Notice Board as Metaphor for Social Media Service in Chemical Factory

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Abstract. Work in paper and chemical factories include controlling several processes and cooperating with several workers. This needs lots of awareness and information sharing. Breakdowns in information sharing can lead to low quality production and unsafe work situations. During last couple of years different social media and web 2.0 applications and services have become popular ways of sharing information in leisure environment. We created a prototype from social media perspective to respond the needs in information sharing in factories. Our electronic notice board prototype (El Nobo) uses a metaphor from process operators' current work environment and is designed to face the specific needs that occur in the chemical factory process operators' work. The prototype aims to introduce social media type of working practices to process control work and to test the possibilities of informal cross-organizational information sharing in industrial settings.

Keywords: Awareness, Control room, Factory work, Prototype, Process controlling, Social media, User interface, Web 2.0.

1 Introduction

Controlling complex processes for example in paper and chemical industries is a challenging task. Even a seemingly small factory contains several states, items and personnel working with it, and operating larger factories definitely isn't a simple and straightforward assignment. For example chemical plants usually include multiple interlinked production units and processes. Thus process control work requires lots of collaboration between workers both inside the unit and between various units in a factory complex. Information sharing is an important part of this collaboration and also the process itself requires a lot of attention to ensure production quality and staff safety. [1]

For example our studies revealed a situation, where factory 1 didn't inform to factory 2 that they cannot receive all the raw material factory 2 produces. This lead to a pile of mixed type raw materials outside the factory and they couldn't optimize the production of such deteriorated materials. It is quite unlikely that lack of information would lead into tragic accidents, but minor mishaps might happen if correct information is not reported to the right person.

User research conducted at a chemical plant in Finland showed that the process operators need practical ways and tools to share information about their current tasks and process situation between the different production units of the chemical plant. Based on the user research findings an awareness-sharing tool was designed and a prototype of it implemented. The designed tool utilizes notice board metaphor and aims to increase informal communication between the control rooms of the chemical plant. The prototype is implemented with Flash and Java.

2   Background

Traditionally work related collaboration and information sharing has been studied in the field of Computer Supported Cooperation Work (CSCW). CSCW describes how people use technology in shared time and/or space [2]. There are several different combinations with time-space relations and the relation needed should be considered precisely in the system design [3]. For example, in work shifts the users work at the same place, but at different times. This would set a different kind of approach to the system design compared to a system for cooperation between different control rooms, where the users work at the same time, but at different places. Cooperation might vary from close user related cooperation to distant system related cooperation and this creates different kind of approach to design compared to traditional multi-user systems [4]. There is a practical need to design computer and communication tools to support cooperation and to harness the collective human resources [5].

During last couple of years different social media and web 2.0 applications and services have become hugely popular ways of sharing information in leisure time settings. The promises of these technologies, i.e. facilitating flexible design, creative reuse, and user centered content, providing a rich user interface, facilitating collaborative content creation, establishing social networks of people with common interests, and helping to gather collective intelligence [6][7], are very interesting also from work and industrial perspective.

Utilizing social media services in work context can be problematic. The services seem to promote practices and ways of working that require companies to change their work cultures. For example social media services promote freedom of organizing and interest based connections and collaboration whereas in work context there usually is a predefined organizational structure and also defined tasks and duties. In addition the social media services promote such openness in reporting ones activities that it can awake resistance in companies and business settings. [8]

Central theme in both CSCW and current popular social media services, such as Facebook and Twitter, is awareness. Awareness is providing and receiving information to and from others regarding one's current activities. In a strict environment, like in a control room, the awareness is more depending on the situation. Endsley describes situation awareness as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" [9]. Endsley divides situation awareness into three levels [10]. At level 1 worker picks up elements from the environment. At level 2 he or she creates an understanding of the current situation. At level 3 he or she forms a projection of future state and decides possible actions to achieve or avoid the upcoming state.

The provider of the information must consider what is important information and how to present it. The provider can choose the amount and format of the provided information and thus has more power in the information sharing process, but the provider might be unmotivated and elude the exchange if he or she doesn't gain anything from it. [11]

The receiver must access the information and understand what it means. With the information, the receiver is up to date with related activities and can thus direct his/her own work to preferable ways or get well prepared to possible problems [12]. It is rather important to understand what information avails the receiver [11].

The shared information might have different meaning to different user groups depending for example on their experience and role [13]. A person who has been working for a long time might have encountered similar situation before and can make an assumption from certain signs that something needs to be done. On the other hand a person working on a specific part of the process might understand that a certain problem at another part of the process might affect on his or her part of the process, while others wouldn't understand this. Flexibility is needed to support different kind of work and users [4]. It is important to have right amount of information. Clearly scarce amount information might leave out something important that is actually needed, but having too much information might confuse the receiver [14]. Besides, receiver can also make some assumptions if the awareness information is not received [14]. For example it can mean that the provider is busy and unable to provide information.

2.1   Work Environment and Users in Chemical Factory

The user research revealed that currently the operators are sharing information with other operators, maintenance personnel, process experts, field workers, automation specialists and transportation personnel. Information is shared in several ways. Important information to other places is provided with telephone or radiophone and long-term information, like announcements and task history, is provided with notice boards and electronic operation diaries. The face-to-face conversations are of course used when possible.

There are also work practices related to the information sharing. For example information about the recent events at the production unit and special notions about the state of the process are shared regularly at the shift changes. State of the machinery and for example wearing is monitored actively and maintenance is contacted preferably before anything gets broken. There are also other situations where operators wish to predict the problems to avoid critical situations. These occasions might need information sharing that deviates from the usual pattern.

Most of the information is related to monitoring, controlling and developing the manufacturing process. There is also information exchange regarding general events, like visitors, power consumption and maintenance. Maintenance includes needs for repair persons, executions of repairing and cleaning the machinery or their surroundings. The biggest information sharing needs are related to cross-organizational communication, i.e. information sharing between the different production units. Since the production units are interlinked the operators need to know about those events in other production units that result to disturbance in e.g. material flows between the production units.

Operators' tasks include monitoring and controlling the process with automation systems [1]. The control room is isolated from the actual production centre and it is filled with monitors, charts, manuals and communication devices. The monitors show several statistics, process state diagrams and machine details which need to be observed constantly and in certain occasions readjusted.

The operators vary from young and inexperienced to older and more experienced ones. They have solid, at least average computer skills, and they are capable of handling regular computer software, like web browsers and email-programs. Their education background varies, but all of them are trained to operate automation systems.

3   Electronic Notice Board Prototype

As mentioned previously there is a clear need for operators of chemical factory to do information exchange in various kinds of combinations of time and space. The daily information exchange varies from face-to-face meetings during the shift change to sending messages for supply orders. Our aim was to support sharing of awareness information and to try out how social media tools could be fitted in chemical factory context. Our previous prototyping efforts indicated that social media tools can require changes in users work practices and also in organization level of utilizing companies [15]. Hence the designed tool and prototype did not utilize all possible social media functionalities but focused on quite straightforward information sharing.

With high fidelity interactive prototype the users can gain a hands-on experience of the system in real environment doing their actual tasks. This is pretty much the closest possible way to attain realistic user experience without actually implementing the final system. We built a simple prototype that utilizes a metaphor of notice board and gives factory operators a possibility to share notices of their current situation between multiple process control rooms. One aspect of the prototype is to allow and encourage the users to learn the use of community related interaction methods and social media. The system will not replace current communication methods but gives the users some new features to work with together with the old methods.

Our prototype gives solution to the problems users are currently having with information sharing in chemical factory environment. The aim is to let users share any information they might assume to be interested by other users. It is more up to the receivers to choose if the information has any value to them. Users can also present open questions to everyone and those who happen to know the solution can answer to the questions. Without knowing exactly whom to ask it is impossible to present such questions e.g. via telephone. This should encourage the users to share more information related to their work and thus improve the quality of the process and reduce problems related to it.

3.1   Prototype Description

Electronic notice board (El Nobo) is a notice board shared by three work shifts in four different control rooms. Visually El Nobo reminds a real cork surface notice board with notes attached to it with pins (Fig. 1). Users can write new notes to the board, which are then shared to other locations through a server (Fig. 2). Each user can move and order the notes in his or her preferred way. Important notes can be placed in the

Fig. 1. Overview of the prototype with five notes on the board. The highlighted note is a new one. On the right side is symbols for new note (top), trash can, settings and quit.

center and uninteresting ones can be removed from the view. Each note displays the time it was written and the location it was received from. The interface is implemented in Finnish to match the users' language. In traditional tools, like in e-mail, messages are presented as a list or a tree. However, the El Nobo user interface allows the users to handle messages in two dimensions, which provides new possibilities to arrange the information.

The users don't have individual user accounts to El Nobo, but they have accounts to the factory complex's intranet, which they use to log in at shift change. The intranet cannot be accessed by outsiders, so there is no need to strain the users with additional identification. The client machines at the control rooms have fixed IP-addresses. The server identifies these addresses and translates them into corresponding control room names. So, unlike in traditional social media tools, El Nobo doesn't use personal accounts, but control room specific accounts.

This design is based on the operators work habit of sharing the user accounts. When a shift starts, only one of the operators in duty logs into the computer and all of them use the same account during the shift. Since there is only on team (shift) in duty in one operator room at a time we simplified the system even more and created only control room level accounts. Simplified account management also simplifies the using of the system since the operators do not need to remember yet another username-password combination. Users usually find multiple overlapping accounts and passwords laborious [16].

Graphical side of El Nobo is build up with Action Script 3 in Flash development environment. The Flash allows an easy way to create different kind of user interfaces with vast amount of visuality and interactions. Flash applications also can be run on normal web browsers and users are quite likely to be familiar with some Flash-applications e.g. games.
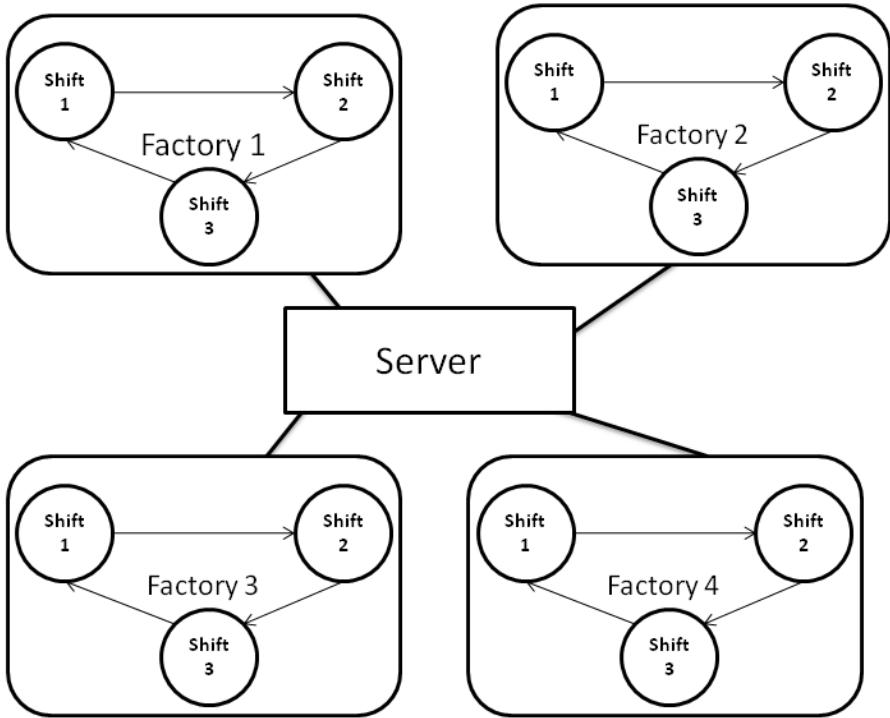
Fig. 2. The structure of the information sharing in chemical factory with the prototype. Information is shared face-to-face from work shift to another and from one factory to others by the prototype's server.

The server is build up with Java environment and consists of socket listener and note log. Also a policy server is needed for Flash communications because of the security policy. The main server listens for incoming notes and requests of notes. Note's message and related information is saved to the log held on server machine. Clients keep polling the server for new notes and if there are any, server sends them from the note log.

The prototype was built up rapidly using some code from previous projects and freely available code snippets from Web tutorials. The prototype is not supposed to be a complete product, but to present the idea of sharing digital information with notice board metaphor. Thus the prototype will not be used as a base for the final product, if any is to be created. The final product would most likely have more functions, some possibilities of personalization and some level of integration to the automation systems, which are not presented in the prototype in the name of simplicity. Nevertheless the prototype is a "working one" and can be given to the users for freeform use.

3.2 Design Reasoning

Our aim was to cover the information exchange between different control rooms and shifts in real-time and with postponed messages. This means that the workers are

located at the same area but not exactly at the same location. If needed, they can go over to the other control room, but then their own room is not operated. Thus there is a need for ability to access same information from different locations. There's always an operator on shift in all of the control rooms, but he or she might be busy controlling the process, so the information exchange timing can be immediate or delayed. El Nobo can be used as a kind of instant messenger or as a bulletin board depending on the situation. Thus both time derived styles of communication are supported.

Currently the users share awareness information mainly by telephone or radiophone and almost exclusively in problem situations. Problems with telephone are that the user must know who to contact and what's his or her phone number. If the information receiver isn't present at the moment the information can't be delivered and although the receiver might realize the need for information sharing, she or he has no clue for the reason for it. The main problem with radiophone is that the user needs to change the frequency to enter channel of other factory and while doing this he or she cannot receive information from the channel of his or her own factory. In addition the telephone and radiophone communication are 1-to-1 communication and in chemical plant there is almost always need to share the information with multiple partners. El Nobo is shared among all control rooms and notes are stored automatically for every shift until they decide to remove it, so each note gets to all operators working in the factory.

The purpose of the El Nobo is to give users a new and simple channel for sharing information over time and space. Through network the notes are sent to different locations and by saving the notes to the server they are delivered on different work shifts. Compared to natural note board this gives the users a chance to use the board on their own work environment instead of some shared location among the other users. Currently the users have similar notice boards to share information among different work shifts, but they are lacking information sharing between different working locations. Since note boards are already used in the work, the metaphor should be familiar to the operators. El Nobo just has a little different environment (computer screen) and interaction methods (mouse and keyboard) compared to physical note board.

Users usually wish to execute information sharing in their own preferred ways [11]. We are giving the operators a new tool that can be used to share any additional information they wish to provide. There are no limitations of what kind of information can be provided and the users have total control of the received information. The prototype does not support private one-to-one communication but the need for private communication between two control rooms seems to be rare.

System derived changes to existing work practices should be avoided if possible [17]. Thus El Nobo is designed to fit into the users' current work habits, the operators already have a distinct computer for other than process operating usage, so the system can be placed there without interfering the process monitoring. During monitoring there is not much need to actually adjust the process, so there's plenty of time to observe also the new communication system. El Nobo should increase the amount of situation awareness and help the operators to predict exceptions and develop the collaboration practices.

4   Conclusion

Situation awareness is an important part of controlling processes in modern factories. In addition to the information about the controlled process the process operators need a lot of information also from other sources such as interlinked factories, suppliers, and maintenance. Current information gathering and sharing practices are focused on problems and special events. Thus the operators are not aware of the current situation even in interlinked other factories. As a result the collaboration between production units is not as efficient as it could be. For example the operators do not know the capabilities of operators of another factory they cooperate with. These problems seem pretty simple, but sharing and organizing such information in needed time window is not a simple task and poor information might lead to for example lower production quality.

Use of Social media tools is rising and we are interested to see how they work at chemical factories. The El Nobo electronic notice board was designed to support the situation awareness across control rooms in a chemical plant. During March-April 2009 El Nobo will be evaluated in real chemical factory complex with real users. The evaluation results will be analyzed regarding usability of the system in awareness information sharing and whether the users learned new Social Media and Web 2.0 promoted ways of working while using the prototype.

We had to make some choices in the design stage without the necessary user knowledge. Our assumptions included such things as having a personal view of the notice board would be better than a shared view and there's no need for versatile note handling. We are interested to see if the users actually have a need to store and organize notes and do not just throw them away. Also there are some limitations with the note board metaphor and our prototype has quite limited functionality. For example the prototype does not support pictures, videos or audio messages. The installation of the prototype will however include blogs for the operators to share longer messages and pictures.

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