer, between the product development authoring tools and PLM. The right-hand side of the figure presents the connection of PLM and other systems involved in the manufacturing and transactional processes downstream (MES, ERP, e-business).

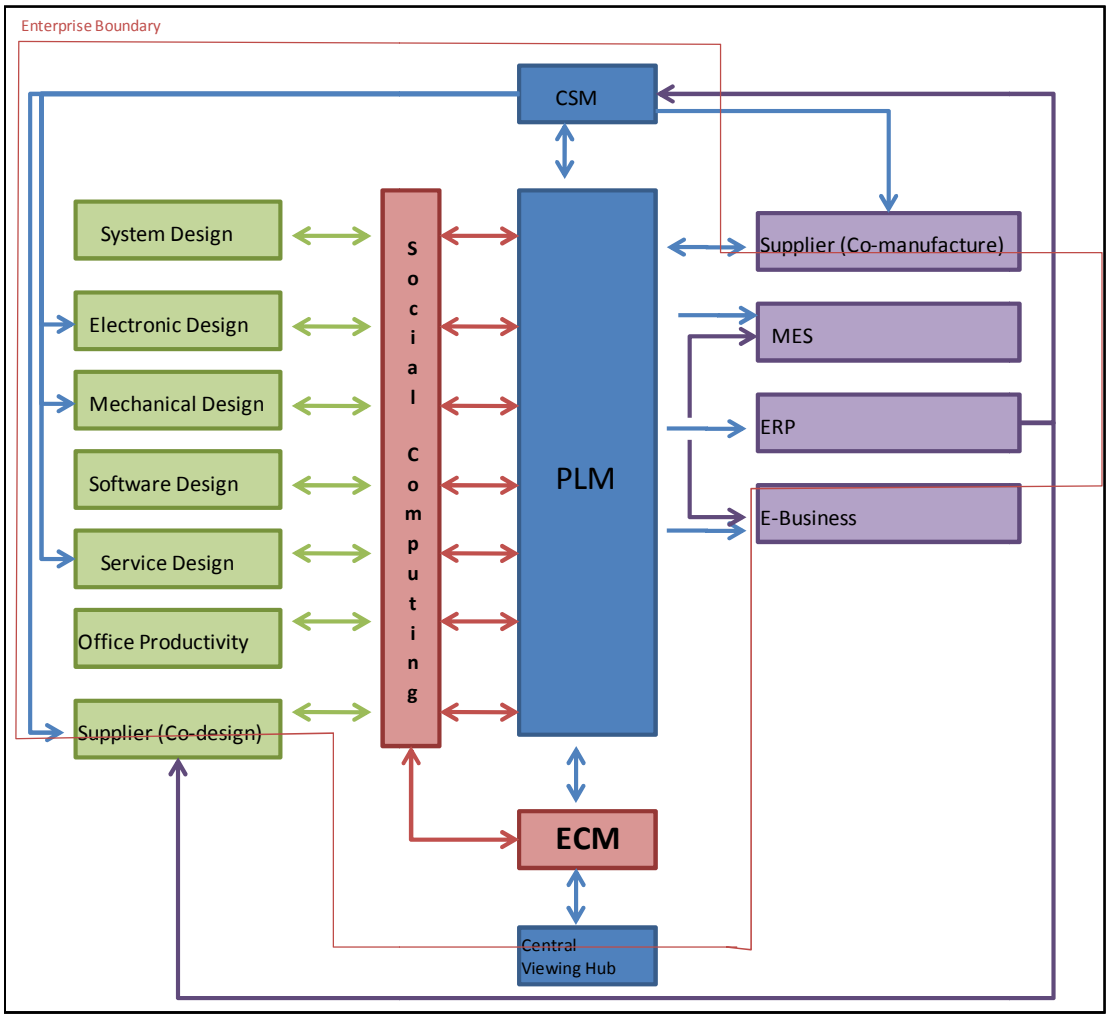


Figure 18: placement of social PLM

9. Atos Origin PLM

In the realm of PLM implementation there are seldom one-size-fits-all solutions, since engineering and manufacturing firms differ on internal business processes, organizational size, industry, product, etc. PLM software vendors offer a broad range of applications to support the product development needs of the manufacturing and engineering firms, whether it is a general or specific need (see figure 1 for the PLM functional modules). Addressing these divergent product development needs requires the PLM application to be tailored to each organization. Hence, PLM applications are offered in *packages*, i.e. comprehensive, customizable and configurable product development software that can be fit to correspond to a specific industry need. Customization, configuration and subsequent implementation, demands in-depth knowledge of PLM the software and its programming. This tailoring process is one of the many complexities that hamper the PLM implementation (Batenburg, Helms, & Versendaal, 2005) (Bryan & Sackett, 1997) (Kumar & Midha, 2001) (Liu & Xu, 2001), thus requires special know-how to obtain.

The industry assisting these engineering and manufacturing firms in this implementation process is called PLM Service Providers (Gartner, Inc., 2009), and is where Atos Origin PLM is active.

Atos Origin PLM is at the forefront of the PLM implementation business in the Benelux-region. It focuses on PLM in the manufacturing industry and specializes in on the interfacing of PLM with Manufacturing Operations Management (MOM) and Enterprise Resource Planning (ERP) systems (Gartner, Inc., 2009). Also, the firm is known for ability to deliver PLM vendor-independent services, giving it greater appeal to manufacturing firms.

The objective of this section is to establish business opportunities social PLM represents for Atos Origin, by uncovering the current business capabilities that Atos Origin PLM possesses and highlight capabilities that facilitate or impede a business in social PLM. Business capabilities are uncovered by a review of the current services Atos Origin PLM, and a discussion on the strengths and weaknesses of this organization.

9.1 PLM services

The core business of Atos Origin PLM is based upon the delivery of supporting PLM services towards discrete manufacturing firms. An internal business process is developed to enable the delivery of these services. This business process, named MAPLE, has three main segments: Consult, Build and Operate. Adding the PLM services to each of these segments forms the Atos Origin PLM service portfolio (see figure 19, Product Lifecycle Management Services).

9.1.1 Services overview *

Consult

Elaboration on the specific PLM Consult services Atos Origin delivers.

Build

Short description of the type of Build services offered.

Operate

Once PLM solutions have been selected (Consult) and implemented (Build), engineering and manufacturing firms can outsource the system performance maintenance to Atos Origin PLM (application management).

Finally, PLM-on-Demand[15] is a recently launched, Web-hosted Product Data Management (PDM) solution. This service is aimed at engineering and manufacturing firms whom prefer not to spend on capital intensive investments for PLM hardware and maintenance.

9.1.2 PLM Services Discussion *

Insight gained from the review of the PLM services, indicates several organizational traits, its customers and its business.

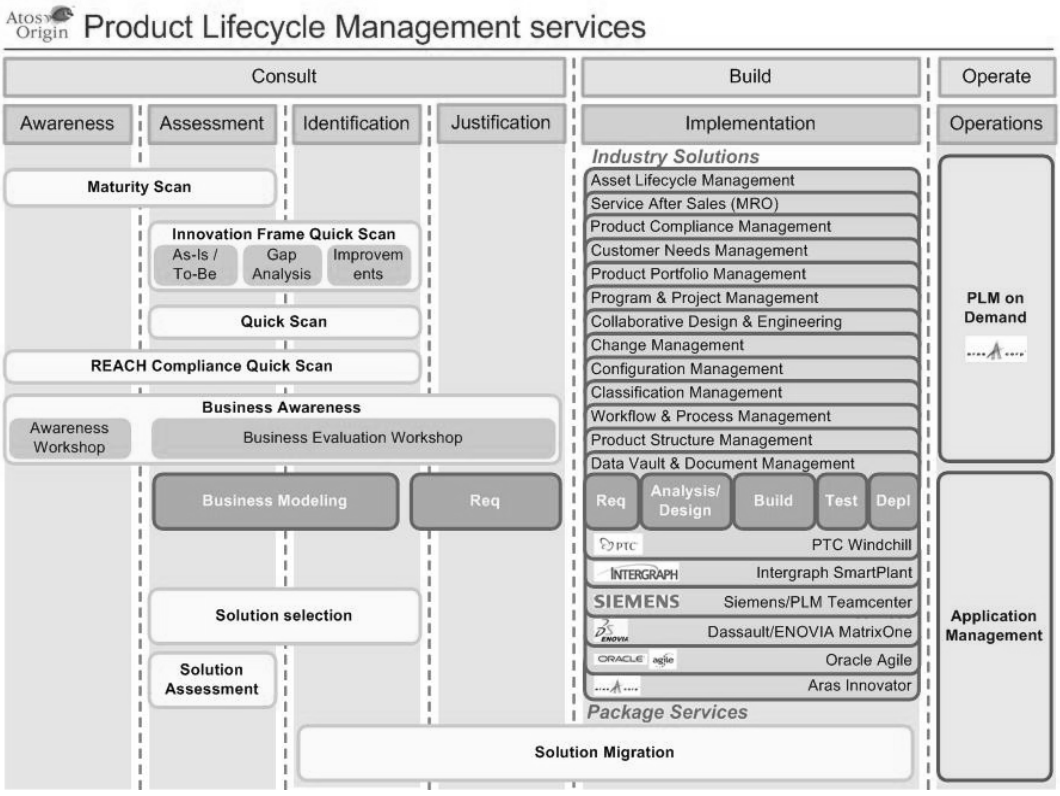


Figure 19: Atos Origin PLM Service Portfolio. Source: Atos Origin PLM

[15] Atos Origin PLM PLM-on-Demand White Paper. http://www.nl.atosorigin.com/NR/rdonlyres/027F782E-F69A-4D34-BD9B-49CA531C3AC3/0/PoDWhitePaper2010v04.pdf

9.2 Competences and problems: focused SWOT

Investigating the services offered by the organization provides limited insight into its actual capabilities. Limited because while the organization's service portfolio illustrates *what* the organization can deliver, it gives no mention of *how* these are delivered. Uncovering organizational successes and failures provide perspective on its strengths and weaknesses, which are discussed in light of the social computing developments of PLM.

Organizational competences determine the quality of customer services delivered. The article of Prahalad & Hamel (1990) define (core) competence as "The collective learning in the organisation, … harmonising streams of technology, … the organisation of work and the delivery of value".

The "focused SWOT" methodology (Coman & Ronen, 2009) (see Appendix C) was employed to uncover the organizational capabilities and –problems (i.e. weaknesses).

Senior PLM engineers, responsible for attracting new customers and projects at Atos Origin PLM, help to present a handful of successful and failed business events occurring in the recent 2-3 years, on which the established core competences and problems are based (see overview in figure 22). These events were discussed during a so-called Event Factor Review session.

9.2.1 Event Factor Review *

In total seven distinct business events were presented. One mentioned "failed" business event was omitted since it did not meet the inclusion criteria mentioned (Actionable) in Appendix C, which was the turbulent financial climate of the year 2008-2009.

Below follows a brief description on the successful and failed business events that were noted as having added to or subtracted from the organizational value, respectively.

Note: successful business events do not necessarily only display organizational strengths, but perhaps also organizational weaknesses, and vice versa.

*9.2.1.1 Successful business events **

Four *successful* value-adding business events are discussed, from which strengths and weaknesses can be derived.

*9.2.1.2 Failed events **

Three recent business events are discussed that have failed for some reason or another; these provide basis for deducing some organizational weaknesses.

*9.2.1.3 Further observation **

Topics not directly related to a specific business event, are mentioned.

9.2.2 Core competences and core problems *

The strengths and weaknesses from a business event (successful or failed) can often be explained by other strengths or weaknesses. Hierarchically arranging these items helps uncover the organizational competences and problems.

Figures 20 and 21 present the *Core Competence Tree* (CCT) and the *focused Current Reality Tree* (fCRT), respectively. Items (strength or weakness) are connected to one another by means of arrows. Arrows indicate a cause-and-effect relationship of the items. Items with no prior strength (weakness) to explain them are considered as the core competence (problem) of the organization. The construction of

both the CCT and fCRT starts with choosing a general item, and determining which underlying item can provide explanation for its occurrence.

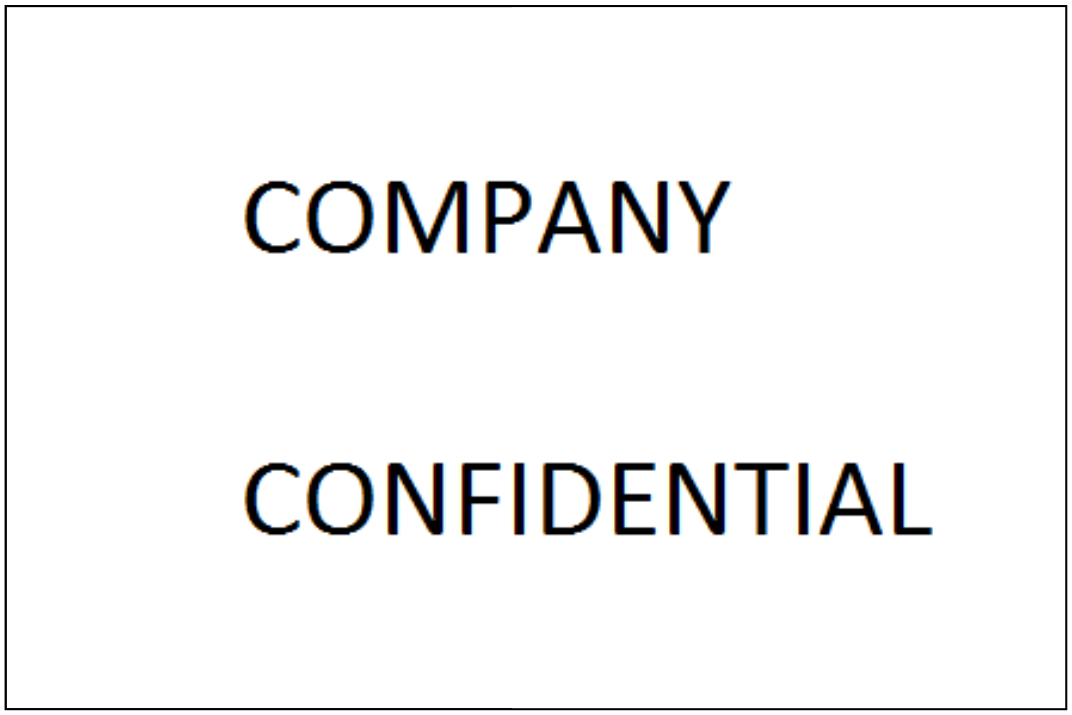


Figure 20: Core Competence Tree (CCT)

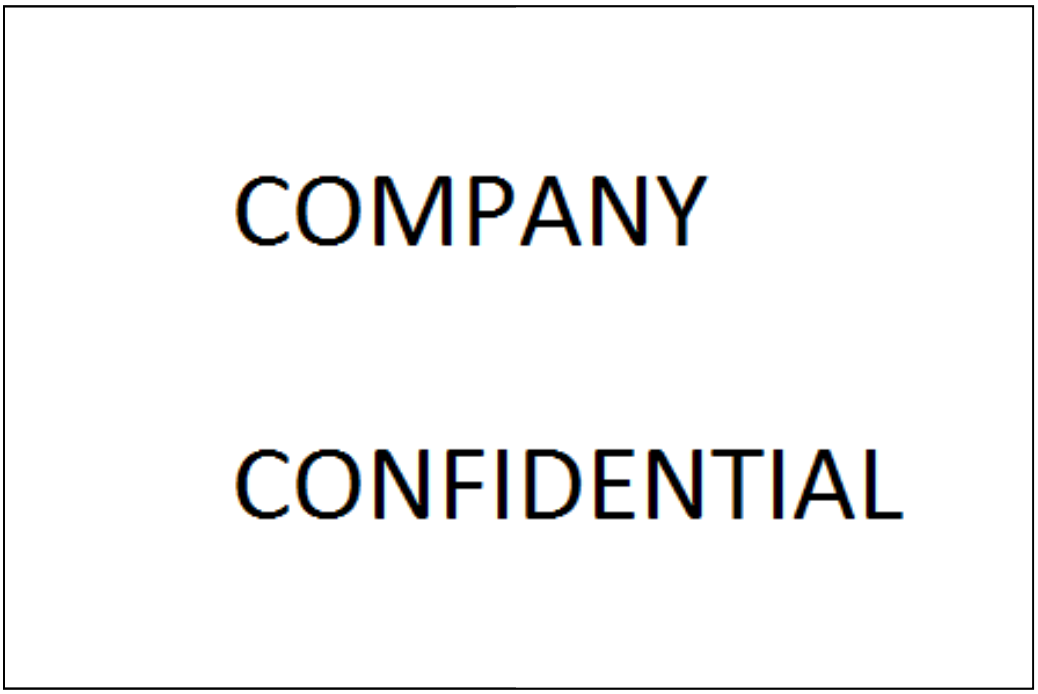


Figure 21: focused Current Reality Tree (fCRT)

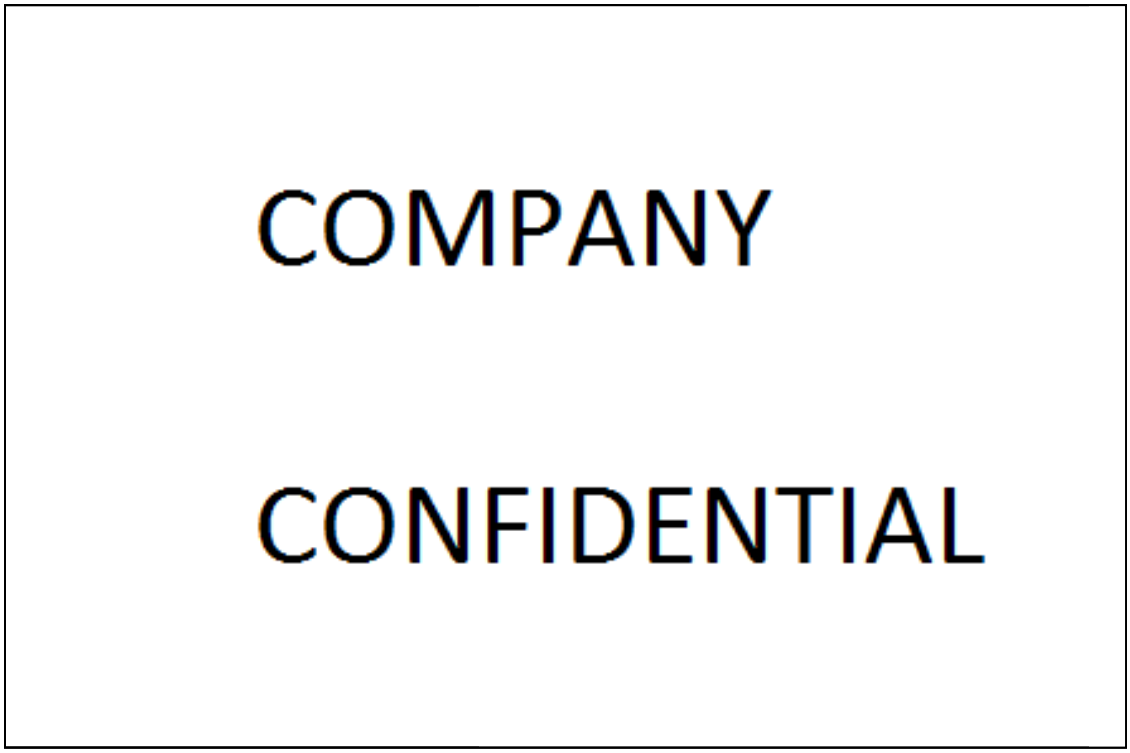


Figure 22: Event Factor Review

9.2.3 Atos Origin PLM Organization Conclusion *

Review of the Atos Origin PLM's service portfolio and important business events, result in several noteworthy findings.

10. Internal development of Social PLM at Atos Origin PLM

This section elaborates on the business implications of social PLM for the PLM service provider Atos Origin PLM (PRQ.5). Insights from the supply side of the PLM market and the Atos Origin PLM organization are used as basis of these findings (see figure 2).

10.1 Business opportunities *

10.1.1 CNM *

Arguments are presented on how social PLM relates to Customer Needs Management, and what actions Atos Origin PLM can undertake in this area.

10.1.2 PLM vendor partnership *

The existing PLM partnerships Atos Origin PLM has can be leveraged to follow the development of social PLM.

10.1.3 Synergy *

Social PLM presents an opportunity for Atos Origin PLM to create cooperative relationships with other internal units. Social PLM has the potential to benefit all of these units, thus representing potential organizational synergies.

10.2 Business threat *

10.2.1 Underdeveloped social PLM market

The nascent character of the social PLM market is discussed and its implications for a current potential social PLM business.

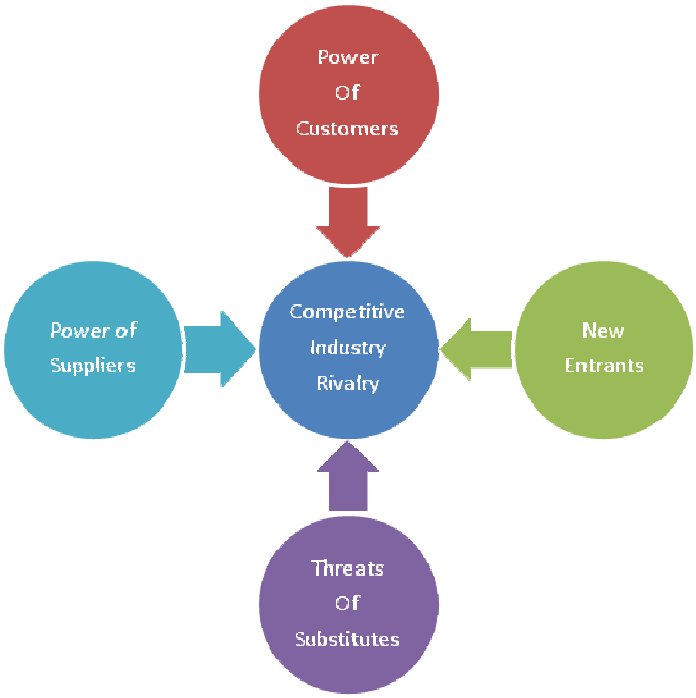


Figure 23: Porter's Five Forces

10.2.2 Legacy systems *

The subject of legacy systems and social PLM is discussed.

10.2.3 Small, medium enterprises (SME's) *

Atos Origin PLM's current business approach toward SME's is mentioned, and its implications for a social PLM business.

10.3 Conclusion Internal development *

This research reaches a statement on what actions Atos Origin PLM should take towards social PLM.

11. Implications, further research and conclusion

11.1 Implications for PLM science

This research set out to study the emergence of a new concept to support product development processes, called Social Product Development. Throughout the research, it became obvious that this concept threads through relatively uncharted waters, from both academic and empirical perspectives. Thus greater understanding of the social PLM concept was obtained by deconstructing it into researchable elements, covered by partial research questions that looked into a specific aspect.

Social PLM emerged from the findings, as an information technology solution geared towards enhancing the collaboration in the new product development process, by offering social computing technologies. Social PLM and PLM have some common objectives; shortening the new product development cycle to achieve faster times to market. Also, both social PLM and PLM emphasize the need for collaboration, but differ in their nuances. PLM mentions collaboration as one of its central themes; PLM consists of three themes: collaborative creation, management and dissemination of product engineering data (CIMdata, 2009). Collaboration in the *collaborative creation* PLM theme implies the timely dissemination of valid, structured product data as part of managed project workflow. Social PLM conceptualizes collaboration differently; social interactions amongst product development engineers enable the information-processing process of new discovered knowledge. The nuances differ, since the latter cannot be managed. Extrapolating this new collaboration nuance social PLM brings, it can be argued that social PLM adds a *fourth theme* to PLM: social collaboration.

Social PLM noticeably omits the mention of PLM's core strength; the creation, management and use of product-engineering data related to a product throughout its lifecycle. The concept of social PLM is focused on the enabling and capture of knowledge created in social interactions amongst product development engineers. Where the interactions amongst engineers are related to the development of a specific product, the knowledge accumulated and retained by the social PLM solution may not; knowledge generated in these interactions may relate to possible solutions and perspectives of a product, which are perhaps abandoned later. Whether or not generated knowledge is applied to a product, social PLM enables a method to retain this for a future possible application. Wikis and blogs are such examples. The implication of social PLM development, signals a new direction and attention in developing dynamic databases of product-related knowledge. Product engineers are the embodiment of a community, and are responsible for creating knowledge databases (wikis, blog, tags, and links).
Based on research findings of social PLM, it is shown that social computing technologies and the existing PLM solutions have their respective strengths, and can co-exist together in the product development process; thus answering the question: "*will it blend?", yes it does!* (see section 1.4).

The integration of social computing in PLM presents the interesting observation where the complete functioning of this product development solution, is dependent on the implementation and use of a separate, non-product related platform. This observation is not common for PLM, although PLM does interface with other enterprise systems (e.g. ERP, MES), it does not require their presence its standalone operation. Social PLM may imply the emergence of hybrid-PLM solutions.

11.2 Recommendations for further research

This research faces some substantial shortcomings. Apart from investigating a new concept in the academic realm of PLM, empirical evidence is also limited in quantity and depth.

The business values of social computing and social PLM, such as collaboration, sharing, knowledge discovery, etc., are inherently difficult concepts to quantitatively measure. Regardless, best practices of the use of social PLM can increase the appeal of these technologies. This research then proposes the execution of in-depth case-studies at a number of companies to establish social PLM best practices.

Also, this research focused solely on the potential significance of social PLM on the discrete manufacturing industries. It may be possible that other types of industries, that also employ PLM solutions, exhibit and demand more social interactions. Other types of industries are for example, process industries (food and beverage), clothing industries, etc. Research into the applicability of social PLM in these industries may produce interesting insights.

A final recommendation for further research relates to the nascent character of the social PLM software market. At the time of this research, a number of market elements were still not present (e.g. suppliers, customers, competitors), thus making it not possible to establish the attractiveness of the social PLM (see figure 23). Further research to establish a complete overview of the social PLM software market is recommended, once it has been able to develop further.

11.3 Conclusion

Having extensively explored the subject of social PLM, this section will provide answer to the Main Research Question (MRQ):

What is the impact of the integration of social computing in PLM for the product development process, PLM systems, PLM users and PLM suppliers?

PLM embodies an organizational strategy that handles the lifecycle of product engineering data, from creation, management, dissemination and its use through the application of information technology solutions. The broad concept of PLM envelops various perspectives:

- The perspective of the engineering and manufacturing industries adopting the product development solutions,
- The actual solutions developed to aid these manufacturing industries,
- And the software vendors developing these product development solutions.

Given these different perspectives, social PLM has a different impact contingent on the specific perspective. The impact of social PLM on each perspective is made obvious by employing the CIMO-logic (context, intervention, mechanism and outcome):

Engineering and manufacturing industry perspective

Research has shown that implementing the intervention of social PLM, in the context of increasing pressures from customers and competitors, with shortening times to market and emphasis on cost reduction, will help these industries to develop product innovations, by enhancing the ability of product development engineers to create social network ties, discover non-redundant knowledge, solve problems, disseminate knowledge, create mutual understanding and engage in sense making.

PLM systems

The findings present a context in which there is a described need for an information system able to capture the informal interactions among product development engineers, and organizations, during a product development, and connect these interactions for use in other product development systems downstream, such as PLM.

The intervention is social computing offered by PLM vendors, which in this context produces the outcome of organizational knowledge management and knowledge retention, collaboration and sharing of product-related and project-related content, through the mechanism of interfacing PLM solutions with business-collaboration platforms that feature social computing capabilities.

PLM suppliers

The concept of social PLM has shown an interesting development on the side of the PLM vendors. In light of the research findings, it is argued that social PLM is the further development of CNM solutions by the PLM vendors. In this context, the emergence of Web 2.0 and Enterprise 2.0 technologies and adoption triggers its implementation in PLM solutions. An interesting observed intervention, are the partnerships PLM vendors have formed, to produce the socially-apt PLM solutions. The outcomes of social PLM solutions are generated by the mechanism of the functionally integrating business-collaboration platforms.

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Appendixes

Appendix A: Atos Origin and PTC partnership press release

ATOS ORIGIN »

Atos Origin and PTC Partner to Deliver World-Class Product Lifecycle Management Solutions

Contact
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You are here: Newsroom > Press Releases > Atos Origin and PTC Partner to Deliver World-Class Product Lifecycle Management Solutions

Paris, Needham USA, 17 June 2009 -Atos Origin, an international IT services company, and PTC® (Nasdaq: PMTC), The Product Development Company®, today announced they will partner to provide best-in-class Product Lifecycle Management (PLM) solutions for discrete manufacturing companies in the Aerospace & Defense, Industrial, Electronics & High Tech, Automotive, Medical and Consumer industries in Europe.

The partners will focus on a consulting-led approach and exploit in-depth market knowledge to offer customers innovative, sustainable and results-oriented solutions that will reduce time to market considerably.

"We have been implementing best-in-class PLM solutions based on PTC's technologies for over 10 years for a range of international customers including Ballast Nedam, Hansen Transmissions International, Hiab, John Zink, National Oilwell Varco, Thales Nederland BV, Verreries du Courval," said Thierry Breton, Chief Executive Officer of Atos Origin.

"We are very impressed with PTC's technology and believe it to be the premier PLM platform due to its IT architecture and scalability, as well as flexibility in managing heterogeneous data," Thierry Breton continued. "Working together, Atos Origin and PTC will offer customers innovative, sustainable and results-oriented solutions with a reduced time to market. This strategic agreement will position us as a leader in the Product Lifecycle Management market which shows considerable growth over the next few years".

Atos Origin will deliver 'design-build-run' solutions based on integrating PTC solutions to its clients. The scope of activities includes product lifecycle management, product design, and technical documentation management. By the end of this year, Atos Origin plans to have a consistent critical mass of certified consultants on PTC technologies to start serving existing and new clients throughout Europe.

"We are delighted to expand and formalize our relationship with Atos Origin," said Marc Diouane, Vice President Europe at PTC. "This alliance brings together the deep vertical expertise of Atos Origin in managing global IT projects with PTC's superior Windchill technology. The winning combination of Atos Origin and PTC promises to help customers implement and realize the full value of a Product LifeCycle Management solution."

Both parties are present at the Paris Air Show that takes place in Le Bourget from 15 to 19 June 2009 where they host daily dedicated seminars on PTC in Chalet A310. Themes like *PLM, Sustainability & Environmental Compliance* will be discussed in-depth, PTC and Atos Origin will co-present a seminar on 19 June titled "Optimize Change Management through Business Intelligence".

About Atos Origin
Atos Origin is an international information technology services company. Its business is turning client vision into results through the application of Consulting, Systems Integration and Managed Operations. The Company's annual revenue is EUR 5.5 billion and it employs 50,000 professionals in 40 countries. Atos Origin is the Worldwide Information Technology Partner for the Olympic Games and has a client base of international blue-chip companies across all sectors. Atos Origin is quoted on the Paris Eurolist Market and trades as Atos Origin, Atos Worldline and Atos Consulting.

About PTC
PTC (Nasdaq: PMTC) provides discrete manufacturers with software and services to meet the globalization, time-to-market and operational efficiency objectives of product development. Using the company's CAD, and content and process management solutions, organizations in the industrial, High-Tech, Aerospace and

Appendix B: Social Product Development press release

PTC®

Press Releases

Social Computing Meets Product Development

Microsoft and PTC collaborate to develop a Social Product Development Platform that Fuels Communication, Collaboration and Innovation in a Web 2.0 Environment

NEEDHAM, MA. - June 8, 2009 - With the widespread adoption of Web 2.0 technologies and the evolution and acceleration of global product development initiatives, PTC (Nasdaq: PMTC), the Product Development Company®, believes the market is ready for a measurable shift in the way products will be developed. The cornerstone of this shift is the marriage of social computing to product development, or what PTC is calling social product development. Robin Saitz, SVP, Solutions Marketing & Communications, discusses the thinking behind Social Product Development.

"Collaboration has long been a critical component of product development, and today's operating conditions are shining a spotlight on the ability of companies to share information and knowledge with team members in a secure, IT-friendly environment," said Rob Gremley, executive vice president of PTC.

Joe Barkai, practice director for Product Lifecycle Strategies at Manufacturing Insights, an IDC company, notes "product companies will look to increase the adoption of Web 2.0 tools to capture and reuse organizational knowledge, and, when appropriate, to go outside the traditional boundaries of the enterprise to seek advice and other collaborative opportunities. As organizations continue to embrace social networks, they realize these are not merely collaboration platforms for open conversations and exchange of information, but strategically important to an organization's ability to use social computing technologies for product development."

A recent commissioned study conducted by Forrester Consulting on behalf of PTC surveyed more than 7,000 users of PTC and other products used for product development. Among respondents to this study, 89% use some form of social technologies at least once per month and 70% use these technologies for work purposes, suggesting that this population is well positioned to adopt social product development practices.

"With Microsoft® Office SharePoint® Server 2007, Microsoft connects Web 2.0 and social networking technologies to address collaboration in a business environment," said Kathleen Winder, director of SharePoint Collaboration Partnerships, SharePoint Server Group, Microsoft. "PTC is bringing additional value to product development through its Windchill ProductPoint solution by extending the Microsoft Office SharePoint Server platform to work with complex CAD and structured product data. PTC has combined the business logic layer of Windchill ProductPoint with the social computing capabilities of the SharePoint application framework, to introduce the benefits of social computing in social product development."

The PTC® technology stack used to support social product development consists of three technology layers as part of one, seamless, secure and easy-to-use platform.

- Microsoft Office SharePoint Server 2007 (SharePoint) for document collaboration, and social computing.
- PTC Windchill® ProductPoint® for sharing, and reusing structured content such as CAD models.
- A layer of authoring applications that can include PTC Pro/ENGINEER® for creating digital product

Appendix C: Focused SWOT-methodology

Source: Coman, A & Ronen, B. (2009) 'Focused SWOT: diagnosing critical strengths and weaknesses'. International Journal of Production Research, 47: 20, 5677-5689.

Criteria for evaluating strength and weakness lists.	Concise: Four or five items per list.
	Actionable: Items should call for actions. They should easily allow for the crisp definition of action goals provided to executives charged with remedying the problems.
	Significant: The items in the lists substantially impact the company's value. Actionable weaknesses that have a negligible effect on the company's value should be eliminated from the analysis.
	Authentic: The lists should obviously be authentic rather than wishful thinking.
Core Competence Tree (CCT) technique to discover the company's core competences.	Pruning the strengths list to eliminate redundancy, vagueness, and irrelevant symptoms.
	Linking the strengths using cause-effect logic.
	Discovering 2–3 core competences.
Focused Current Reality Tree (fCRT) technique to discover the company's core problems.	Pruning the weaknesses lists to eliminate redundancy, vagueness, and irrelevant symptoms.
	Linking the weaknesses using cause-effect logic.
	Discovering 2–3 core-problems.
Weakness elimination criteria.	The weakness must exist over a period of time (and not be a one-time phenomenon).
	The weakness must be expressed in undesirable terms.
	The weakness must be under our control or influence.

Appendix D: CIMO-logic – the components of Design Propositions

Component	Explanation
Context (C)	The surrounding (external and internal environment) factors and the nature of the human actors that influence behavioural change. They include features such as age, experience, competency, organizational politics and power, the nature of the technical system, organizational stability, uncertainty and system interdependencies. Interventions are always embedded in a social system and, as noted by Pawson and Tilley (1997), will be affected by at least four contextual layers: the individual, the interpersonal relationships, institutional setting and the wider infrastructural system.
Interventions (I)	The interventions managers have at their disposal to influence behaviour. For example, leadership style, planning and control systems, training, performance management. It is important to note that it is necessary to examine not just the nature of the intervention but also how it is implemented. Furthermore, interventions carry with them hypotheses, which may or may not be shared. For example, 'financial incentives will lead to higher worker motivation'.
Mechanisms (M)	The mechanism that in a certain context is triggered by the intervention. For instance, empowerment offers employees the means to contribute to some activity beyond their normal tasks or outside their normal sphere of interest, which then prompts participation and responsibility, offering the potential of long-term benefits to them and/or to their organization.
Outcome (O)	The outcome of the intervention in its various aspects, such as performance improvement, cost reduction or low error rates.

Appendix E: Overview of the social software market

Vendor	Product	Main social computing ability
blueKiwi Software	-	Social networking, microblogging, community management.
CubeTree	-	Activity sharing
Drupal	-	Building communities with support for social interaction.
Google	Docs, Wave	Document sharing and collaborative authoring. Merging of email, online chat, social networking and wiki-style group access to Web pages or documents
IBM Lotus	Connections	Full featured collaboration platform with comprehensive social computing suite (user profiles, activity sharing, blogs & wiki).
Jive Software	Social Business Software	Platform for structured collaboration, with social interaction support (user profiles, blog, wiki and tagging).
Leverage Software	-	Social network building software.
Microsoft	Microsoft SharePoint Server (MOSS) 2007	Full featured collaboration platform with comprehensive social computing abilities; wiki & blog, podcasting and people search.
Novell	Teaming	Building of communities and social interaction support.
SocialText	-	Enterprise Microblogging
Telligent	Communities, Enterprise	Ability to create external (customer) and internal (employee) facing communities. With features such forums, blogs, activity feeds and tagging.

Appedix F: Description of Web 2.0 technologies

Wikis -- Wikis are simple websites on a specific topic. Visitors to the website can register as authorized administrators. As administrator, knowledgeable user on the topic can add their own content, while editing content added by others.
As administrator, users can share and collaborate to refine the accuracy and relevancy of the topic. Further, administrators can augment their knowledge contribution by embedding active-links (e.g. URL's to other wikis) and other forms of multi-media.

Blogs -- Blogs (abbreviation for web logs) enable individuals to write and share opinions, perspectives or any kind of information relevant to the author. Main objective of a blog is to share an author's personal insight with a community and elicit commentary from the visitors.
Wikis and blogs both share the similar objective of sharing written information, but the formats differ substantially. Where wikis allow a community of visitors to collaborate on the content of the information and knowledge accumulates iteratively, the content of a blog is not open for modifications by others. Rather, the personal content in a blog forms a starting point for a discussion carried out with blog visitors, thus allowing knowledge to accumulate cumulatively. These visitors can voice their opinion on the related content.

Chat messaging & presence-detection -- The advent of chat messaging technology brought with it another technology, presence-detection. The combination of these technologies, allow users of a certain chat messaging application to add other users to a list. Once added to a list, users see the availability to communicate with others through presence detection, a notification system indicating the availability status of users.
If presence-detection signals the availability of a user, conversations can be invoked by transmitting written messages in real-time between users. However, reciprocation between users does not have to occur in real-time, since sent messages are stored and can be replied to at any future moment, given that the users involved are available.
Advancements in Internet technology, has allowed presence detection to be applied to other Internet-based communication

RSS-feeds -- *Really Simple Syndication* (or RSS) feeds are publication notification mechanisms for information that is frequently updated. One can encounter RSS-feeds in blogs, wikis and podcasts. The objective of RSS-feeds is simply to notify individuals that changes have been made (e.g. new content) to a specific wiki, blog or podcast. Individuals that wish to follow changes made to wikis and blogs can subscribe to the RSS-feed of these, from within the Internet browser.

Tags -- Wikis and blogs are examples of unstructured data that can be written by any Web-user. Publishing this unstructured data (on a website), without the allocation of keywords to indentify or categorize it, will make an easy retrieval of this information challenging, as the number of wikis and blogs accumulate over time. Tags is the term used to describe (one or more) keyword(s) that are assigned to a particular blog or wiki. Tags most likely reflect the content or topic of the published information, which can be utilized by visitors to retrieve information on that content or topic. Using tags to search for information assigned to multiple wikis or blogs gives the visitor a chronological overview of the information.
Assigning keywords to identify and categorize information for later retrieval is not new. Every database management system (DBMS) possesses over such functionality. Such systems make use of system-specified keywords, in a categorization process known as *taxonomy*. Such system-specified keywords may not always correctly reflect the nature of the content of the wiki or blog. In contrast, tagging allows the author of the blog or wiki to define user-specified keywords for assignment. This process of assigning

user-specified keywords is known as *folksonomy*; a categorization system developed over time by folks (McAfee, 2006).

User-customizable profiles -- Users of online social networking platforms, identify themselves by means of a user-customizable profile. The concept of user profiles is self-explanatory: the publishing of user contact information and credentials, making one findable in a large network of individuals.
Social networking sites nowadays have extended on this basic concept. Through the user-profile, users can announce their activities, post blogs and share any kind of digital media with other users in the user-specific network. Thus, not only do user-profiles facilitate the search of members of a network, but it provides the user with a portal to share information with this network.

Ratings -- Web 2.0 platforms enable its visitors (members of a community) the ability to assign rating to a particular piece of data. User-generated information (i.e. blogs, videos etc.) can be rated on a variety of subjective criteria. The objective of ratings is to allow the community to decide upon the rank of the information.

Appendix H: Description of Enterprise 2.0, SLATES

- *Search*, in principle, not a form of social computing, but is an essential enabler for navigating the organizational information.
- Certain sources of organizational information are referred to more often than others. These referred sources, or *links*, accumulate over time. Over time, popular and most-used sources are ranked higher, improving their accessibility for the knowledge worker.
- *Authoring* refers to providing organizational knowledge workers to produce blogs and wikis.
- Categorization and searching for information by means of *folksonomical* keywords (*tags*), organizational (knowledge) workers can achieve accurate results. Further, the generation and utilization of folksonomical keywords has another benefit. Allowing the system to index the number of times users have searched a specific tag, a visual overview can be generated known as a *tag cloud*. Tag clouds are useful in providing the user keywords that have the most actuality within the organization (see example in figure 5).
- Ratings organizational users have given to the enterprise information is stored and processed by the Enterprise 2.0 system. This rating information is used by the system to automatically generate recommendations to other information that might be relevant to a specific user. This automatic generation of recommendations is referred to as *extensions*, and is aimed at helping the knowledge worker to discover information that might have been overseen beforehand.
- Helping knowledge workers to stay on top latest changes and developments of information of interest, users make use of the so-called *signals*. Signals are the notification technologies in Enterprise 2.0 systems, and fulfill similar functions as RSS-feeds. The aim is to generate an overview of the latest changes that have taken place, with regard to information of interest the knowledge worker wishes to follow.