# Department of Education, Communication and Learning

# Online community for sharing knowledge

Development project in a consulting organization

**Author: Andrija Ilich**

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| Thesis: | 30 higher education credits |
| Program and/or course: | International Master's Programme in IT & Learning |
| Level: | Second Cycle |
| Semester/year: | Spring term 2016 |
| Supervisor: | Johan Lundin |
| Examiner: | Marisa Ponti |
| Report no: | VT16-2920-005-PDA699 |

# Abstract

Principles of communities of practice are being used to initiate exchange of knowledge among geographically distant employees of a consulting organization. The goal, under the knowledge management project within consulting organization, is to develop online environment for knowledge sharing purposes among experts within product lifecycle management.

# Foreword

This thesis is written as conclusion of the Master programme in Applied Information Technology with Specialization in Learning and Communication at the University of Gothenburg.

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# 1. Introduction

As part of a knowledge management project within a large consulting organization, this report addresses the challenges related to sharing of the knowledge among employees that have a common practice and an employer, but are engaged in different projects at various customers sites. It also shows how to transform this tacit knowledge into an explicit knowledge that is available to everyone in the organization by designing and using an online environment for knowledge sharing, as an online community of practice (CoP).

Large organizations have always searched for the best way to utilize the knowledge of their individual employees to the maximum extent. The main challenge related to this is to discover, capture and transfer this knowledge, as an intellectual resource, in order for it to become a collective knowledge, and thereby increase the competitiveness of the entire organization. By managing knowledge sharing, organizations could advance in the areas of innovation, capacity for adaptation and response to competition [1].

Knowledge sharing among employees is especially difficult for consulting businesses, as relatively new forms of organizations, because their consultants are usually located at different customer sites. Due to this scattered placement of the employees, consulting businesses require bridging of the social as well as geographic boundaries among the consultants (referred to as peers in their groups of similar expertize). In order to establish this bridge, they have to rely on the use of information and communication technologies (ICT) for collaboration and knowledge sharing.

ICT supports the organizations to develop by learning, which also affects innovation and individual development. To fully utilize ICT for knowledge sharing, peers are usually encouraged by the consulting firms to document practices and share them with others in their group of expertize. This is usually done with a help of online knowledge management systems using various tools they provide, e.g., emails, repositories, intranets, communities of practice, etc. [2].

The project we analyzed focuses on the personal and context-specific knowledge of the embodied routines, actions and procedures in the everyday work of the Product Lifecycle Management (PLM) practice. In order to address this management need, new solutions need to provide an appropriate environment for exchange of tacit knowledge and its conversion into the explicit form. This is achieved by designing an online environment, based on the company's intranet system, that supports exchange of the knowledge in real world social interaction among the peers of different PLM groups, as our intended audience. The environment enables transfer of individual knowledge into collective knowledge and facilitates its exchangeability as well as understandability. It also provides possibilities to more easily find information required by different peers that is constantly available to be actively re-used.

The evaluation of the proposed online environment for knowledge sharing is done by assessing its usefulness and ease of use. Results of the evaluation show which segments of the system should be improved in the future. We also recommend

what steps could be done in the further development of the system in order to derive the best benefit for stakeholders.

# 2. Project Background

A consulting organization placed in Gothenburg, Västra Götalands region in Sweden is conducting a knowledge management project. This company, named "Gothen Consulting" for the purpose of this report, provides consulting services to incumbent industrial firms in this region.

The goal of the project is to design an online environment for sharing knowledge among consultants within the same group of expertize, such as PLM, in order to initiate asynchronous communication among members. Direct contacts between different peers in the organization can lead to face-to-face meetings and can, through social interaction, provide opportunities for exchange of the knowledge, in terms of routines and actions gained through working experience. Moreover, this approach can provide less formal way of knowledge sharing and could also avoid possible issues related to braking of the customer's intellectual property rights.

The project is being conducted by the automotive department for one of its PLM groups where its managers have the need for an online environment which can be used by the industrial designers and other PLM experts for sharing work experiences and knowledge. The PLM group has around 30 consultants which includes industrial designers, mechanical, system and IT engineers, business consultants, project managers, etc. Tools which are commonly used in this area are Teamcenter[1], CATIA, SolidWorks, CREO[2] and PDMLINK[3].

In industry, PLM is a strategic business approach of managing the lifecycle of a product-related design, production, and maintenance information, as well as disposal of manufactured products. This approach emerged from CAM (Computer-aided Manufacturing), PDM (Product Data Management) and CAD (Computer-aided Design) tools. Its systems integrate data, people, business systems and processes in order to provide backbone for companies [3].

Organized exchange of knowledge and work experience among the consultants has never been done before in the analyzed department of the Gothen Consulting company. Due to the fact that the consultants are scattered among different physical places (i.e., on customer sites), the requirement for a design of a common knowledge sharing place, as an online CoP, is to be part of the company's intranet system.

Besides following principles of CoP learning theory and looking into research field of knowledge management, development of the project shall also look into the research field of computer supported collaborative learning at work (CSCL at Work) in order to adapt the online environment to problem solving activities. Furthermore, the

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[1] Teamcenter is an advanced PLM software that facilitates management of BOM's (Bill of Materials), management of requirements, manufacturing data, service lifecycle management, management of suppliers etc. (http://www.majentaplm.com/teamcenter/teamcenter-overview/);

[2] CATIA, SolidWorks and CREO are 3D computer-aided design (CAD) software tools;

[3] PDMLink is web-based product data management (PDM) system that manages content, change and configuration management (http://www.ptc.com/product-lifecycle-management/windchill/pdmlink).

online environment shall provide conditions for continuum of the knowledge conversion from tacit form into explicit form and back into tacit form by following literature regarding the knowledge management systems.

# 3. Literature review

Most organizations today support learning and knowledge sharing between their employees in a hope that it will lead to the faster organizational development. This is especially the case with the rapid development of information technologies that facilitates active engagement of employees in spreading their knowledge within the their organization.

While many researchers focus on using information technology in knowledge management [4] and collaborative learning in organizations [5];[6], the main goal of their studies is to facilitate the distribution of knowledge among peers who share the same workspace and/or field of work, i.e., regardless if their workspace is physical or virtual (scattered over multiple physical sites). Moreover, there is a long tradition of research concerning knowledge sharing in distributed teams, however it is in most cases not focused on workers who share practice but have quite different tasks.

Finally, not many studies focus on the employees who are consultants that share the same practice but not the assignments, working environment, projects and workspace even though it is quite challenging to capture, save and share knowledge among employees who are engaged in different companies and the only two things they have in common are their source company and field of work. This is even harder if the knowledge that needs to be shared is tacit.

In this project, we focus on the analysis of organizational learning and knowledge management in large consulting organizations, or similar environments, where peers are geographically distant, although they use same virtual space for learning. Nevertheless, our study is closely related to the following general research areas: (i) knowledge management and organizational learning, (ii) competence management, (iii) formal and informal communities of practice and (iv) computer supported collaborative learning at workplace. In the rest of this section, we provide a brief description about the current state-of-the-art in these areas.

**(i) Knowledge management and organizational learning:** According to I. Becerra-Fernandez & D. Leidner (2008), knowledge management is defined as "organizational policy and set of practices aimed at recognizing, creating, categorizing, maintaining, sharing, and applying the collective knowledge of people assisted by IT". This scientific area is pretty wide, and in this project we stress the section of knowledge management systems and IT-support for organizational learning at various levels such as individual, group and organizational levels.

Knowledge management systems (KMS) have been adopted by consulting firms in order to provide opportunities for learning and exposure to knowledge. As volume of information that comprises the knowledge in organizations rises, KMS provides structured support to capturing, sharing and applying this knowledge based

on the available information. Depending on the praxis, that knowledge can be explicit, tacit or both explicit and tacit.

According to Becerra - Fernandez and Sabherwal (2014), consultants can document acquired tacit knowledge gained in projects and then share that knowledge via lessons learned reports with others. Consultants that read these reports could reexperience previous projects thus gaining new tacit knowledge. One might say that this way of sharing knowledge can be pretty useful learning tool if these reports are posted as intranet documents, available to employees all time, and read and understood. Even though online ICT tools can support lessons learned knowledge sharing, readers reexperience is questionable if a document is written poorly or if report ends somewhere under the pile of new documents. Challenge is to keep these reports easy to write and easy to read. If these challenges gets overcomed KMS can be used as a powerful tool for organizational learning.

In their study, Nonaka & Takeuchi (1995) agree that re-experiencing through reading documentation can facilitate learning, hence refining tacit knowledge of the reader. Furthermore, they claim that "writing is an act of converting tacit knowledge into articulable knowledge". Thus, the actual writing is an important part of learning in organizations. Besides claims that tacit knowledge can be converted through writing and social activities, they shows four steps of knowledge conversion through epistemological dimension and how redundancy in social interaction among tacit and explicit knowledge results in expansion and creation of new human knowledge.

One might conclude that these two dimensions are not completely separated but rather complementary and that knowledge exchange should be done through interaction between tacit and explicit knowledge. Thus, in one community that shares the same practice, users can reflect on their working experiences through writing and transferring that knowledge into explicit form. KMS can provide support for capturing and keeping this explicit form available for other users, thus creating a collective knowledge. Novice users can then find, read and re-experience, hence learn about the problems their senior peers encountered and apply this knowledge in their own working environments.

However, Nonaka & Takeuchi (1995) also claim that tacit knowledge can be converted through socialization and that the key of acquiring it is experience. Davenport & Prusak (1998) also show how socialization at water tank in IBM office has a positive impact on the tacit knowledge exchange. It might be questionable if knowledge conversion would be as much effective without the dimensional interaction. In terms of consulting remote working environment, this means that besides intranet's support for learning documentation, there should also be a support for social learning activities within the main organization in order to create interaction between the tacit and the explicit knowledge.

**(ii) Competence management:** In addition to support of social activities and learning documentation, intranet systems can also provide opportunities for knowledge sharing among individuals according to their specific needs. Lindgren, Henfridsson and Schultze (2004) conducted an action research study about competence management systems (CMS) where they applied the principle of transparency. According to this principle, competence data of employees should be unrestricted, visible and accessible to everyone across organization, thus providing

opportunities for knowledge sharing by finding a key person within it. They propose the use of VIP Prototype for keeping tacit knowledge implicit in a form of profiles and provides community feature by finding users with common interests and competencies. However despite the fact that competence management systems provide opportunities for knowledge exchange through social interaction among the users, they are not able to capture and transfer the individual knowledge into the collective knowledge.

**(iii) Communities of practice:** Knowledge management literature as well as VIP solution shows that communities are suitable environments for knowledge sharing thus leading this review towards communities of practice [7];[8];[9].

CoPs are based on mutual exchange of experience and competence. Communities create opportunities for competence negotiation through experience. Therefore, they represent essential social units of learning. Elements such as events, leadership, connectivity, membership, projects and artifacts should be considered in design process [10]. According to Wenger (2000), "Communities of practice grow out of a convergent interplay of competence and experience that involves mutual engagement". However, M. Rohde & V. Wulf (2013) stress the difference between communities of practice and networks of practice (NoP), where in NoPs members do not work together and share the same practice. Networks of practice are only used for passing information between its members while communities of practice enable creation of new knowledge. In our project, PLM group has characteristics of both, where its members do not work together in a sense of daily basis although its community is intended for creation of new knowledge.

Furthermore, Wenger (1998) represents three modes of belonging in terms of forms of peer participation in CoP. One among them is engagement, where members engage with each other and shape the experience who they are, thus learning what can they work as community and how the world responds to their actions. Joint activities that represents engagement within a CoP are talking, helping each other with problems regarding practice, or doing things together in a form of joint events such as guest lectures, workshops, meetings and learning projects.

In terms of our project, these activities can build and sustain PLM group CoP and shape and improve the way its members work. This is especially the case when members are engaged within broader learning system such as industry, where each member from different working position can bring valuable knowledge into the community regarding his or her experience. Connectivity between the members can include brokering relationships between consultants that create opportunities for exchange of experience. Furthermore, community's online space can create opportunities for joint creation of mutual artifacts, thus supporting computer supported collaborative learning.

**(iv) Computer supported collaborative learning:** According to Andrea Kenle (2013) there are two types of computer supported collaborative learning (CSCL) at work. In the first one, an expert has a solution to a problem and shares it with learners or novices. In the second one, the answer to an unknown problem must be co-constructed in the organization. In our project, the analyzed PLM group has lots of senior members that are experienced in this practice. Therefore by practicing type

one of CSCL at work, they can provide support for novice engineers and transfer knowledge gained through experience.

In addition to this, the second type of CSCL at work can be practiced in this group if members encounter a new problem in PLM practice and discuss, criticize and argument about possible solutions. Furthermore, both types can be practices through online discussion and comment on posts or by referring to someone from the contact list, where novice can find an expert with specific knowledge. However, Sean, P. Goggins (2013) stress the difference between experts helping novice members and helping experts themselves to learn more, where the first case is defined as CSCL while the second case is defined as computer supported collaborative work (CSCW). In order to fulfill the needs for all of its group members, this project will support both learning activities as for novices and senior consultants.

Reviewing the literature leads to the framework of the development project. Analyzing both knowledge management systems and competence management literature help us develop CoP that supports knowledge sharing and computer supported collaborative learning at workplace.

# 4. Description of the project

In this section of the document, we first explain in more details the goals of the project (4.1). We then describe current design situation at the analyzed Gothen Consulting company (4.2). After that, we present a review of the company's intranet system that is used for creating an online environment for knowledge exchange (4.3). Then, we present the main problems that consultants from the PLM group encounter in their search activities (4.4). Finally, we present our design vision for the online environment and its main functions that should support the needs of the PLM consultants (4.5).

## 4.1 Goals of the project

As a consulting company, Gothen Consulting employs people from different areas and expertise to contribute to the PLM department. Typically, employees are placed at different customer sites and they do not know whether their colleagues from Gothen are placed within the same site or not. This is a clear design challenge and it stems from the fact that Gothen's competence management system, called *Career Portal*, contains only information about employees' competencies but not their location. Therefore, consultants from the PLM group do not have access to the information on where their colleagues are working.

Besides that, if Gothen employees encounter difficulties in solving assignment problems, they do not have support from other experts that come from Gothen and can only contact them at their working sites. However, sharing documents and information outside of the working group at the customer sites can brake intellectual property rights of the customers. On the other hand, even if an engineer would like to seek help from Gothen colleagues regarding ongoing problems without sharing sensitive details, there is no predefined practice of doing this actions. In order to

provide support to consultants, improve their position during engagements, as well as to improve their competencies and innovation dynamics, the goal of this project is to provide support for knowledge exchange among the consultants of the PLM group by designing and deploying an online CoP environment using the Gothen Consulting intranet system.

In collaboration with the PLM management team at Gothen Consulting, the following main requirements for the project have been defined:

- Consultants should have easy access to the basic information about their colleagues, e.g. name, place of work, type of assignment, experience and relevant knowledge about different software tools (e.g. CATIA).
- The project shall provide an online environment where engineers can support each others during assignments.
- The project shall provide an online environment that can support consultants learning and professional development within concept of PLM.
- PLM Knowledge Management online space need to be created within the company's intranet system. Thus all searching and posting activities as well as document database needs to be limited to this environment.

## 4.2. Design situation

This project is conducted for the group of PLM consultants from Gothenburg. The intranet system supports collaboration tools with closed communities that can enable knowledge sharing and collaborative learning activities. For this reason, it is technically feasible to develop the project using this system.

In order to enable face-to-face meetings, users need new tools to find a person with specific skills and experience. The already existing functions for finding contacts and discussion forum are insufficient, confusing or unknown to employees. Besides the fact that consultants agree that sharing of the knowledge can be beneficial for everyone, they do not find that Gothen's intranet system provides a good possibility for this.

Furthermore based on the interviews with six consultants from the group, we found that they usually use Gothen's system only for internal email and the report of the working hours, hence other parts of the system that can be used for knowledge sharing are unknown to them. On the other hand, the consultants use customer intranet systems in their daily work.

Organized exchange of knowledge does not exist in this group, thus tools of Gothen Consulting must be applied in order to create an online environment that will support these kind of activities.

## 4.3 Intranet review

Gothen intranet is SharePoint based system. SharePoint is web application platform in the Microsoft Office server suite [11]. It provides functions for intranet and other systems such as content and document management, cloud storage, enterprise social networking and so forth.

At the intranet home page there are two newsfeed sections, one for corporate and other one for department news. Middle of the home page is usually occupied with one or two picture links to currently biggest news for the company. That part get refreshed once in couple of weeks while corporate and department sections are refreshed on daily basis. Footer of the home page contains quick links to sections that are mostly used such as *Time Report, Webmail, Paychecks* and so forth.

There are seven main sections at the navigation bar on the left side and search tool on the right side.

1. *Personal Site* section leads to employees personal page which reminds to a social network profile. It contains couple of contact information and department page which shows employees place in the organization.
2. *How We Work* section is informational page which describes basics to new employees. It explains how things work with paychecks, time reports, career and such.
3. *What's up* section contains news pages, job opportunities, activities in the company, education list and so on.
4. *Tools* section offers links to cloud service, company email, documents, career portal, and administrative functions regarding loan and time report.
5. *Collaboration* section provides links to various collaboration tools such as forum, project and team rooms, and communities.
6. *About us* gives information about the company's history, policies, goals and strategy, vision and such.
7. *Search* section offers search tools within different parts of the system such as forum, documents, people as well as for search within the whole system.

All in all, Gothen intranet system is an informational platform. Search, collaboration and sharing functions are offered thus it is possible to use it in purposes for knowledge sharing and collaborative learning.

## 4.4 Problem with contacts

Intranet system offers two different types of contact lists, first one is Career portal and it usually contains individuals competence data, other one is Personal site where individuals profile reminds to a social network profile.

If, for example, a consultant would like to find another person that works with PDMLink there would be three ways to do it:

● by logging into the Career Portal (4.4.1);
● by using Search intranet tool (4.4.2);
● or by contacting the group manager (4.4.3).

Every approach has it's own advantages and disadvantages but each needs to be analyzed in order to find the best solution for consultants.

## 4.4.1 Career Portal search

    *Career Portal* is place where employees can register and fill out CV as well as write about their competencies and work experience. It is divided in sections about industry, competence, tools, certificates and user defined information. *Career Portal* has its own search engine and it is a very helpful tool when looking for the right person with certain skills and experience.

    However, this portal is not fully integrated part of the intranet system and requests separate login. This affects search results within the intranet system and do not provide results from *Career Portal*. Therefore, looking for someone's competencies becomes difficult and complicated, especially for users that are not familiar with the intranet system. It also takes several steps and clicks to get to the portal, hence ease of use is lacking in the case of consultants who do not have much experience with the intranet system.

    Furthermore, each user is supposed to fill its own *Career Profile* regarding its own competencies, tools and certificates, although only 17 out of 31 consultants from the group have done that, which leaves 14 profiles completely empty. Besides that, half of these 17 profiles are filled in a poorly and minimalistic manner, hence leaving not so much for those who seek for specific competencies. As shown in Screenshot 1., difference among filled and empty Career Portal profiles is substantial.



Screenshot 1. - Filled and empty *Career Portal* profiles;

    *Career Portal* is placed under *Tools* submenu of the Gothen Consulting intranet system and after clicking on it a user must act a separate login for it. *Search* option in *Career Portal* is placed among four main portal options, and then window, rich with information, opens up. Portal *search* tool is very detailed and offers various types of submenus and keywords, as well as instructions in order to make best search (Screenshot 2.).

    In order to get a clear picture about results that this function can provide, we conducted search of a person that is competent with product data management tool,

known as PDMLink. When this search action is performed, it showed that there is 56 people within whole Gothen organization that are competent with this tool. However, not all of them are members of the PLM group, and it is not feasible to narrow down results only to this group. Therefore, *Career Portal* can give solid results in searching key competencies but results of the specific search can be insufficient.



Screenshot 2. - *Career Portal Search* tool;

## 4.4.2 Using Search function - Personal Site

On the other hand, the *Personal Site* (Screenshot 3.) contains basic information about an employee as well as his or her position in the organization. However, this site is not intended for placing any information, such as competences or customer site, that might be important for PLM consultants.

*Personal Site* is divided into three sections: *Newsfeed, Content* and *Profile*. *Newsfeed* updates about anniversaries, new colleagues on the level of the corporation,

upcoming birthdays, posts, taggs, colleagues statuses and so forth. *Content* shows documents and blog posts that are shared with others and it is part of the *Profile*. Other information shown on the Profile are about the place within the organization, memberships, overview and list of colleagues which consists of people from several departments all placed in one unordered list.
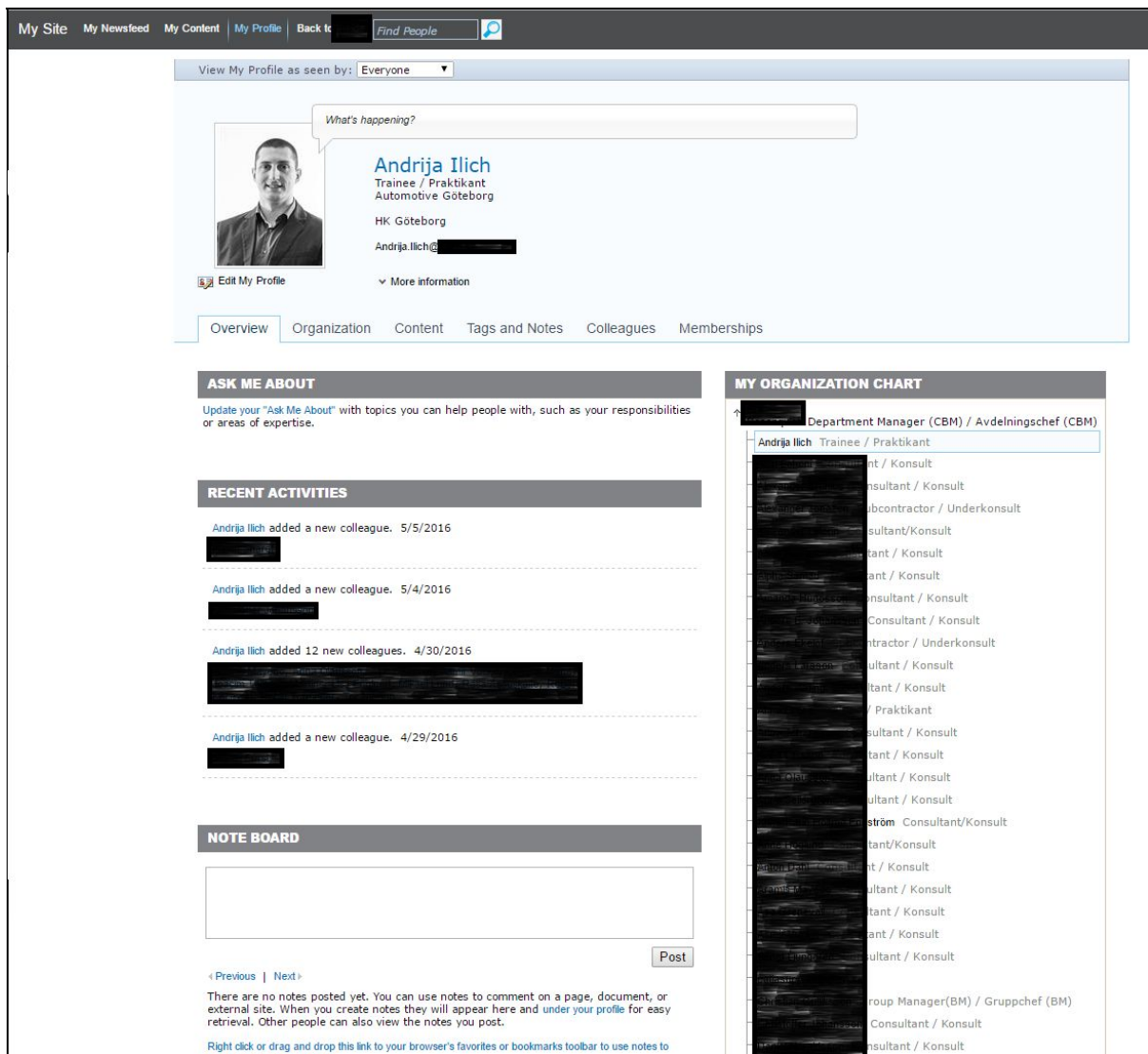


Screenshot 3. - *Personal Site* profile;

Finding something about current place of work and position in the organization is impossible on *Personal Site* unless the user have put these in the "Ask me about" section of the *Profile*. First step in finding other users is to open *Search* function and then choose *People* option in order to narrow search results only to persons as shown in Screenshots 4 & 5. In order to get clear picture about results that this function provides, we conducted the same search action with PDMLink keyword, as we did with *Career Portal.*
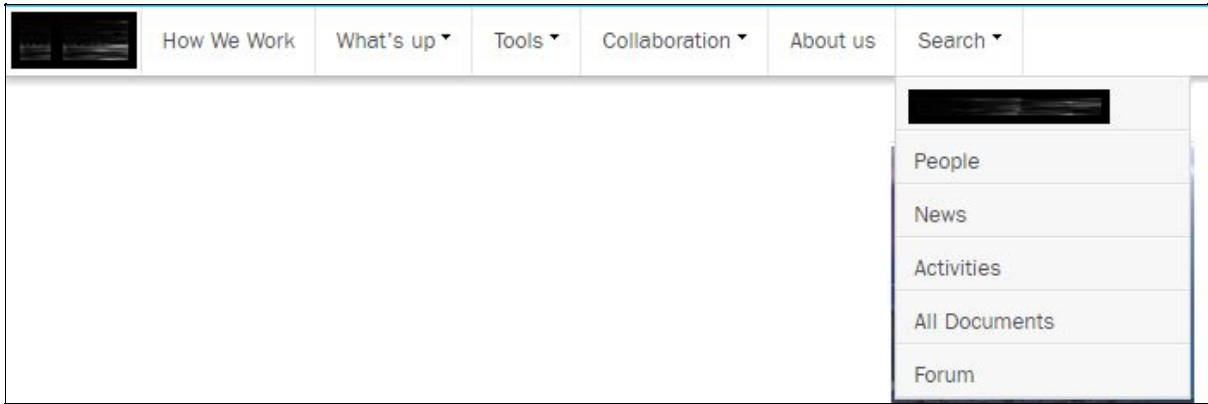
Screenshot 4. - Navigation bar *Search* option;
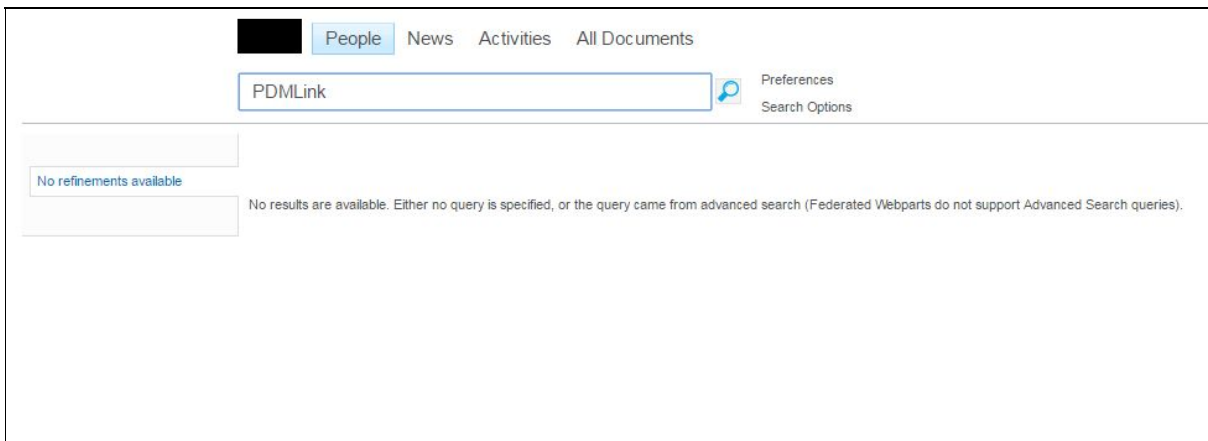


Screenshot 5. - Using *Search* function;

This looks like a simple and logical step when trying to find someone, but then result becomes unexpected, there is only one person shown (Screenshot 6.) with knowledge about PDMLink. Which is not correct of course since this is a very common knowledge within Gothen.
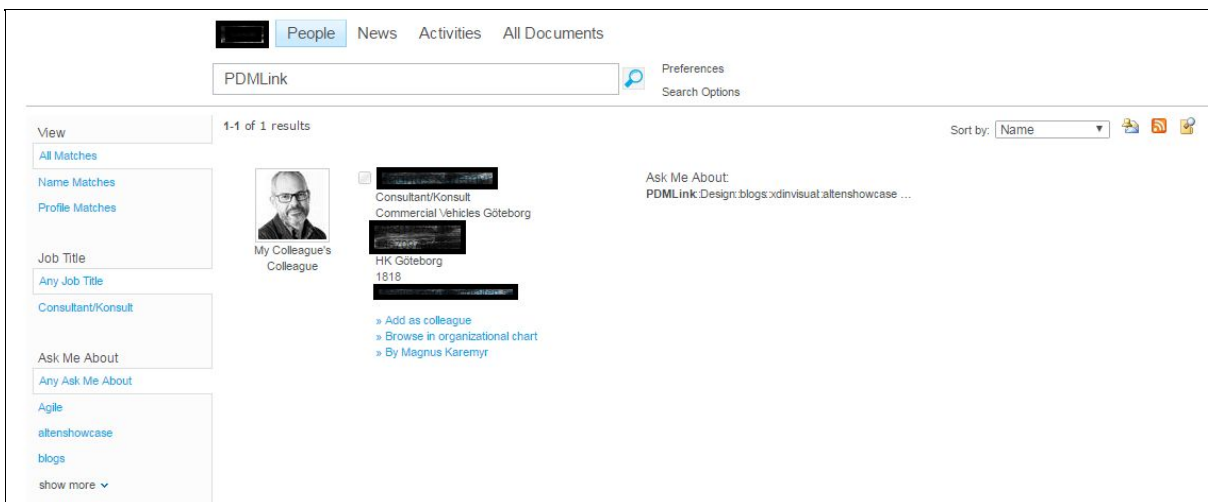


Screenshot 6. - PDMLink search results;

The reason for this result is that the owner of the profile is only person that placed PDMLink word inside section *"Ask me about"* of the profile (Screenshot 7.). This does not mean that this is only person that has competence in PDMLink, *Career Portal* proves differently. This is a good way to show competence, although not everyone use this section as the search results show. Furthermore, it is unclear is this person member of the PLM group.
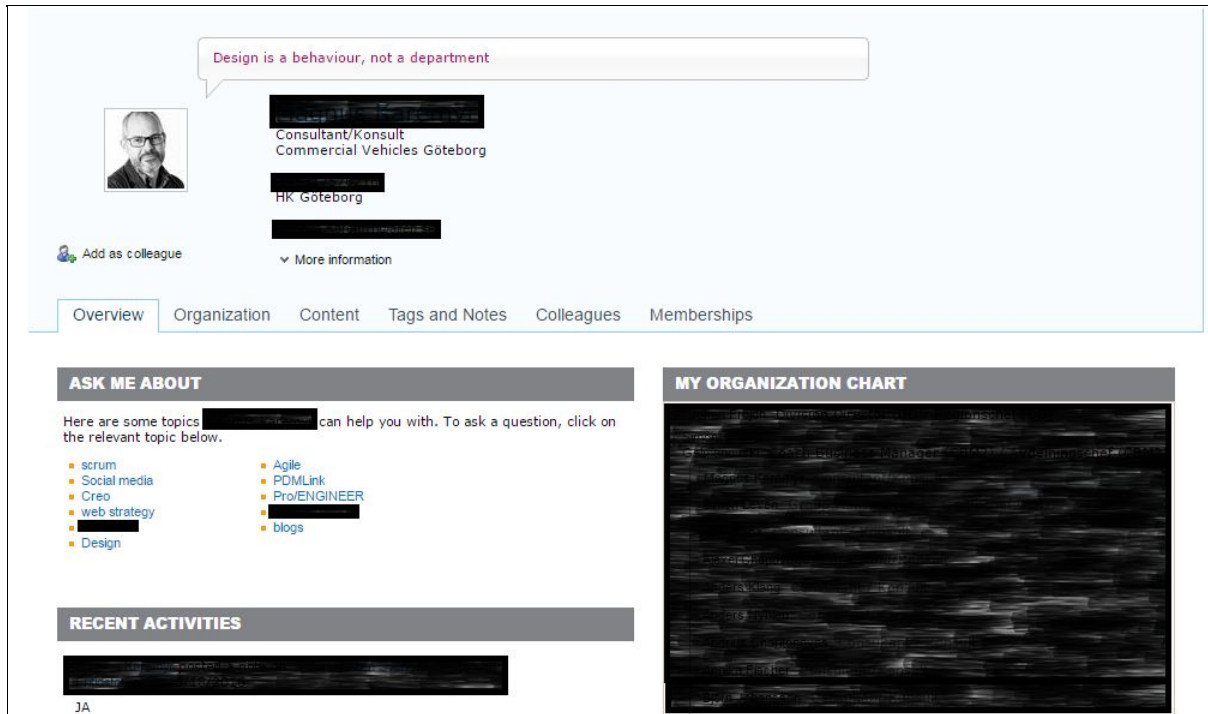


Screenshot 7. - PDMLink person;

Intranets *Search* function is simple to use but not intended for this kind of purposes, furthermore *Career Portal* requires too many steps to get to as shown in use case models 1. and 2.
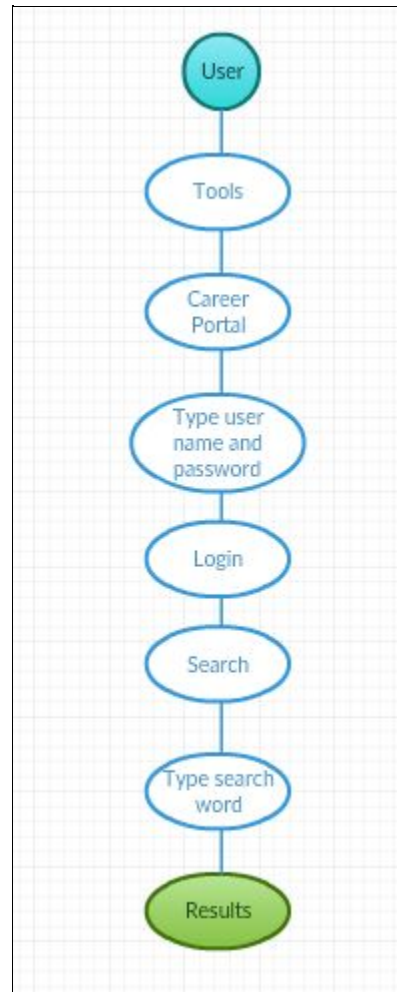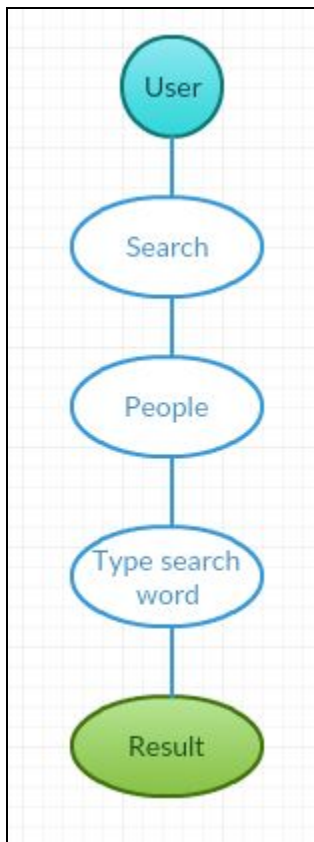
Model 1. - Intranet *Search* function user steps;     Model 2. - *Career Portal* user steps;

## 4.4.3 Contacting the group manager

According to our meetings with the management, this approach is considered to be time consuming both for consultants and managers. Group manager often have busy schedule and this kind of requests are low on the list of daily priorities and it also takes some time to collect contact data of all consultants that can be relevant for the person that is asking for them. That is one of the reasons why customer wants to create contact list, within the knowledge sharing space, that will contain crucial data which consultants usually ask for from the group manager. Contact list can provide consultants these information at all time, hence making this action faster as well as easier both for management and consultants.

Altogether, *Career Portal* is rich with different search features that can help consultants to find a person with specific knowledge, however, search results can not be limited only to the people from the Gothenburg PLM Group. Even if it could limit results to this group,  consultants benefit might be questionable when taking into an account that almost half of them have empty profiles. Furthermore, *Personal Site* does not support  presentation of competencies.

Customization of these two tools, according to needs of the management, is not technically feasible. Therefore, a new approach in search of competencies and people must be found.

## 4.5 Vision

We believe that the solution, that can satisfy requirements and overcome problems, lies in the community of practice. Furthermore, after reviewing the knowledge sharing possibilities of the Gothens intranet system, we decide to create an online community of practice as an integrated part of the system. CoPs are based on membership of the peers in the community, their connectivity and artifacts they exchange, e.g., documents, presentations, blogs, etc.

Thus, the first step in forming CoP is to assure membership of the peers and this can be done by creating online communities, as part of an intranet system dedicated only for this particular group of consultants. The connectivity between the peers is assured by creating a list of contacts where crucial details about consultants are added in contact description in the form of keywords. These keywords can also be used as contact tags in order to appear as clear and noticeable search results.

The second step in forming CoP is to enable mutual support in solving problems and collaborative learning. This can be done by providing space for sharing and managing knowledge. According to Schöns reflective practice (1978), organizations need to assure support for engaging peers in reflection on their practice, as a way to develop knowledge based on the lessons learned. Regarding the nature of consulting business, lessons learned can become source of knowledge from various parts of different industries this company offer services to.

At Gothen Consulting company, several users have already been active in this discipline at their previous workplaces. Thus, we designed decisions related to the creation of the online CoP together with them, which lead to the creation of knowledge sharing tools that allow posting of lessons learned and design step descriptions that PLM consultants use in their daily practice.

At the same time, knowledge sharing tools need to provide an easy way for the users to create and exchange artifacts, such as posts, by offering templates in order to simplify them for the readers. Furthermore, the need to provide chance to criticize these post and further discuss about shared knowledge which also supports collaborative learning. These actions will eventually, after a certain time, produce repository of knowledge within the department. Consultants will, of course, need a repository for various types of shared documents including posts, attached files, teaching material and presentations from  workshops.

Therefore, further design decisions will focus on four main functions needed for collaborative learning and knowledge sharing among PLM consultants.  These four functions will be related to:

1. Search tool that limits results within PLM online environment;
2. Contact list with crucial information and possibilities for fast and easy finding in the search tool. This function will provide the ability to find colleagues with whom consultants can engage in personal contact with;

3. Post sharing tool where descriptions of working processes, lessons learned and project problems can be shared, seen and commented by users. This function supports the knowledge conversion continuum of its tacit and explicit forms, where users learn by both writing as well as reading posts and comments;

4. Workshop support with presentation and document database. Management of collective knowledge is important and must be structured in a proper way, thus giving users an easy way to find documents according to their interests.

Given that this project is limited to the resources of the intranet system, collaboration community tool is most suitable online environment for this purpose. Moreover, this tool can be customized and offers templates intended for online collaboration, thus further development actions which will be made with focus on the four main functions.

# 5. Results - development and customization for knowledge sharing

Development of the online environment starts with the customization of tools offered by the Gothens intranet system in Section 5.1. We then follow the design vision and in Section 5.2. describe the development of the *Search function* and *Contact list.* Furthermore, we present development of the *Shareboard function* in Section 5.3. and customization and taxonomy for *Repository function* in Section 5.4.. Finally, we present customization of the site by adding supporting functions in Section 5.5.

## 5.1. Community

SharePoint offers simple tools for creating new sites within the system. The one who creates a new site becomes the site manager and controls the user permissions. When the site is created, it is possible to choose various options. Each options is defined further on in the text.

Collaboration tools offered by the intranet system such as *Project Room, Team Room* and *Communities* are basically the same as they provide similar functions. The only difference is the purpose of the offered tool where *Project Room* is used for projects, *Team Room* for team collaboration within organizational teams, and *Communities* for exchange of ideas on common topics and identification of colleagues with common interests. Based upon the requirements and problems that we identified, community tools represent an obvious choice. Therefore, we created a site in the *Communities* subsection of the *Collaboration* section.

The next steps in the customization of the new site is to (i) give title and description to it, (ii) make clear choice regarding the site address (URL) site and (iii) select one of the offered site templates that will guide customization and development for knowledge sharing purposes.

**(i) Title and description** of the *Community* section is displayed on each page of the site. The title is chosen according to the department name and purpose of its use -

"*PLM Knowledge Management".* As the description should provide more information about the purpose of the site, it is described as "*Site for exchange of ideas, experiences and knowledge on common topics within PLM as well as identification of colleagues with common interests."*

**(ii) Site address** represents the URL of the web site. It is only possible to type the last subsection of the site URL line which goes from home page through the *Collaboration* section. In order to keep it simple and easy to use, title of the site is placed for the last line of the URL "*.../collaboration/PLM_Knowledge_Management*".

**(iii) Template Selection** determines what kind of lists and features will be available for the users as part of the new site. Many aspects can be changed after a template is used and the site is created. As shown in Appendix 1., most of the templates are centered around the functions they are named after, which also means that their functions are limited for wider use. For example, description of the **Enterprise Wiki** template sounds appealing for knowledge sharing, but once created it is not easy to adapt it and it is hard to add any other functions related to our goals.

As the main goal of this project is to provide the opportunity for knowledge sharing, collaboration templates such as **Blank Site**, **Group Work Site** or **Team Site** offer tools that are most suitable according to project needs. Customization is simple and It only takes to choose one template and adapt it for the knowledge sharing purposes. Different templates offer different functions that can be helpful in design of PLM Knowledge Management site. **Team Site** already offers navigation bar with document libraries and a place for discussions. **Group Work Site** contains functions such as *Circulation* and *Phone-Call Memo* which are not necessary for this project. For this reason, **Team Site** represents a more attractive template as a starting point as it requires the least customization effort.

**Team Site** template consists of navigation bar on the left side and two sections in the middle of the window. Navigation bar has:
- *Libraries* part  with a document library,
- *Lists* part which contains *Calendar* and *Tasks* functions,
- *Discussions* part intended for team discussions.

However in order to make the best use of the online community for knowledge sharing purposes, **Team Site** template needs to be customized further. Some of the functions are not suitable and are impossible to customize so they are removed, for example *Discussions* part (see Section 5.5.1.). Other functions are customized and adapted (see Sections 5.4. & 5.5.), while some new functions are added (see Sections 5.2. & 5.3.). The reasons for these actions are presented further in the text.

Two sections in the middle of the site are made out of so called "*Web Parts*". *Web part* represents a widget of a sharepoint page, it can be customized by the content and appearance as well as the place on the web page, as shown in Screenshot 3.
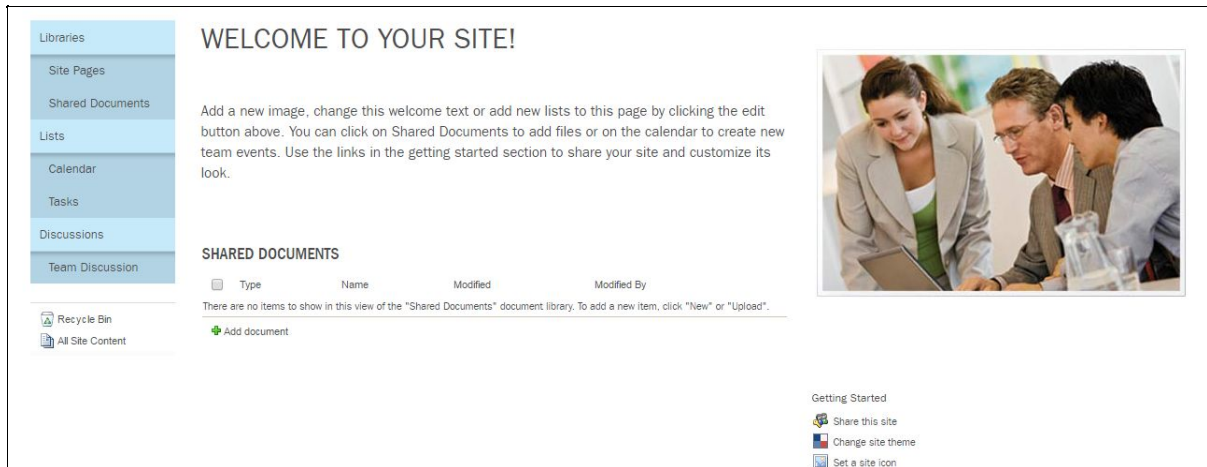
Screenshot 3. - Team Site;

Customization must be managed according to four main features.
1. Process of finding the crucial contact must be designed.
2. Determination of how should list of contacts look like.
3. Determination of how should sharing of descriptions and lessons learned look like.
4. Determination of how should document base look like as well as other supporting features of the PLM online environment.

## 5.2 Development of *Search* function and *Contacts* list

In order to show contacts inside the viewing sight of the users, new contact list needs to be created inside the closed PLM environment filled with only those basic information they actually need. This can be structured as a part of **Team Site** by adding *Contacts* feature and filling it only with basic contact information about PLM consultants, thus enabling direct contact between members. By creating contact list in this environment intended for specific group of people, design becomes more simple and user friendly as everything is kept in one place. *Contacts* feature shall contain information such as:
● Name;
● Customer company or consultants working site;
● Competencies;
● Email address and phone number;
● Project experience;
● Ongoing projects.

All these information is displayed with keywords in order to prevent information overload, thus making design easy to read and understand.

As mentioned before, Intranet system supports personal pages in the *Personal site* section and *Career Portal* as a part of the *Tools* section. However, both of these sections are rich with their own set of information and have downsides that affect perceived ease of use. Therefore, finding specific information about colleagues would demand too big effort, and results may be unexpected and unclear, especially if user

is using the system's search tools. This would give little or no result to the user and will crucially affect the motivation after several unsuccessful attempts. In order to keep with the concept of Perceived Ease of Use [12], *Contacts* web part is created and adapted for the needs of department.

SharePoint supports *Contact* web part that looks like widget that can be placed at the site's home page. Thus, users can have contact information as a part of the home page. Besides this, *Contacts* section is available as subsection in the navigation bar, if the users want to get more detailed look over the list.

In order to get to the PLM Knowledge Management site, and then to the *Contact list,* it does not take much effort from the users. Starting from the intranets home page, users need to perform three actions to get to PLM Knowledge management site as shown in model 3., hence the list will be easily available. Furthermore, if user from any particular reason want to see just the contact list, link to it is placed in the navigation bar.

Contact list of PLM consultants is created and is filled with only basic information that others need to find. On one hand, If one user needs help regarding a specific problem that is related to a software tool that is commonly used in this practice, it would be meaningful that he or she finds people that have knowledge and experience with this tool. On the other hand, if issues at work are related to a specific project and someone from PLM group has experience in similar projects in the past, it would be helpful if this individual would share some of his/hers knowledge to the others.

Either way, social interaction can provide opportunity for conversion of tacit form of knowledge, that one possess, into explicit form of knowledge by interacting with a colleague. Therefore, this list needs to enable social interaction and provide users with information that will help them to find someone who possess specific knowledge that they need. Hence, in collaboration with management, five basic areas are created in the contact list:

- Software tools competencies;
- Place of work;
- Contact information;
- Ongoing projects;
- Previous experience.

Model 3. - Finding PLM site and contact list steps;

### 5.2.1. Contacts Web Part

Sharepoint web part for contacts offers a lot of detail information about a user, basic template consists fields such as the one from Screenshot 9. contains these options:
- Title
- First Name
- Full Name
- E-mail Address
- Company
- Job Title
- Business Phone
- Home Phone
- Mobile Number
- Fax Number
- Address
- City
- State/Province
- ZIP/Postal Code
- Country/Region
- Web Page, with URL and further details about the page description

| | |
|---|---|
| Title * | [                    ] |
| First Name | [                    ] |
| Full Name | [                    ] |
| E-mail Address | [                    ] |
| Company | [                    ] |
| Job Title | [                    ] |
| Business Phone | [                    ] |
| Home Phone | [                    ] |
| Mobile Number | [                    ] |
| Fax Number | [                    ] |
| Address | [                    ] |
| City | [                    ] |
| State/Province | [                    ] |
| ZIP/Postal Code | [                    ] |
| Country/Region | [                    ] |
| Web Page | Type the Web address: (Click here to test) [http://] Type the description: [                    ] |
| Notes | [                    ] Click for help about adding basic HTML formatting. |

[ Save ]  [ Cancel ]

Screenshot 9. - New Contact function;

It is also possible to attach files and add tags to contacts. Tags makes taxonomy of search results structured and easy available within the PLM Knowledge Management site.

Any field in the *Contacts list* can be fully customized, and also new fields can be added. According to the five basic information we described earlier *Contact list* template offers fields that can be used in these purposes. Fields such as *Full name* and *Email address* can be used as basic contact information. Fields such as *Company* and *Job Title* can be used for letting others know about users assignment position at customers site. However, other three areas require new fields, these fields are created and titled:

- Competencies - describes software tools competencies;
- Experience with - describes consultant's previous experience;
- Ongoing Projects -  describes projects which is consultant currently active.

## 5.2.2. Adding and tagging contacts

List of all 31 consultants is created with completing fields such as *Title, Full Name, E-mail Addresses* and *Competencies*, thus leaving other two to users to fill them themselves. PLM Group Manager provided all information designer needed to attach them to each contact. Following the example of the *Career Portal*, keywords are used regarding employees skills and competencies. Thus, contact list field named competencies  represented keywords of software tools or areas in which consultants possess knowledge and working experience. Keywords used on the list are:
- Aftermarket;
- Agile / Scrum Coaching;

- AVP;
- Bom;
- Creo;
- Catia;
- KDP;
- Manufacturing;
- PDM;
- PM;
- PDMLink;
- SolidWorks
- Training;
- Teamcenter;
- Templates;
- Time engineering;
- Virtual Manufacturing.

## 5.2.3. Search Web Part

Even there is around 30 contacts it is easy to scroll and read about each one of them. In case that number of contacts become larger it will be too big to scroll around, therefore *Search* web part is added and placed above *Contacts* widget.

Besides making easy for users to easily search and find peers from the PLM group, this function will allow them to search documents and posts shared within the PLM Knowledge Management site.

*Search* function can be limited only to PLM Knowledge Management site (Screenshot 10.) but it can also offer wider range of results from all sites in the intranet system, and also limit results to other notions.
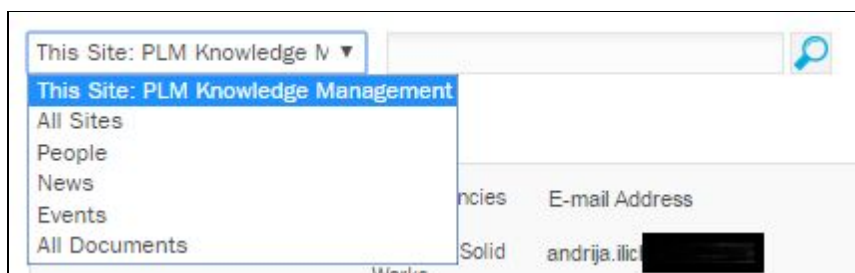


Screenshot 10. - Search Web Part;

Tags make search easier and can be used as filters, therefore all contacts were tagged with keywords regarding their own competencies as well as with the name of the customer that they are engaged with (Screenshot 11). This gives much more choice to the one who is searching, whether if he or she look for someone in the same company or someone with competence and knowledge in a certain field. It is important to stress that, beside the PLM Knowledge Management environment, these tags can work across Gothen's intranet system
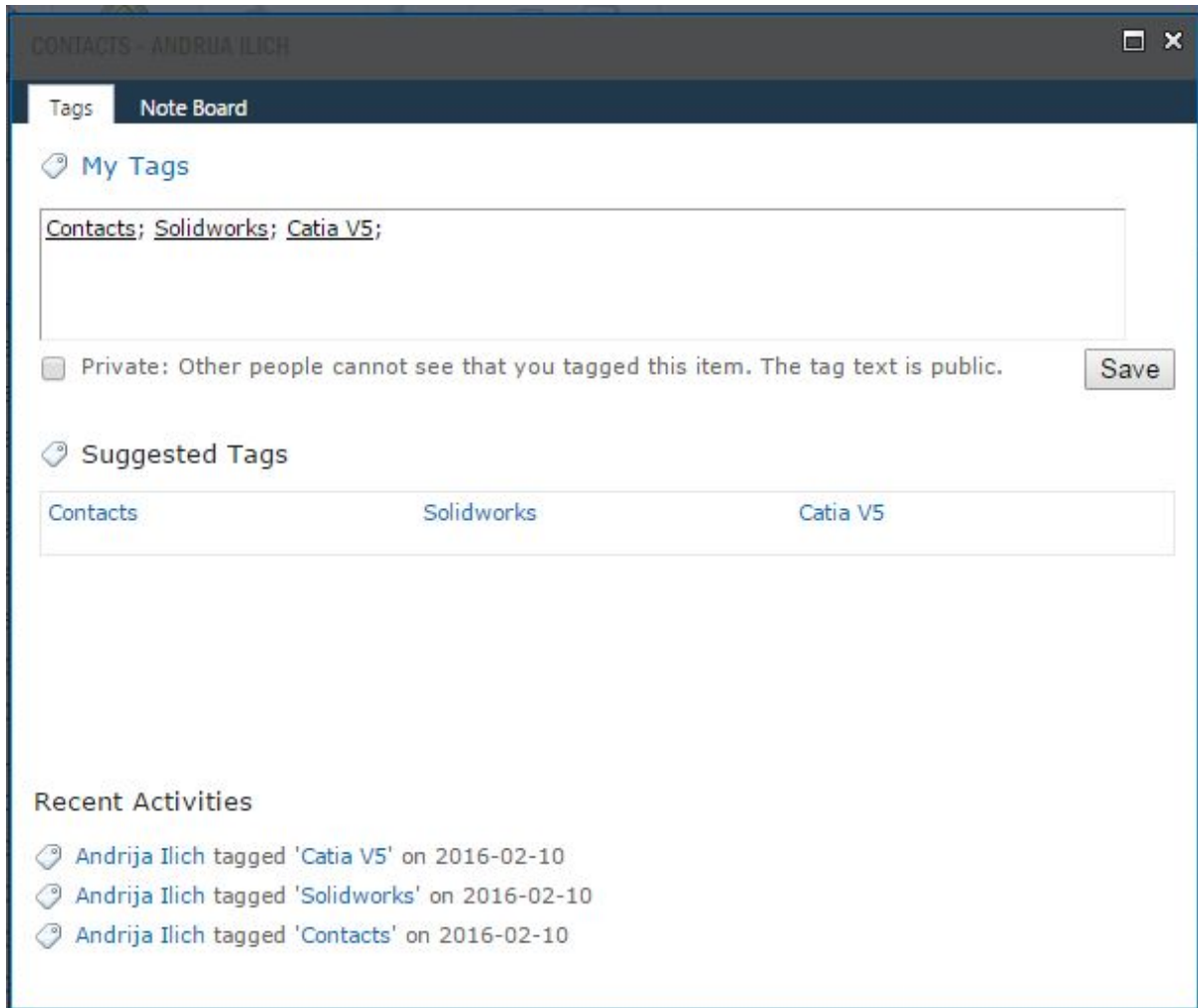
Screenshot 11. - Tagging a contact;

In order to test PLM site search function and its usability, search of PDMLink keyword is repeated as it was done in Sections 4.4.1 and 4.4.2. The result were shown only from the PLM Knowledge management site, it showed four contacts and six other types of results. Option to use tags in search results was available as shown in Screenshot 12. and then they were limited according to chosen tag. This option can be very helpful if number of contacts becomes too big, hence the amount of data as well.
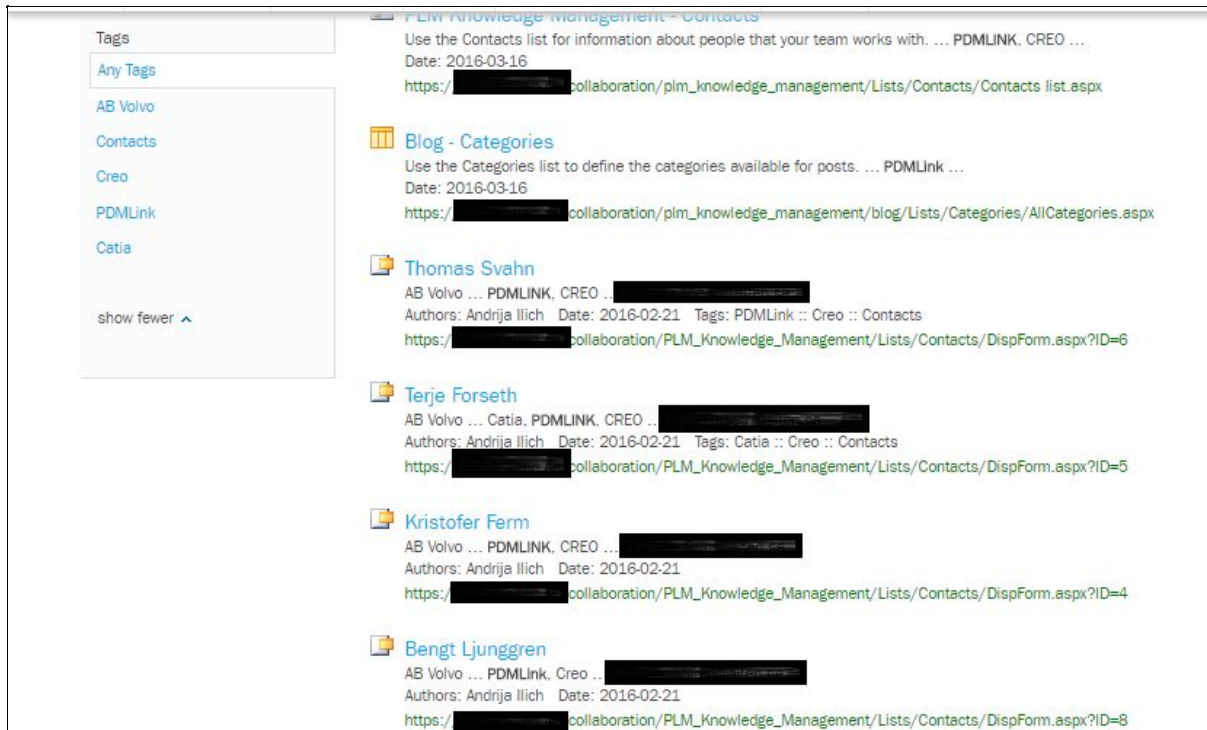
Screenshot 12. - PLM Site search results;

## 5.2.4. How does search function and contact list provide opportunities for knowledge sharing?

According to needs of knowledge exchange among employees, consultants could gain from exchange of experiences in solving specific problems as well as know-how in using industry design and product documentation tools. Thus, type of knowledge that needs to be exchanged is more tacit than implicit, and it needs to be converted in some way. Tsoukas (2003) suggests that through practical engagement and  participation in social practices tacit knowledge can be converted into explicit and learned or acquired from more experienced people.

Beside current working environment, project groups, teams, colleagues around the office, consultants can also rely on support of the Gothen Consulting, and by the help of this PLM site they can address their colleagues from Gothen for assistance. That could be people who work with same tools, have experienced similar projects and problems or work on same site but on a different project. Things that can be discussed and documented outside the customer's company are limited, intellectual properties rights can be breached. Although notions and problems can be named in general, safest approach is leading towards face-to-face discussion.

Therefore, search function and contact list is helping users to find colleagues from the same profession that can provide them right support, consultation or advisement.

## 5.3. Blog - Shareboard

Third function should provide space for knowledge sharing and collaborative learning. This shall be done by sharing lessons learned, descriptions of the problems and solutions encountered in projects. Furthermore, comments and discussions related to this kind of posts can result in collaborative learning.

SharePoint offers a pallet of web parts, among them *Blog* function is offered. *Blog* function provides post sharing option as well as post categorization and comment feature. Hence these features provide suitable environment writing tool for knowledge sharing needs.

*Blog* tool also offers writing template which makes writing easier for a user. Template contains *Title, Body, Category* and *time and date* info called *Published* as shown in Screenshot 13.



Screenshot 13. - Blog template at start;

In order to have structure among posts, categorizing feature is customized. Therefore, each post can use one or more categories as tags which makes posts easy to find by using *Search* function. Moreover, posts are structured according to categories, which gives users a choice to filter post according to their interests.

Keywords used for tagging contacts are related to users workplaces and domains in practice. Designer use this example of keywords in order to create *blog* categories, by adding names of clients companies, tools and notions important for this PLM group. Thus, making posts easy to relate to a project done in a certain company with specific tools or in specific areas of PLM. It is also easy for users to add a new category for posts if some new tool, company or notion becomes significant or frequently used in this PLM group.

Besides blog *Categories, Title* and *Body*, template is adapted in collaboration with technical director of the PLM group in Gothen Consulting. In order to improve ease of use of the template we added two features.

Firstly, in order to define the type of a post, choice menu will give opportunity to a user to define it. Three choices are offered:

1. *Project*. This choice will inform reader that post is intended to describe a project.
2. *Tips & Tricks.* This choice will inform reader that post is intended for sharing a method or description of the actions that can improve one's productivity. Furthermore, this choice represents a text related to a specific solution.
3. *Other*. This choice gives freedom to a user to define post if it is not related to any of the two options offered above.

Secondly, one more feature is added regarding the subject of a post. Above the *Body*, box of two lines is created and named *Subject / Brief description.* In case of sharing projects lessons learned, *Subject* represents name of it. Otherwise, post can be represented with a short description. All in all, this text box should contain a brief description of the text written in the body of the post. Furthermore, small instructional texts are placed under each section in order to hint user regarding the purpose of the options, this is shown in Screenshot 14.

Screenshot 14. - Complete Blog post template;

In the early stages of the development, designer conducted meetings and discussions with potential users. Many of them expressed that word *Blog* associates to notions that come from Social Media and usually belong outside of working environment. Blog expression is, according to them, mostly connected to informal ways of writing such as things related to fashion, feelings, everyday life. Hence, even though they like the idea of sharing and tagging posts, most consultants do not see

themselves in roles of bloggers and find hard to imagine how to blog about working experiences.

In order to avoid misunderstanding, confusion or false association, we renamed blog tool to *Shareboard*. In meeting sessions with consultants that were introduced with tools of the system for the first time, *Shareboard* was presented as a completely new tool and word blog was not mentioned. Even though it is the same tool, discussions with both groups of consultants showed that *Shareboard* is taken more seriously, formal and closer to expertise. Therefore, *Shareboard* is represent to consultants as a new notion in sharing, as a virtual board for sharing tips, methods, lessons learned and so forth. Which resulted, that they accept the Shareboard as a formal tool for sharing and writing in the working environment.

### 5.3.1. How can specific designs based on Sharepoint provide opportunities for collaborative learning?

As a component of supporting work-based learning, Blog is one of new technologies that is making collaboration through Social Media outside of work [13]. *Blog* can be very useful in sharing new ideas, methods, experiences, lessons learned and other knowledge resources on work. What is more, blogs posts can be commented and by that become source of discussion and critique. It also supports categorizing feature, so that any post can be categorized and related to one or more PLM domains.

Sharing lessons learned, success stories or any experience in previous engagement can contribute to those who write as well as to those who reexperience events through reading [14]. Experiences from client engagements in finished projects and assignments can also inspire consultants for change and positive action. Manpower Inc. have successfully applied this knowledge sharing approach with it's (VAM) virtual account management system [15]. *Shareboard* template provides opportunity to users to write about lessons learned with ease.

## 5.4. Repository

ICT change capacity to manage and apply knowledge, especially regarding implicit knowledge. By using repositories it can be stored, distributed and accessible to everyone in the community. According to David G. Schwartz and Dov Te'eni (2000) using repositories in organizations for knowledge distribution has potential to enable learning. Furthermore, *Repository* must provide disciplined process for creation and categorization of useful learning material.

This repository was divided into two section. First one was used for sharing and keeping new useful links and the other one for document files.

### 5.4.1 Links

There are external communities, blogspots, news and magazines which contain critiques, articles and other things from world of PLM. In order to keep these external links available for group members web part was created and dedicated for this

purpose. This was done by the help of several consultants who voluntarily contributed to find as much sources as possible in order to provide new and external sources of knowledge for the PLM group.

If users would like to add a new link to this list, it is simple and easy to do it, there are several details that user needs to fill out in order to post it as shown in Screenshot 15.



Screenshot 15. - Posting a link;

## 5.4.2. Documents

In order to have a proper taxonomy structure. **Team Site** template is adapted and *Libraries* web part is moved down to the bottom of the navigation bar. Adaptation covers creation of subfolders such as:

- PLM;
- Presentations;
- Methods;
- Teamcenter;

*PLM* subfolder will be used for files shared within areas of PLM that are not specifically connected to any larger category in PLM practice.

*Presentations* subfolder will be used, as it's name says, for posting presentation material used in workshops. After every workshop, management will be responsible to upload all documents that are used. Thus, consultants that were unable to participate can be updated regarding workshop activities, and these documents can also be used as learning materials for those who want to go through them thoroughly.

*Methods* subfolder represents place for storing documents of any type regarding design methods used in industrial design. If a user want to share a method he or she have support of the system to create a small presentation or teaching material that can contain pictures, slides, unit CAD files, text instructions and so forth.

*Teamcenter* is software tool used in product lifecycle management, this subfolder will contain tips & tricks as well as learning material regarding productive use of it.

It is fairly easy to create new subfolder if sharing becomes more specific towards certain PLM category.

## 5.5. Supporting functions

Besides three basic functions this site is focused on, there are some supporting functions that this system offers and that can support organization activities of the PLM group. This includes introducing users with CAD forum, enabling to post brief information and news in Announcement section, and setting up a calendar function in order to support group events organization.

### 5.5.1. CAD Forum

Team site template have section intended for discussions. This discussions web part was insufficient and not user friendly, it lacks taxonomy features such as categories, topics and so on. If this tool is used, after a certain time number of discussions would lead to chaotic information overload and all discussion posts will become a list. Therefore, discussions web part was removed from the navigation bar. Instead of it, old *CAD Forum* can be used in these purposes.

Gothen's intranet system have *CAD Forum*, but it was not used for some time. The reason for that on one hand is because not many people knew that it exists and on the other hand, those who knew about it did not had incentives or purpose to use it.

By placing the forum as a part of the knowledge sharing environment, it could be presented in the new light. New purpose of the forum was added as the tool for posting questions and asking for help regarding difficulties in using software tools or engineering approaches at work. So now, *CAD Forum* can be there for professional call for help among peers.

### 5.5.2. Announcements

*Announcements* is the news feed function. It was placed in the top right of the home page and it offers simple *Title* and *Body* structure. Besides using it as a news feed it's purpose is meant for announcing upcoming workshops of the PLM group, therefore it was titled as *Announcements*.

### 5.5.3. Calendar

Since the beginning of development and customization, **Team Site** template contained *Lists* web part which contains *Calendar* and *Tasks* functions. Consultants

from the PLM group do not operate as a team in their daily working activities, therefore there was no need for the *Task* function and it was removed from the site. But people will meet and conduct workshops, thus calendar function is needed and it was kept during the design process.

# 6. Development project evaluation

In order to test the current design of the PLM Knowledge Management online environment, we conducted formative evaluation. This approach should judge to which extent are the requirements, goals and objectives of the project met as well as how should further development of the environment be conducted. Formative evaluation is, according to Guyot (1978), "a building process which accumulates a series of components of new materials, skills, and problems into an ultimate meaningful whole". This approach is also effective in analysing learning, achievements and learning materials. As the proposed online environment supports knowledge exchange and collaborative learning, formative evaluation is considered as a suitable approach for testing.

The choice of a concrete method for performing the formative evaluation needs to be adapted to the organizational circumstances of Gothen Consulting. As users of the environment (consultants) are geographically scattered over various customer sites and spend most of their working hours there, it is complicated to conduct a field work at different sites in order to evaluate the system. For this reason, pluralistic walkthrough [15], that is done in a single workshop, is better suited for these conditions because consultants could gather at one place and conduct evaluation in a short period of time.

However, there are still limitations for performing the pluralistic walkthrough evaluation that required certain adaptation of the method. In particular, in order to participate in the workshop, consultants needs to leave their workplaces for a certain amount of time and also be payed for these working hours spent at the evaluation workshop. Management found it hard to support this approach due to costs. Thus in order to adapt to these conditions, we performed the evaluation with individuals in separate sessions at Gothen Consulting, however still according to principles of pluralistic walkthrough.

Pluralistic walkthrough is usually used for evaluation of the system usability during prototyping and developing stages. It is conducted with potential users in panels that represent online simulation of the user activities. Panels consist of tasks that users try to perform. After each task is performed, the participants write down their responses and then the discussions starts. The main principle of pluralistic walkthrough is that during the discussions, participants are the ones that speak first and only after all comments are exhausted can the evaluators start speaking.

Our goal was to test how potential users find the system useful and how they can connect it to their practice. Moreover, measuring user perception can provide guidance for further development. This can be achieved by testing two theoretical

constructs such as perceived usefulness and perceived ease of use of the tested online environment.

Perceived usefulness represents a degree to which a user considers a system useful that, at the same time, improves user's job performance. Furthermore, perceived ease of use represents a degree to which users consider the analyzed system easy to use in terms of no, little or high effort.

This evaluation is based on the principles of pluralistic walkthrough although in individual sessions where participants performed four tasks. After each task, they filled out a questionnaire with questions regarding perceived usefulness and perceived ease of use of the system. Participants also followed principles of the walkthrough and started a discussion after each task and questionnaire. Discussions were intended to reveal how can PLM Knowledge Management online environment fit into their practice.

## 6.1. Panels

The project focused on four main features to support the users of the proposed online environment. Participants evaluated each feature in one panel. Each panel consisted of one task with two questionnaires - one for perceived usefulness and one for perceived ease of use - and a question to start the discussion.

- **Panel 1:** The participants performed search activities with the help of the "Search" function. If a potential user would like to find a person with specific competence and knowledge or a specific document, the "Search" function should support these intentions. Therefore, participants performed a search of a specific person within the PLM group that have knowledge in the product data management. The description of this task is presented in appendix 7.2.
- **Panel 2:** The participants performed search activity by using the "Contact list" function. In order to find people that work in a specific company, users needed to go through contact list and use filters. The description of the task is presented in appendix 7.3.
- **Panel 3:** The participants performed sharing activity by using the "Shareboard" function. Sharing experience from a project is considered meaningful and relatively easy to be performed by the users. Therefore, this task required from the participants to share a post in the Shareboard. The description of the task is presented in appendix 7.4.
- **Panel 4:** Finally, the participants conduct a search for specific document inside Repository. This task is intended to evaluate if users find easy and useful to use uploaded presentation documents. Description of this task is presented in appendix 7.5.

In order to distribute and analyze the tasks in each panel, we used Google Forms tool. Each panel used one file which had its own link that could be used for distribution. All participants used the same files for the panels that helped us summarize the results automatically at one place using Google Forms. Each file contained instructions for the task performance, two questionnaires and the discussion question.

## 6.2. Questionnaires

Each panel consisted of two questionnaires, one related to the perceived usefulness and one related to the perceived ease of use. Questions used in this evaluation are created based on the example of Davis (1989), who used 10 questions for each purpose. All questions are related to the importance of PLM Knowledge Management site to the job effectiveness of the consultants as well as the productivity and time savings. Questions used in panels are provided in appendix 6. (Search function), 7. (Contact list), 8. (Shareboard) and 9. (Repository). Questions were presented as statements to which participants needed to agree, disagree or express as neutral. Questionnaire regarding perceived usefulness was consisted out of 13 statements, and the one regarding perceived ease of use consisted out of 10 statements. Links to Google Forms are placed in Appendix 10.

## 6.3. Results

Evaluation was conducted in a period of one week with five potential users from the PLM consultants group. Results are presented in four groups concerning each feature of the system. In order to present answers in a clear and understandable way, results are shown according to positive, negative and neutral opinions that participants expressed according to statements in the questionnaires. This means that five participants rated 13 questions, which gives 65 answers regarding perceived usefulness although there was 10 questions for perceived ease of use, which gives 50 rated answers as shown in Table 1. However, due to limited time of one of the evaluation participants, Repository feature have 52 respectively 40 questions answered.

|  | Positive | Neutral | Negative |
|---|---|---|---|
| Search function perceived usefulness | 55 | 10 | 0 |
| Search function perceived ease of use | 36 | 11 | 3 |
| Contact list perceived usefulness | 55 | 10 | 0 |
| Contact list perceived ease of use | 48 | 2 | 0 |
| Shareboard perceived usefulness | 49 | 16 | 0 |
| Shareboard perceived ease of use | 41 | 9 | 0 |
| Repository perceived usefulness | 36 | 14 | 2 |
| Repository perceived ease of use | 34 | 6 | 0 |

Table 1. - Number of statements rated positively, neutrally and negatively by participants.

Furthermore, we present these results rated in a sense of percentage of positive, neutral and negative opinions.

- ● **Panel 1:** Participants rated perceived usefulness of the *Search* function with 84.6% positive answers, while 15.4% was neutral and there were no negative rates as shown in Chart 1. Evaluation of perceived ease of use of the Search function resulted in 72% of positive, 22% of neutral and 6% negative rate as shown in Chart 2.



Chart 1. - Search perceived usefulness;        Chart 2. - Search perceived ease of use;

When participants finished with rating statements in questionnaires they answered a question that was supposed to initiate the discussion. The question is intended to relate usefulness of this particular function and its purpose with the PLM practice. The question was: *Regarding Search function, how do you think that PLM Knowledge Management site would fit into your practice?.*

Answers were:

- ➢ *"Searching for people and Posts";*
- ➢ *"It would help to find contacts of people working in similar projects and having the skillsets to maybe help me with my work";*
- ➢ *"I hope that it will make the specific search function easier";*
- ➢ *"finding my colleagues";*
- ➢ *"It helps me to find people that can help me with my work. search function don't work well always";*

During the discussion, participants expressed that they consider this function useful in finding colleagues with specific skills and competencies. Furthermore, they considered that this function can be useful in their practice. However, the result, in the task that participants performed, did not show two contacts with specific competence, even though these two contacts were properly tagged with that competence keyword in the Contact list. Therefore, two participants complained regarding this usability issue caused.

- ● **Panel 2:** On one hand, participants rated perceived usefulness of the Contact list in 84.6% positive and 15.4% neutral rate (See Chart 3.). This means that 55

answers were positive and 10 were neutral. On the hand, they rated perceived ease of use with 48 positive and only 2 neutral answers, which makes positive vs. neutral ratio in 96% vs. only 4% (See Chart 4.).



 Chart 3. - Contact list perceived usefulness; Chart 4. - Contact list perceived ease of use;

When participants finished with rating statements in questionnaires they answered a question that was supposed to initiate the discussion. The question is intended to relate usefulness of this particular function and its purpose with the PLM practice. The question was: *Regarding Contact list, how do you think that PLM Knowledge Management site would fit into your practice?.*
Answers to this question were posted as:
> ➢ *".";*
> ➢ *"that I can search for the right competence that I am looking for.";*
> ➢ *"searching for people";*
> ➢ *"it is easier to find my colleagues";*
> ➢ *"it is easier to find my colleagues".*

During the discussion participants considered this function useful in finding their colleagues and expect to see more information regarding ongoing projects that their colleagues are engaged in.

● **Panel 3:** In this panel participants rate perceived usefulness of the Shareboard with 49 positive and 16 neutral answers, thus making 75,4% of answers positive and 24,6% neutral (See Chart 5.). Perceived ease of use was rated with 41 positive answer and 9 neutral answers thus rating it positively with 82% and neutrally with 18% (See Chart 6.).

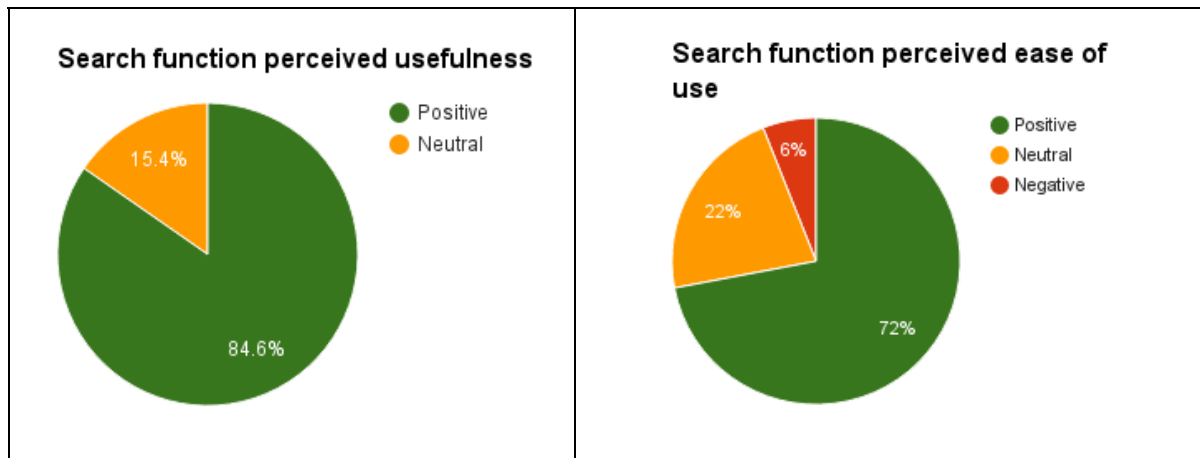Chart 5.- Shareboard perceived usefulness; Chart 6.- Shareboard perceived ease of use;

When participants finished with rating statements in questionnaires they answered a question that was supposed to initiate the discussion. The question is intended to relate usefulness of this particular function and its purpose with the PLM practice. The question was: *Regarding Shareboard function, how do you think that PLM Knowledge Management site would fit into your practice?*

Answers to this question were:

➢ *"Everyone should starting using this as a best practice to have this knowledge base made available for people starting on a new Technology or projects.";*
➢ *"If people would use it, I think It can be a great tool. but I don't know if people will use it.";*
➢ *"share knowledge";*
➢ *"sharing is good but would people do it. I think this tool fits perfectly";*
➢ *"it helps with projects and solutions we can all share".*

Question regarding Shareboard initiated longer discussions than compared with discussions regarding other features of the system. Participants commented that this tool is really helpful for sharing knowledge and solving problems.

● **Panel 4:** Repository perceived usefulness was rated with 36 positive, 14 neutral and 2 negative answers. Expressed in percents, it rated with 69.2% positively, 26.9% neutrally and 3.8% negatively (See Chart 7.). Furthermore, Perceived ease of use received 34 positive answers and 6 neutral, this means that 86% was rated positively and 15% neutrally (See Chart 8.).

**Repository perceived usefulness**

Positive
Neutral
Negative

3.8%
26.9%
69.2%

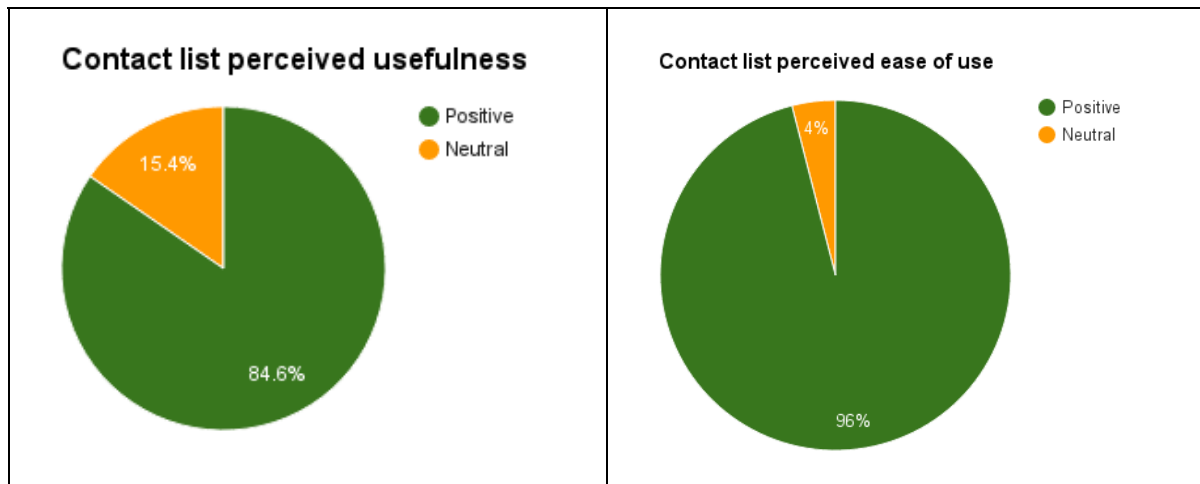**Repository perceived ease of use**
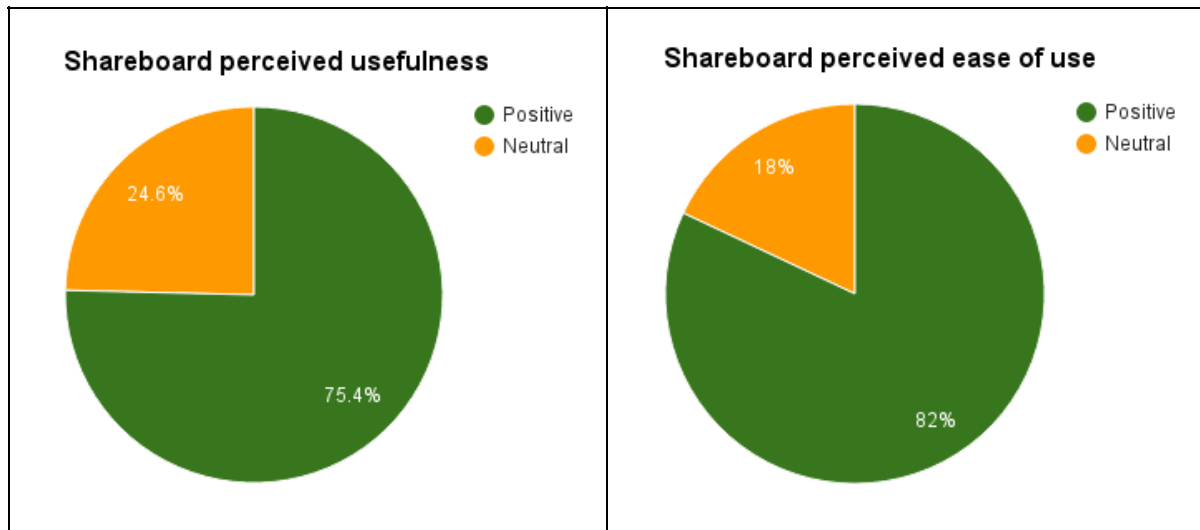
Positive
Neutral

15%
85%
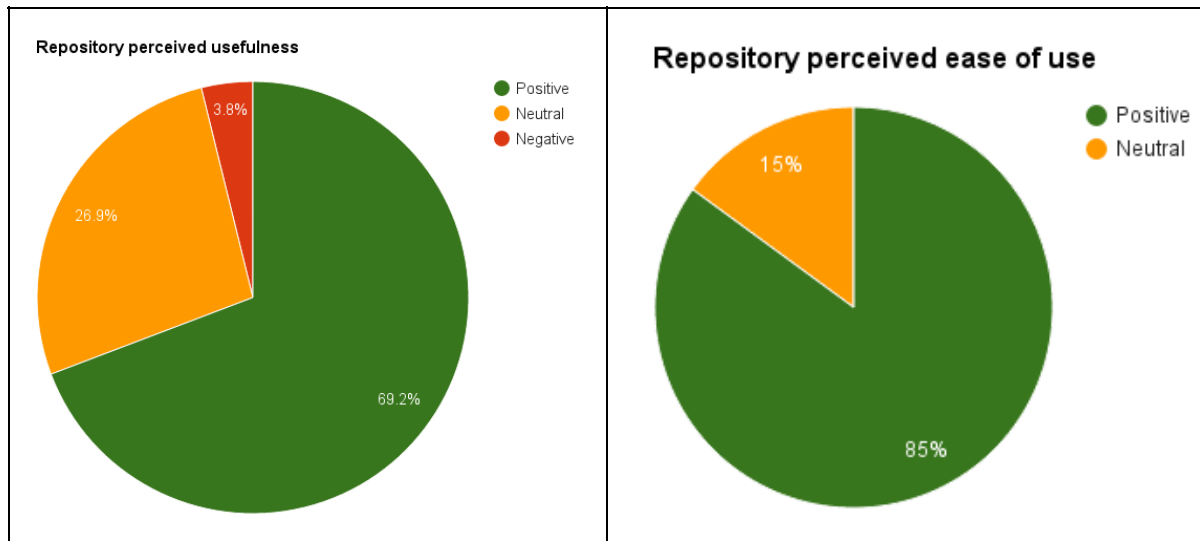
Chart 7.- Repository perceived usefulness;    Chart 8. - Repository perceived ease of use;

When participants finished with rating statements in questionnaires they answered a question that was supposed to initiate the discussion. The question is intended to relate usefulness of this particular function and its purpose with the PLM practice. The question was: *Regarding Repository and its content, how do you think that PLM Knowledge Management site would fit into your practice?.*

Answers to these question were:

➢ *".";*
➢ *"as long as it is easy to find stuff and not to many slides you have to go throu it can be great.";*
➢ *"educational content";*
➢ *"easy to move about and find documents. /though it needs more documents of this kind".*

During the discussion participants considered this feature useful and common to use. However, some expected to see more content intended for their professional development.

## 6.4. Discussion

Consulting organizations have always searched for the way to capture and transfer knowledge among their consultants. In order to bridge social and geographic boundaries, that are consequences of the nature of consulting businesses, these organizations rely on ICT tools such as repositories, intranets and communities of practice. The goal of this project is to design an online environment that should provide support in exchange of knowledge among employees in one consulting organization. This online environment should serve as CoP that PLM consultants can participate in, by sharing context-based knowledge gained through working experience. Furthermore, members of this CoP are supposed to benefit from participation in social interaction with others, thus learning through iterative

conversion of knowledge forms in the continuum between tacit and explicit forms of knowledge.

We looked into the knowledge management systems research field that is focused on exchange of tacit knowledge within large organizations [16], as well as into competence management systems that are focused on managing competence data that can provide opportunity for exchange of knowledge among individuals [17]. Furthermore, theoretical framework of this development project also includes learning theory of CoPs [18], and research field of CSCL at work[19].

According to the theory and literature we reviewed as well as to client requirements for the system and also by examining problems that could affect to exchange of knowledge in the Gothen Consulting intranet system, we created a vision that presents how should exchange of knowledge look like in this project. Therefore, in order to provide knowledge sharing environment for this project we determined that it had to be based on four main features:

- Search function, that should support users in search of specific competence or knowledge that their colleagues have, thus providing opportunity for social interaction and exchange of knowledge.
- Contact list within the group of PLM consultants that should also support users to find colleagues with specific knowledge.
- Shareboard function, that should support sharing of explicit forms of knowledge as well as collaborative learning.
- Repository feature that should support sharing of learning material.

Furthermore, we evaluated perceived usefulness and ease of use of these four features in order to determine steps of the future development. Evaluation results showed that potential users considered these tools useful in their practice, and they also recognized benefit from knowledge exchange among colleagues. However, there was a doubt, expressed in discussions, regarding the use this knowledge sharing environment in the future.

When perceived usefulness of the Search function was evaluated, neutral answers on five questions drawn our attention. Two out of five participants had neutral opinion regarding these statements:

- *The Search function addresses my job-related needs;*
- *Search function can provide support to critical aspects of my job;*
- *Using Search function allows me to accomplish more than would otherwise be possible;*
- *Using Search function can improve the quality of the work I do;*
- *Using Search function can make it easier to do my job.*

It is unexpected that on, one hand, they agreed that this function is useful in their jobs and through discussions they recognized the purpose of the tool and benefit they could have through interaction with other colleagues, but on the other hand, they were neutral in these five statements. Furthermore, when the usefulness of the Contact list was evaluated, three out these five statements were rated positively even though the purpose of these two tools is the same. Both tools help users to find a colleague with specific competence and provide opportunities for social interaction.

Moreover, another unexpected result was that Shareboard feature was commended as *"a great tool"* by all of the evaluation participants. However, all of them also expressed doubts regarding motivation of their colleagues for knowledge sharing. Furthermore, they commented that it would unlikely be used at all. One of the participants also added that management should create an initiative to make consultants use this tool. These initiative could lead to further steps in development of the knowledge sharing project within Gothen Consulting.

Social and geographical boundaries in the consulting organization affected the evaluation of this four tools in this project. Therefore, evaluation method had to be adapted to the conditions and limit the time of discussions and tasks that participants had to perform.

# 7. Conclusions and recommendations

The findings show us that employees in consulting organizations have positive attitude towards the idea of sharing knowledge. However, it seems that there is lack of incentives and initiative due to the culture of the consulting business where communities is not prioritized.

Therefore, it is recommended that further development of this project focus on providing incentives for knowledge sharing the community of the PLM experts in Gothen Consulting. Moreover, assigning of knowledge sharing roles to members of the community could improve motivation as well as state of the knowledge sharing culture within Gothen Consulting organization. However, it would be helpful if the evaluation also included questions regarding  motivation for knowledge sharing in this practice.

Beside intrinsic motivation for knowledge sharing among individuals, it is recommended to encourage all group members to share by applying extrinsic motivation as well. Extrinsic motivation by assigning knowledge sharing roles can be presented further on in different ways. Some of them could be in terms of knowledge champions, for example, Teamcenter champions or CATIA champions of the PLM group in Gothen Consulting.

Recognition for person that is an expert with certain software tools could provide incentives for sharing. As recognized expert among peers and management, consultants  could improve their chances to be allocated to another site or customer site with better wage or to a higher place than previous position. It is known that acknowledged appreciation and recognition for work done is one of highest motivators in workplace [21].

Champion should research and find new tips & tricks in solving problems that others might encounter, and post them in a certain timeframe. Champions could also provide support to others to overcome barriers in organizational learning [22]. Therefore, individuals can be assigned to provide support and consultation for everyone else in specific areas, and also be available for every member of the group at any time. Thus, group could have a key person that possess special skills and competencies for selected category of PLM [23]. This consultant could also grow as an expert through research and work in the expertise and others could benefit as well

through collaborative learning.

All in all, use of knowledge sharing roles could be a substantial contribution to collaborative learning, and serve as positive contribution to sharing culture in consulting organizations.

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# 9. Project as an appendix

## Appendix 1. Template selection

Templates are organized in groups with several templates in each. Templates are offered for:

- *Collaboration*
  - **Team Site** - A site for teams to quickly organize, author, and share information. It provides a document library, and lists for managing announcements, calendar items, tasks, and discussions.
  - **Blank Site** - Can be customized based on individual's requirements.
  - **Document Workspace** - A site for colleagues to work together on a document. It provides a document library for storing the primary document and supporting files, a tasks list for assigning to-do items, and a links list for resources related to the document.
  - **Blog** - A site for a person or team to post ideas, observations, and expertise that site visitors can comment on.
  - **Group Work Site** - This template provides a groupware solution that enables teams to create, organize, and share information quickly and easily. It includes Group Calendar, Circulation, Phone-Call Memo, the Document Library and the other basic lists.
  - **Visio Process Repository** - A site for teams to quickly view, share, and store Visio process diagrams. It provides a versioned document library for storing process diagrams, and lists for managing announcements, tasks, and review discussions.
- *Meetings*
  - **Basic Meeting Workspace** - A site to plan, organize, and capture the results of a meeting. It provides lists for managing the agenda, meeting attendees, and documents.
  - **Blank Meeting Workspace** - Can be customized based on individual's requirements.
  - **Decision Meeting Workspace** - A site for meetings that track status or make decisions. It provides lists for creating tasks, storing documents, and recording decisions.

- ○ **Social Meeting Workspace** - A site to plan social occasions. It provides lists for tracking attendees, providing directions, and storing pictures of the event.
- ○ **Multipage Meeting Workspace** - A site to plan, organize, and capture the results of a meeting. It provides lists for managing the agenda and meeting attendees in addition to two blank pages for you to customize based on your requirements.
- ● *Web Databases*
  - ○ **Assets Web Database -** Assets database to keep track of assets, including asset details and owners.
  - ○ **Charitable Contributions Web Database** - Database to track information about fundraising campaigns including donations made by contributors, campaign related events, and pending tasks.
  - ○ **Contacts Web Database** - Contacts database to manage information about people that your team works with, such as customers and partners.
  - ○ **Issues Web Database** - Issues database to manage a set of issues or problems. You can assign, prioritize, and follow the progress of issues from start to finish.
  - ○ **Projects Web Database** - Project tracking database to track multiple projects, and assign tasks to different people.
- ● *Enterprise*
  - ○ **Document Center**  - A site to centrally manage documents in an enterprise.
  - ○ **Records Center** - This template creates a site designed for records management. Records managers can configure the routing table to direct incoming files to specific locations. The site also lets you manage whether records can be deleted or modified after they are added to the repository.
  - ○ **Personalization Center** - A site for delivering personalized views, data, and navigation from this site collection into My Site. It includes personalization specific Web Parts and navigation that is optimized for My Site sites.
  - ○ **Enterprise Search Center** - A site for delivering the search experience. The welcome page includes a search box with two tabs: one for general searches, and another for searches for information about people. It is possible to add and customize tabs to focus on other search scopes or result types.
  - ○ **Basic Search Center** - A site for delivering the search experience. The site includes pages for search results and advanced searches.
- ● *Publishing*
  - ○ **Publishing Site** - A blank site for expanding your Web site and quickly publishing Web pages. Contributors can work on draft versions of pages and publish them to make them visible to readers. The site includes document and image libraries for storing Web publishing assets.

- ○ **Publishing Site with Workflow** - A site for publishing Web pages on a schedule by using approval workflows. It includes document and image libraries for storing Web publishing assets. By default, only sites with this template can be created under this site.
- ○ **Enterprise Wiki** - A site for publishing knowledge that users capture and want to share across the enterprise. It provides an easy content editing experience in a single location for co-authoring content, discussions, and project management.

## Appendix 2. Evaluation - Search task description

Assume that you are an engineer that works with Product Data Management (PDM). You encountered a problem in your work and you have colleagues from Gothen that might have had a similar issue. Your task will be to find other members that have competence in PDM by using the Search function.

Search function is placed at the home page, on the right side of the screen, just above Contact list widget, you can type the PDM as search word and press enter in order to get results. Contacts are shown as names in results, you can click to open a Contact and see more information about a person.

In the results window, you can even narrow down results by choosing some of the offered tags. Choices for narrowing down the results are placed on the left side of the screen, Tags are placed on the bottom of this list.

Choose one of the offered results. If you can see that a chosen person have skills in PDM and you see his or her email that means that you succeeded in this task.

You can click NEXT then.

## Appendix 3. Evaluation - Contact list task description

Assume that you are a business analyst within PLM employed in CEVT. You would like to learn more about different perspectives of PLM in CEVT, and your intention is to find someone from Gothen that also works in CEVT in the PLM area.

Your task will be to use Contact list in order to find member which are also engaged in CEVT.

Contact list is placed in the navigation bar on the left side of the screen, and there is also Contact list widget on the right side of the home page. In the Company column you can even filter contacts and choose only those that work in CEVT.

If you succeed to find colleagues that work in CEVT and you see their email addresses your task is completed successfully.

You can click NEXT then.

## Appendix 4. Evaluation - Shareboard task description

Assume that you have valuable experience from a project you've been working on. In order to give advance warning to your colleagues in time, you would use Shareboard to do that.

Let's say that your project team migrated to new server machines in order to upgrade to Teamcenter 8.3. Unfortunately some PDFs did not open and showed an error "No compatible tool found". After a while your team discovered that instead of using The Image Viewer tool type it should be better to move to PDF_Tool tool type, therefore your team switched from PDFViewer to TCTwoDViewer in order to overcome the problem.

Shareboard have a widget in the middle of the home screen which makes opening of latest posts faster.

Besides that if you would like to post something you can open this tool from the navigation bar.

When opened, Shareboard shows categories on the left, posts in the middle of the screen and tools on the right side of the screen. In order to create a new post you should click on "Create a post".

Template is intended to make your writing easier there are several areas you can write into:

Title - which represents title of the post;

Topic - which should give more sense to a reader what this post relates to, such as Project, Tips & Tricks, Other or you can even specify it in your own words;

Category - this feature tags a post with keywords and then makes it easier to be found later on. In your case you might want to choose Teamcenter, but you can also choose more if you wish.

Subject / Brief description - should introduce readers what this post is about:

Body - where you share can your thoughts and describe issues and solutions you experienced.

Then it's just left to click on "Publish" and you shared an experience with your colleagues. This means that you succeeded in this task. You can click NEXT.

# Appendix 5. Evaluation - Repository task description

Assume that you want to look into documents presented in the last workshop. Your task is to find and open a document related to the PLM concept.

Repository is placed in the navigation bar on the left side of the screen named "Documents". Sub folder "Presentations" is place where presented documents are uploaded by the management.

File you look for is PLM_concept_ver9.

If you are able to find and open this file, your task is successful and you can click NEXT.

# Appendix 6. Search function questionnaire

## Questions regarding perceived usefulness

1. Finding specific person, competence or knowledge would be difficult to perform without Search function;
2. Using Search function gives me greater control over my contact or competence seeking activities;
3. Using Search function improves person or competence seeking performance;

4. The Search function addresses my job-related needs;
5. Using Search function saves me time;
6. Search function enables me to accomplish search tasks more quickly;
7. Search function can provide support to critical aspects of my job;
8. Using Search function allows me to accomplish more than would otherwise be possible;
9. Using Search function can enhance my effectiveness on the job;
10. Using Search function can improve the quality of the work I do;
11. Using Search function can increase my productivity;
12. Using Search function can make it easier to do my job;
13. Overall, I find the Search function useful in my job.

### Questions regarding perceived ease of use

1. I find it troublesome to use the Search function;
2. Learning to operate with Search function is easy for me;
3. Interacting with Search function is difficult;
4. I find it easy to get the Search function to do what I want to do;
5. The Search function is rigid and inflexible to interact with;
6. It is easy for me to remember how to perform tasks using the Search function;
7. Interacting with the Search function requires a lot of my time and effort;
8. My interaction with the Search function is easy for me to understand;
9. I fint it takes a lot of effort to become skillful at using Search function;
10. Overall, I find the Search function easy to use.

# Appendix 7. Contact list questionnaire

### Questions regarding perceived usefulness

1. Finding specific person, competence or knowledge would be difficult to perform without Contact list;
2. Using Contact list gives me greater control over my contact or competence seeking activities;
3. Using Contact list improves person or competence seeking performance;
4. The Contact list addresses my job-related needs;
5. Using Contact list saves me time;
6. Contact list enables me to accomplish search tasks more quickly;
7. Contact list can provide support to critical aspects of my job;
8. Using Contact list allows me to accomplish more than would otherwise be possible;
9. Using Contact list can enhance my effectiveness on the job;
10. Using Contact list can improve the quality of the work I do;
11. Using Contact list can increase my productivity;
12. Using Contact list can make it easier to do my job;
13. Overall, I find the Contact list useful in my job.

### Questions regarding perceived ease of use

1. I find it troublesome to use the Contact list;
2. Learning to operate with Contact list is easy for me;
3. Interacting with Contact list is difficult;
4. I find it easy to get the Contact list to do what I want to do;
5. The Contact list is rigid and inflexible to interact with;
6. It is easy for me to remember how to perform tasks using the Contact list;
7. Interacting with the Contact list requires a lot of my time and effort;
8. My interaction with the Contact list is easy for me to understand;
9. I fint it takes a lot of effort to become skillful at using Contact list;
10. Overall, I find the Contact list easy to use.

# Appendix 8. Shareboard questionnaire

### Questions regarding perceived usefulness

1. Sharing knowledge or reading about an experience would be difficult to perform without Shareboard function;
2. Using Shareboard function gives me greater control over my knowledge seeking or knowledge sharing activities;
3. Using Shareboard function improves knowledge sharing performance;
4. The Shareboard function my job-related needs;
5. Using Shareboard function saves me time;
6. Shareboard function enables me to accomplish knowledge sharing tasks more quickly;
7. Shareboard function can provide support to critical aspects of my job;
8. Using Shareboard function allows me to accomplish more than would otherwise be possible;
9. Using Shareboard function can enhance my effectiveness on the job;
10. Using Shareboard function can improve the quality of the work I do;
11. Using Shareboard function can increase my productivity;
12.  Using Shareboard function can make it easier to do my job;
13. Overall, I find the Shareboard function useful in my job.

### Questions regarding perceived ease of use

1. I find it troublesome to use the Shareboard function;
2. Learning to operate with Shareboard function is easy for me;
3. Interacting with Shareboard function is difficult;
4. I find it easy to get the Shareboard function to do what I want to do;
5. The Shareboard function is rigid and inflexible to interact with;
6. It is easy for me to remember how to perform tasks using the Shareboard function;
7. Interacting with the Shareboard function requires a lot of my time and effort;
8. My interaction with the Shareboard function is easy for me to understand;

9. I fint it takes a lot of effort to become skillful at using Shareboard function;
10. Overall, I find the Shareboard function easy to use.


# Appendix 9. Repository questionnaire

## Questions regarding perceived usefulness

1. Finding or sharing specific document would be difficult to perform without Repository;
2. Using Repository gives me greater control over my document seeking and document sharing activities;
3. Using Repository improves document seeking and sharing performance;
4. The Repository my job-related needs;
5. Using Repository saves me time;
6. Repository enables me to accomplish document tasks more quickly;
7. Repository can provide support to critical aspects of my job;
8. Using Repository allows me to accomplish more than would otherwise be possible;
9. Using Repository can enhance my effectiveness on the job;
10. Using Repository can improve the quality of the work I do;
11. Using Repository can increase my productivity;
12. Using Repository can make it easier to do my job;
13. Overall, I find the Repository useful in my job.


## Questions regarding perceived ease of use

1. I find it troublesome to use the Repository;
2. Learning to operate with Repository is easy for me;
3. Interacting with Repository is difficult;
4. I find it easy to get the Repository to do what I want to do;
5. The Repository is rigid and inflexible to interact with;
6. It is easy for me to remember how to perform tasks using the Repository;
7. Interacting with the Repository requires a lot of my time and effort;
8. My interaction with the Repository is easy for me to understand;
9. I fint it takes a lot of effort to become skillful at using Repository;
10. Overall, I find the Repository easy to use.


# Appendix 10. Links to evaluation questionnaires

● Search function evaluation - https://docs.google.com/forms/d/1hAe6gxZEnr_yplbTFH9r1eRD8wql8X3Cwn8ekIs998E/viewform?c=0&w=1
● Contact list evaluation - https://docs.google.com/forms/d/1YyRymiy_Hwbi-3s7jgJjqwWbMu3vfaBls-IbXJf9fUc/viewform?c=0&w=1

- Shareboard evaluation - https://docs.google.com/forms/d/1WKc6UOobnl0rE2fXKPE4653gQh-lazj3Zgcqmrnlm Mk/viewform?c=0&w=1
- Repository evaluation - https://docs.google.com/forms/d/1Ezqw38u5VXvP2wpLnuNPnYEARiJgTzLnoN9 NqUmzUX4/viewform?c=0&w=1