Experience Feedback Using Social Media: From the Product Lifecycle Phases to the Design Practices

Koteshwar Chirumalla, Marco Bertoni, Christian Johansson

Product Innovation, Division of Innovation and Design
Luleå University of Technology, SE-97187, Luleå, Sweden

{koteshwar.chirumalla, marco.bertoni,
christian.johansson}@ltu.se

Abstract. Many companies have been using lessons learned practices as one of their key knowledge management initiatives to capitalize on past experiences. For product development companies, learning from product lifecycle phases gives a true competitive advantage to improve the next generation of products. However, companies are still struggling in capturing and sharing lessons learned and applying them in new situations. Based on this consideration, the paper proposes a video-based approach−using social media technologies−as a way to leverage continuous capturing and sharing lessons learned from product lifecycle phases to design practices. The paper presents the findings of a case study within the aerospace industry, which investigates the current industrial practices with regard to experience feedback, and illustrates the implementation of a video-based approach. Further, the conceptual mock-up of video-based lessons learned sharing portal and its social platform that are aimed to support the design practices are illustrated.

Keywords: Experience Feedback, Design Practice, Product-Service Systems, Experience Sharing, Lessons Learned, Web 2.0, Social Media, Video Sharing.

1 Introduction

Learning from experience for competitive advantage has received a great deal of attention in recent years [1] [2]. Since product development is an iterative problem-solving process [3], many companies have been using past experiences in form of lessons learned to guide the design of future products in order to avoid reinventing the wheel each time by accessing its past mistakes or successes [4] [5]. Managing experiences is becoming even more important as manufacturing companies are undergoing a fundamental shift in their business operations and are increasingly moving away from the selling of products to the provision of services or Product-Service Systems (PSS) [6] [7]. At an extreme side of this product-service journey, companies are offering 'function of the product' instead of hardware, retaining ownership and responsibility for the product throughout its entire lifecycle [7]. This affects the way new products are conceptualized and designed in the early phases, wherein the focus is shifted from satisfying artifact's physical characteristics to reducing the overall product lifecycle

costs while maintaining performance efficiency [8]. In this setting, reuse of experiences from different phases of product lifecycle, such as business, design, manufacturing, usage, maintenance, and recycling, play a key role to support design teams to address the relevant lessons from the past issues in new designs [9] [10].

Researchers have proposed different approaches to address this gap in a PSS setting. Baxter et al. [11] proposed a knowledge base structure grounded on three core elements of knowledge such as design, manufacturing capability and service to support the design activity. Vianello [6] proposed a documentation model to reuse of knowledge from the service phase of complex products and has identified that the designers require in-service information at a component level to improve next generation of products through design. Further, studies, for example [12] [13], develop KBE [12], PLM [13] based solutions to capture, analyze and reuse both manufacturing experiences [12] and product use experiences [13] in the new designs. However, the current research on experience feedback primarily based on explicit (objective, codified) field data e.g. condition monitoring, operation and service data and statistical databases, there is very limited focus on utilizing experiential learning that occurs through tacit (subjective, implicit) knowledge and social interactions. As highlighted by Clarkson and Eckert [14], "*traditionally, large amounts of knowledge and experience are never written down and are only stored in the heads of individuals* (p. 328)". Lessons learned (here after referred as "LL" in the text) practices are therefore failed to deliver the intended results as lessons are identified and are often not followed through and applied within the organization [15]. Furthermore, LL practices are limited to a 'single department' or to 'specific projects', lacking contextualized information for reuse it in the new situations [16]. Major issues also refer to staff turnover, reassignment of people to the new projects, time-consumption for capturing LL as well as the time lapses in LL capturing [4]. Hence, there is a need for practical, easy, social-based approach that can help organizations to regularly capture and share LL from product lifecycle phases to early design practices.

On the authors' advice, Web 2.0 or Social Media technologies look particularly interesting to enable capturing and sharing of individual/team experiences and tacit knowledge, as well as to improve communication across functional and organizational boundaries [17]. Accordingly, the objective of the paper is to propose a video-based approach−using social media technologies−for capturing LL from different product lifecycle phases and feed that back to early design practices. The paper presents the findings of a case study within the aerospace industry, including the current industrial practice with regard to experience feedback and the implementation of a video-based LL approach. Further, the conceptual mock-up of video-based LL sharing portal and its social platform that are aimed to support the design practices are illustrated.

2 Experience feedback and social media: a literature review

Experience Feedback is a knowledge management initiative whose objective is to convey experiential knowledge or lessons learned applicable to an operational, tactical, or strategic level such that, when reused, this knowledge positively impacts on the results of the organization [4]. The lessons learned from problem-solving include:

lessons about the domain, lessons about how to find information that is useful to the problem-solver, and the information about the resources that are useful in particular contexts [18]. Several researchers identified that narratives and story telling give the richest opportunities for articulating and sharing tacit and experiential knowledge [5] [16], especially when the lessons are *high-context and situation specific* [2]. Milton [2] stated that a story could support a lesson by providing valuable background and context, facilitating to understand the context when a new person reviewing the lesson, thereby guiding the person whether it applies within the new context or not.

In this perspective, videos seem to be a well-suited medium for supporting tacit knowledge transfer, because they bring rich context−not detached and compartmentalized like text [19]. A recent McKinsey study [20] found that video sharing is one of the most adopted social media tool in companies (i.e., top 3 with 38%). Videos are especially useful for scanning the external environment and capturing subtle and complex aspects of performed activities and to represent overviews of key dynamic processes [21]. Web 2.0-enabled capabilities facilitate video hosting services, which could allow individuals to upload video clips to Internet websites to capture and communicate stories with a richer and more dynamic content [22]. Additionally, Web 2.0 offers annotations, tagging, bookmarking, commenting, editing, and ranking functionalities [17] to increase the ability to share, network, find and discuss videos across dispersed boundaries. According to a 2010 survey among advanced manufacturing industries [23], social media tools (such as: social networking sites, video sharing, blogs, wikis and micro-blogs) are beneficial to share best practices and to quickly identify experts based on content they have uploaded on their profiles or conversations held on accessible social platforms. Wood et al. [21] investigated using videos to elicit and transmit the tacit nature of skilled practices and have created a wiki-based learning resource for novice craft practitioners, which offered a more flexible way of developing and refining their crafting skills. Further, Shariff et al. [24] added features to LL systems to allow users to upload media files, such as pictures and videos, to support a socialization process as well as to promote lessons reuse.

3 Methodology

The paper is based on a case study [25] performed in collaboration with an aero-engine component manufacturer, which develops and manufactures components for gas turbine-, aircraft- and rocket engines. The company usually acts as a design-make supplier to major aero engine manufacturers, in various product and technology development projects. The company works as an independent risk and revenue sharing partner, and assumes responsibility for certain engine components, from design, manufacturing, to maintenance services throughout the entire lifetime of an engine type. The company has recently implemented a Design Practice (DP) System to capture and structure product specific activities and related methods for each component against stage-gate product development process [26]. The system encompasses *flows, activities,* and *methods* to guide design and development work. The DP *flow* indicates which *activities* to be done, in which order, within a project phase, for a specific engine component. The documents related to *activities* and *methods* are stored in DMS

(Document Management Systems) and searchable in DP system. The case study has been performed on DP system to identify solution alternatives to foster experience and lessons learned sharing across product lifecycle phases regardless of projects and organizational boundaries. Empirical data has been collected through observations at the company and interviews with DP system and product lifecycle stakeholders, which include engineers, system owner, business developer, design leaders, manufacturing and quality leaders, process owners, and product support leaders. The interviews and observations are focused on three things: First is to develop a richer understanding on current management of experience feedback along the product lifecycle phases. Second is to get feedback on the applicability of using video-based approach that is proposed by the authors. Third is to perform testing activities at the companies' facilities to verify the integration with the DP system. This paper is based on the case study results from testing the video-based approach and the conceptual scenarios that were discussed to support the DP system with continuous experience feedback.

4 As-Is practice in experience feedback: an example

Since the case company is moving forward to take over the product lifecycle responsibility, the product support team is dealing with operational problems of components wherein they have not been involved during the design of these components. The team is therefore increasingly searching for past experiences or the answers to the decisions that have been taken previously. For instance, what we have agreed with the customer? Why? Who took certain decisions on what basis?

Figure 1 illustrates an example for identifying past experiences when a product support personal received a problem from the customer. If it is an easy or known problem, the personal knows whom to contact to resolve the problem or get some help to know the references to old reports in the DMS. If it is an ill-defined problem, then there are mainly three options available to resolve the situation, including: asking seniors or colleagues in their department, searching in the DMS, or raising the issue in the weekly department meeting. If any senior is familiar with the problem, then he/she can send some old reports or else recommend a person X that could be helpful. The person X could send some reports in case he/she understands the problem by phone or email, otherwise, he/she may request for a meeting to discuss the issue further. The meeting might be helpful to identify some past experiences. If not the knowledge seeker will inform the project team that there was no past experience available to the given problem and there is a need to come up with a new solution by performing an analysis. Alternatively, the person can search for the past experiences in the DMS. However, in the DMS, one can only search with the title names if he/she knows what to look for in the DMS. For example, if one can type the word "milling" in the search title, then he/she will get all the documentation that have the title name milling. The person has to open all the documents to check if there is any relevant document. If there were any document outside of his/her working context, then he/she wouldn't have the access to open it. In that case he/she needs to make a request to access them. Once the personal gets the access, he/she reads the documents. If there is any relevant document, then the personal usually gives a call to the person who wrote that docu-

ment or the people who were working in that project to make sure that this past experience would applicable in his/her context.

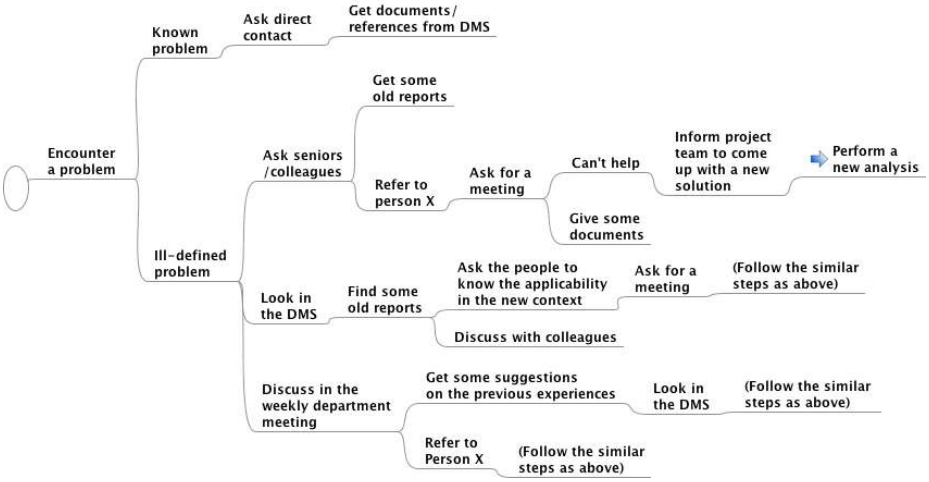

Fig. 1. An example for identifying past experiences in the product support phase

Figure 2 illustrates how the experience feedback is usually happened in the above example. In case the problem is a smaller issue, the product support personal documents a short analysis report. If it is a damage or non-conformance, then the personal has to dig into the archives in correspondence with the supplier and the customer and summarize the results in a "summary report", including answering questions such as why the problems were occurred? What they were discovered? What decisions were taken?

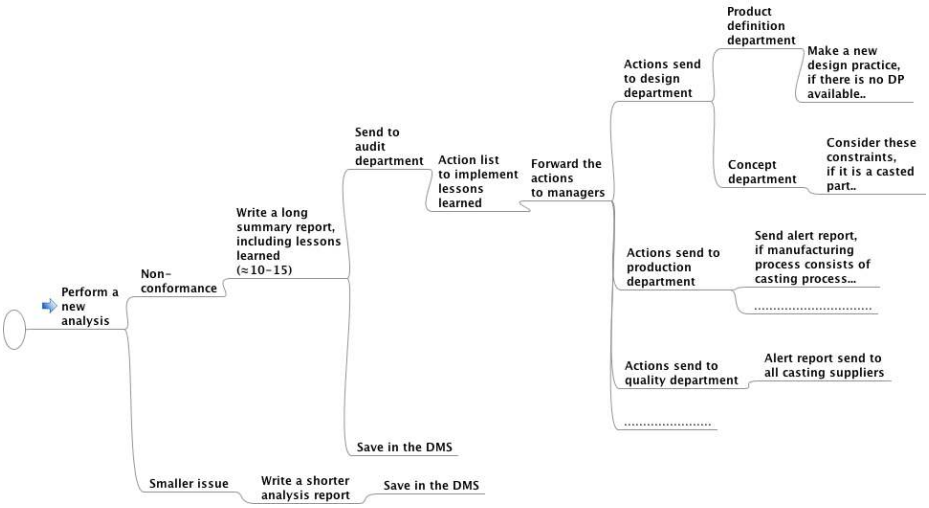

Fig. 2. Experience feedback process from the product support phase for the above example

From this report, 10-15 lessons learned are identified in order to make a list of actions to the different departments to avoid repeating the same mistakes again in the next products. The audit department usually makes the follow up and is informed to different managers to make actions in their respective departments as shown in Figure 2. According to the informant most of these lessons are useful in the pre-study and concept study to inform the designers: "*you should think about this if you design a part that goes in to casting process*". If the lesson might have to do with the definition work, then it needs to go to product definition department to make a new DP in case there is no DP available, otherwise it adds to the checklist in the design review process. If the lesson is regarding the casting manufacturing process, then it can result in an alert report, which can be sent out to all casting suppliers with the recommendations. Eventually, this "summary report" is stored in the DMS with references to other reports. However, people that are working in the same project can only access to this document. Other people can see that there is a document, but they cannot open it. "*I don't know how these lessons learned that we identified is actually spread to other projects and departments*" described the informant. By commenting on identifying experiences he said that: "*of course this knowledge is only comes to me because I am the one is asking for it. It should be stored some where. So everyone could see it, right?*". The problem in documenting the lessons learned report from the projects is highlighted by one of the informants: "*[I think] no one really wrote those reports anyway. Because they thought it is not so important…we are so busy writing the reports we need to, for the clients. They require certain numbers and types of reports. That's what we focus on. This lessons learned template is something you have to do when you get sometime over…I would say [that] those reports have a low priority*".

The above example evidently illustrates the difficulty in documenting, identifying and accessing the past experiences and is emphasizing the importance of personal networks and social connections in the experience feedback process.

5 Experience feedback using social media: an approach for capturing lessons learned through videos

The preliminary experimental results at case company identified that videos are beneficial for capturing lessons learned (LL) as they can capture the context of dynamic problem situations and that reduces time-consuming manual processes while capturing lessons in a continuous manner compared to a more text-based approach of documenting LL. However, capturing an LL video is not merely about making a video with some stories from a project. The LL video must be factual, technically correct, valid and applicable to specific tasks and processes. Hence, the authors have developed a method for capturing LL videos as a means to provide the structure and to lower the threshold for the people who want to share their lessons. The method to structure the LL videos contains seven steps as shown in Table 1. Each step has a set of guiding questions to support the users in formulating their message in a clear, concise, and informative manner for each section of the LL video as shown in Table 1.

The video-based LLs process consists of six stages, including: (1) Identifying the LL during an activity, (2) Preparing and formulate a LL story using the steps and guidelines in the below LL template, (3) Recording the LL video, storing and sharing

with proposed tags and secrecy level settings, (4) Validating and disseminating the LL with secrecy level and tags settings, (5) Searching and retrieving the LL using the tags, and (6) Reusing the LL in new activities.

Table 1. Layout of lessons learned capturing template in the proposed video-based approach

No	Steps	Guidelines	Notes
0	LL State-State-ment	Shortly summarize the main points about this lesson and why it is important for others to know.	
1	Working Context	**Describe the background of the task:** Name of person, job role, product type and project name? What is the operational level of the task within the product development process? Who are the stakeholders?	
2	Task Descrip-tion	**Briefly describe the task:** How was the task planned/ exe-cuted? What key parameters or tools were used? What are the conditions when the task was executed?	
3	What Went Wrong or Well?	**Describe problems/successes that you came across dur-ing the activity:** What was the problem/favorable outcome? Where/How did you identify the problem(s)/favorable out-come? What is the effect of the problem(s)/success on task execution?	
4	Lesson Learned	**Describe the lesson that you learned:** What are the root-causes of problem/success? What steps have you undertaken to solve the problem or to find the success? How can the problem be avoided or how can the success be repeated?	
5	Lesson Learned Measures	**Describe the measures to the improved solution of the problem(s):** How can your LL improve the problem area or success area? How would you quantify the change/ im-provement compare it with pre-existing solutions?	
6	Applica-bility and De-limita-tions	**Describe the applicability or delimitations of the lesson learned:** Who are the potential beneficiaries of your lesson? Where can the lesson be applicable? What is the level of quality? What additional activities are necessary? What are the limitations of your lesson?	

The LL contributor records the LL video and proposes several tags on the basis of job role, project name, product type, lifecycle phase, discipline, area of impact, stake-holders and validator, to make the LL searchable. Further, contributors can propose the name of a validator or specialist in the LL area for approving their LL video in a rapid manner. Additionally, the contributors can propose a "secrecy level" to their LL from scales 1 to 4 to enhance privacy and confidentiality for sharing sensitive lessons from the projects across boundaries. Based on the case observation, the study identi-fied 4 secrecy levels. Following the LL contributor request for approval of their LL video, the proposed validator gets the alert message to review the LL. The validator can go through with the dissemination settings proposed by the LL contributor and approve it with minor or major changes. The knowledge seekers search for the LL

videos based on the tags defined in the system and can add their reflections, comments and rankings after their usage of LL.

YouTube® (www.youtube.com) has served as a video repository during the first round of experiments and as a portal for testing basic tagging and annotation functionalities. A number of other video hosting services have been further analyzed to identify functionalities able to cope with the needs emergent from the empirical study. These include annotating, tagging, commenting, bookmarking, ranking/rating, aggregating and embedding functionalities. Based on the gathered user needs, all the required features were drawn and mapped against the list of functionalities. Eventually, this led to the conceptual mock-up of video-based LL sharing portal with the following interfaces shown in Figure 3.

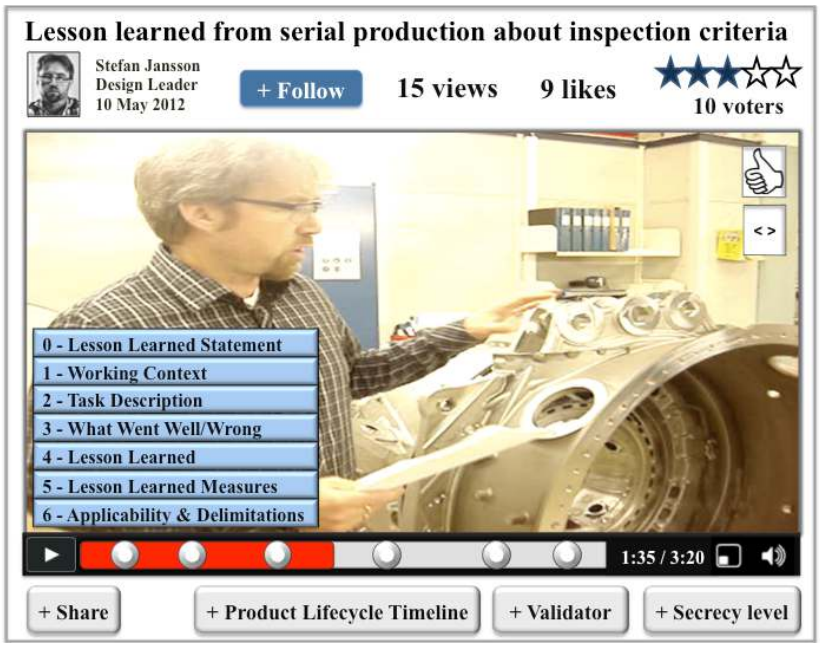

Fig. 3. Conceptual mock-up of Video-based LL sharing portal with functional interfaces

As seen in Figure 3, the LL video displays annotations of LL template topics/steps as an overlay on top of the video. The observations showed that this way of representing the LL videos allows the knowledge seekers to browse for interesting topics of LL instead of going through whole video. Additionally, the experimental observation also considered having "browsing points" on the video status bar, which symbolize the 7 topics in the captured LL story. The observations also revealed that these capabilities built on top of the LL video could allow the users to browse and absorb many LL videos in a shorter time span. The empirical observations highlighted several bookmark links to be considered in the platform, including, but not limited to, "share", "product lifecycle timeline", "validator" and "secrecy level". For instance, the "Share" bookmark link can facilitate an LL contributor to quickly add video clips to the project blogs, intranet, departmental sites, and so on.

6 Benefit of the approach for industrial use

According to the previous research [6], design teams like to access the past experiences at a component level. However, the As-Is practices are majorly ad-hoc, project-based which does not support the designer to access the past experiences at a component level with a richer context. The company is changing the process flows within DP system based on LL reports, eventually missing the rationale why they have changed a certain process. As observed during the study, DP system lacks support for handling the lessons learned from various projects, especially concerning lessons from the downstream processes such as manufacturing, serial production, product support and maintenance. Furthermore, the study found that the lessons with high-context such as casting and welding operations are harder to explain and report in the text-based document. Video-based LL approach could allow product lifecycle stakeholders to capture the lessons with an illustrated story and share it to the product lifecycle timeline per each component as shown in Figure 4. Within the DP system, this practice could allow designers to access related LL from various projects on the same page together with the best practice documents. In this way, videos can carry a learning point that is specific, actionable recommendation to the component designers in the early phases, enabling to access more context-specific lessons compared to the traditional project-specific lessons learned documents. Such practice can help continuous capturing and disseminating of the lessons learned from the downstream processes, which could help the design teams accessing properties governing lifecycle behavior in the early conceptual stage per each component.

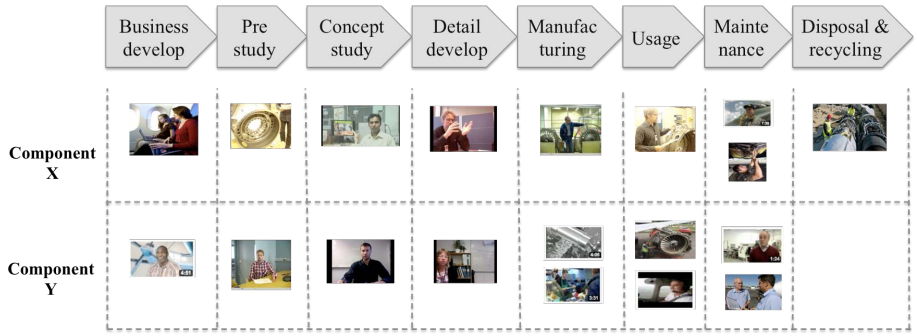

Fig. 4. The conceptual view of sharing video LL from product lifecycle phases to DP system

Another technology enabler for developing social ties across organization is to leverage conversations around LL videos. The study found that adding commenting functionalities related to the LL videos allow other people in the organizations go through the video and add their relevant comments to the LL story. In addition, adding "like," rating, follow the user and "embed" social features in the portal enhances the bottom-up and social networking capabilities across boundaries. Based on preliminary experiments, the LL video-based approach, in this way, can capture the rich context of lessons learned and feed that back to early design practices, thereby leveraging cross-functional sharing and networking across borders.

Based on the proof of concept validation at industrial environment, the study proposes a conceptual mock-up of video-based LL social platform—with using social media technologies—for capturing and disseminating the experiences across boundaries. The major functions considered in the platform are video portal, network profiles and discussion space, including the basic interfaces such as search, tag cloud and dashboard (See Figure 5). A *Video Portal* is intended to contain a variety of LL videos, which are classified under the approved tags by the validators. When designers who are seeking for specific experiences from past projects can access the relevant videos based on the tags. As they click on the relevant video, they can view the video with annotations of LL topics, the entire tags and comments as shown in Figure 5.

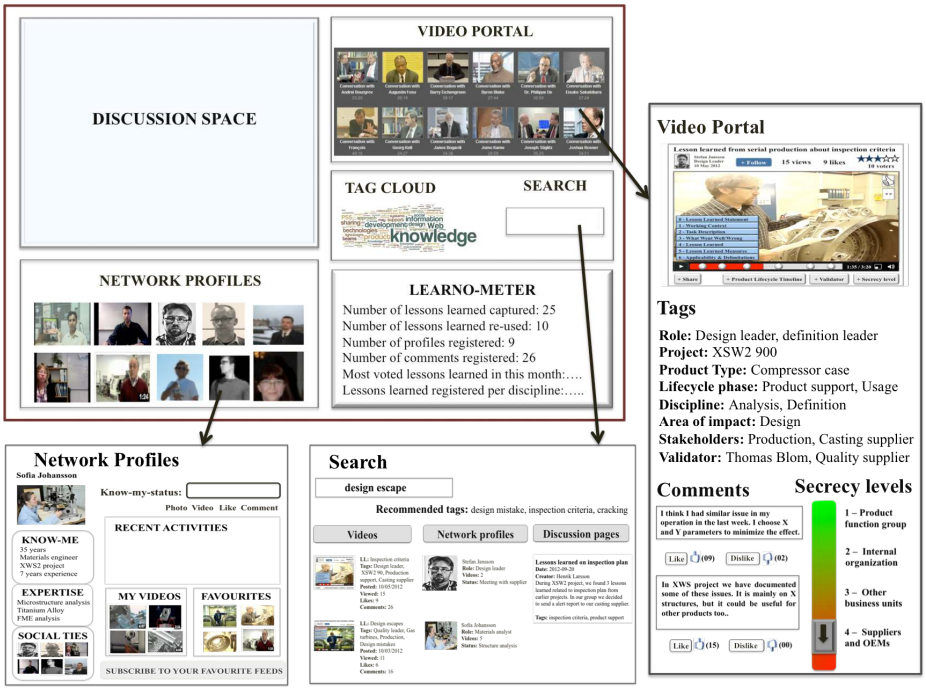

Fig. 5. The conceptual mock-up of a proposed video-based lessons learned social platform

Further, the *Network Profiles* is intended to contain the profile pages of LL contributors. Every LL contributor can create their profile pages and user name when they uploaded their first LL video to the platform. In profile pages, every user can see their LL videos and save other relevant LL as their favourites on basis of their job roles and working projects. In the network profile, every user asks to enter their skills and later these skills are tagged into the system as "expertise". Additionally, the users can see their social ties, recent activities as well as subscribe to the favourite feeds they are interested in. This will enhance the social networking capabilities across different departments. Another functionality considered is a *Discussion Space*, which is in nature more of a blog and wiki combination. Blogs can be used to capture and leverage conversational knowledge across boundaries. For instance, blogs can be used to

discuss the past experiences and LL search results before the gate meetings. The wiki functionalities in the blog can enable to combine different LL videos at the end of each stage-gate and to create a summary of LL practices as a Wiki page from the specific project. The *Search* function is intended to allow the knowledge seekers to search for the relevant LL from previous projects by entering the keywords. The platform can also recommend relevant tags for the user based on the key words they have entered in the platform. While searching for past experiences, the search function will be able to show the LL videos, network profiles and the discussion pages relevant to the key search word. Moreover, the learno-meter, a *Dashboard,* is intended to visually displays the quantify numbers of LL capturing and reuse for estimating the performance of the tool. Finally, the *Tag Cloud* in the platform is intended to gather various tags created in the system (i.e., tags from LL videos, network profiles and discussion pages) and present the visual display in an abstract manner. This way of structuring knowledge in a bottom-up manner could assist both management and operation levels to see what is the current 'hot' topic in the organization as well as within the platform.

7 Concluding remarks and Future work

This paper has proposed a video-based approach–using social media technologies–as a way to lower the threshold for continuous capturing and sharing lessons learned (LL) from the product lifecycle phases to the design practices, supporting front-loading in product development by enabling experience feedback from product lifecycle phases. The approach encompasses a LL capturing template, guidelines, process description and technological enablers. The approach is based on a 7-step template, which is intended to facilitate the capturing of contextual information and tacit knowledge compared to what is already available in literature. Preliminary verification activities have shown such a solution improves the preparation and formulation of LL in a story format compared to other traditional templates and recording means. The study identified that the video-based approach is beneficial to give manufacturing, operational and maintenance inputs to early phases of design practices at a component level. In the future, the study will extend to the development of a full-scale prototype system, using open-source video sharing applications. The prototype will serve the purpose of testing the viability and performances of approach by experimental means, observing and analyzing through a range of experiments how social media mechanisms can support designers by enabling experience sharing across product lifecycle phases in emerging product development trends such as PSS.

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