The *ANDON* System: Designing a CSCW Environment in a Lean Organization

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Abstract

The design of Andon is part of a study aimed at exploring multi-disciplines involved in CSCW (Computer-Supported Cooperative Work). Its development is an attempt to use participatory practices and a proposed lifecycle model to overcome the difficulties that arise during the development of CSCW applications. This work presents and discusses the design process of Andon: a system to support collaborative work in a lean manufacturing organization.

Index Terms — Participatory Design, Lean Organization, CSCW (Computer-Supported Cooperative Work) interface.

1. Introduction

The main idea proposed by the lean production process is an attempt to explore the knowledge of all the members of an organization in the diverse activities of the factory routine [11]. This research is part of a project [20], involving a university and a lean factory, aiming to contribute to lean production practice through a system that facilitates and motivates the collaboration of the organization's staff in the problem-solving process in the plant.

Recent literature outlines the inefficiency of standard lifecycle models for the development of CSCW systems [1,2].

According to Jonathan Grudin [3,4] there are three different classes of systems: mono-user, for the organization, and for workgroups. In developing systems for groups the standard rules of Software Engineering fail. This failure is not due to technical problems, but arises from not considering the social aspects of the workgroup in the lifecycle of the system design. This problem frequently generates failure in the use of systems developed to support collaborative work.

The success of these systems is not guaranteed only by the technology involved in their development, but is also determined by their acceptance in the workgroup [12,13]. Several factors can impede the success of a groupware in supporting collaborative work. This work tries to overcome these problems, developing a system with the users' participation from problem identification to the final evaluation of the system. The users' participation is motivated by participatory techniques, such as Ethnography [14,15] and Started Conference [7], and a proposed lifecycle model, which combines characteristics of traditional HCI models, such as Prototyping Model [8] and Star Model [9,10].

This paper presents techniques of participatory design embedded in a proposed life cycle to allow the people from the application domain to participate in the design and development process. *Andon* system aims to support collaborative work in a lean industrial organization.

We expect as results a better understanding of interfaces for CSCW systems and a conclusion about the adequacy of participatory practices when carried out within a lean organization.

This paper is organized as follows: Section 2 presents the application domain setting; Section 3 discusses current works in this academic context; Section 4 presents the proposed methodology to overcome the problems outlined; Section 5 presents some results achieved; Section 6 concludes.

2. The domain setting

The factory we are working with is a multinational organization that presents the first signs of a culture tending to lean production ideas. The main characteristics proposed by lean production ideas are the distribution of decision-power among the personnel, the incentive to teamwork and a more dynamic role for the shopfloor workers. Together, these characteristics propose that solutions to problems in the factory routine should be created by people that are closer to the problems, that the work in the organization should be more collaborative and that the workers should be more dynamic and multifunctional in the workgroup [11]. The design methodology proposed in this paper is inline with the challenges imposed by the lean production paradigm in organizations.

The *Andon* system aims to contribute through the implementation of lean factory ideas by facilitating

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discussion and communication among the people involved, including suppliers.

3. Related works

The development of systems to support work in organizations has received great incentives, today, for several reasons, including the evolution of technology and the competitiveness generated by globalization. In this context, several computer environments arose aimed at facilitating the workgroup's activities inside companies. For a long time these systems presented failures in relation to their acceptance by the workers. The main communication artifacts accepted on a large scale by different workgroups are e-mail and bulletin board systems [4].

Literature has shown that these failures are principally related to the systems' interfaces. In overcoming problems in the development of CSCW systems some attempts were made at large commercial systems for organizations, i.e. *Lotus Notes* [17], *Lotus Sametime* [18] and *ICQ Groupware* [19].

One of the proposed solutions is to consider human factors during the development of the system, as suggest by Robinson et al. [5]. Robinson, Pekkola and Snowdon propose the development of a virtual environment (VIVAS - Virtual Office) to support collaborative activities inside the office, considering social factors from the culture of the domain during the implementation of the software. While the project VIVAS intends to consider human factors during the development of the system, the rationale of *Andon* is that the culture of the workgroup is decisive during the whole development of the system.

In development of POLITeam system, Helge Kahler [6] showed involvement of users in the design of the POLITeam system through participatory techniques, such as interviews and conferences. According to H. Kahler, these techniques were very efficient during the project of the POLITeam system. This system was implemented to support work in the offices of the Germany Ministry. The POLITeam is used by people with a high educational level, who are skilled with computer tools.

Besides the techniques that allow the users' participation in the development of systems in an indirect way, such as the interview, we propose participation through interactive techniques between the users and the designers, during the whole development lifecycle.

4. The proposed methodology

The traditional lifecycle models do not overcome the problems raised during the development of systems to support communication involved in collaborative work [1,2]. These models do not allow an effective participation of users in the stages of system development. In these models, users participate only during the identification and analysis phases and become passive in the remaining development stages. This work proposes a lifecycle model in which some techniques of participatory design are used to capture users' collaboration in each activity of the system design process.

The proposed lifecycle model presents some characteristics inherited from traditional models, such as the Prototyping Model [8] and the Star Model [10]. These models combine different advantages that can contribute to the goal of this work: the fast development of a prototype for the system and an evaluation phase which exists during the entire development.

4.1. Participatory design techniques in the lifecycle

The techniques of participatory design presented in this work, were carefully chosen among several techniques proposed by Muller, et. al [7]. We aimed to find a model that does not impose rules to be followed during the development of the software, but that is aimed at stimulating the users' participation in the system design, describing activities and techniques that really consider the needs, the demands, and the opinions of people from the domain.

The proposed lifecycle allowed the achievement of the participatory techniques design as presented in Fig. 1. It shows several participatory activities distributed along the evolutionary phases of the system's development, trying to better satisfy each development stage and to consider the restrictions imposed by the system domain.

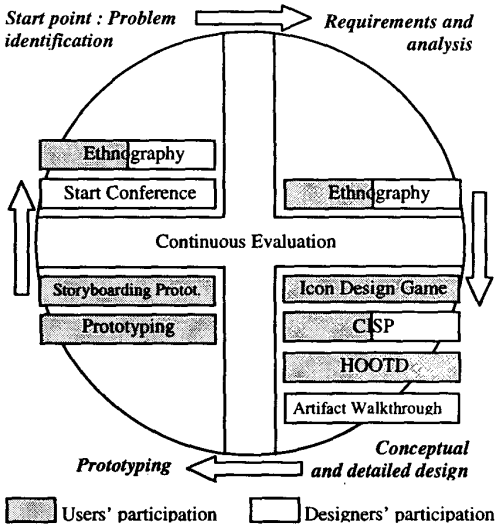

Fig. 1. *Particitory practices embedded in the proposed lificycle*

Using these techniques, our aim was to obtain a system that naturally incorporates culture from the workplace, since this is essential for artifacts dedicated to stimulate collaboration and learning inside organizations [16]. This lifecycle model with embedded participatory techniques may be a way to deal with the problems that appear during the development of CSCW systems for collaborative work, because these activities enable the cooperation of people involved in the domain.

5. Preliminary results

Over sixteen weeks, activities such as Starting Conference, immersion in the user's world (Ethnography), participation in real meetings (Ethnography) and HOOTD, were carried out with the intention of formalizing a basis to support the system construction through collaboration with the system's users. Some results and important information in relation to the ideal communication interface for the environment were collected during the practice of these activities. The main results obtained by applying the different practices are summarized as follows:

- From the Starting Conference activity resulted the first information about the domain, stressing the motivation of this project.
- By running several Ethnography techniques, i.e. observation and immersion, we raised information for the communication interface.

The application of the Artifact Walkthrough technique made possible the formation of a graphic representation of the *Andon* system's main processes. Supported by the study of some tools and methods of the work process in the factory, such as *CED* (Cause-Effect Diagram), the *Five Steps for Problem-Solving*, the *SPC* (Statistical Process Control) and the *It is/It is not Matrix*, the use of Artifact Walkthrough resulted in a sketch of the workflow, represented by boxes in Fig. 2. The HOOTD was applied in sequence considering the different tasks represented by objects enabling the identification of essential functions of the problem resolution process.

Using previous results, the HOOTD technique enables the user's direct participation in suggesting the function structures existent in the system. The users manipulated cards that represented possible functions in an attempt to obtain a good menu for the *Andon* environment.

Based on these results, we could conceptualize an interface for the *Andon* system. Fig. 3 and Fig. 4 present snapshots of *Andon*'s interface, showing the Brainstorming Process and the Effect-Cause Diagram. All the results of applying the participatory techniques were embedded in the development this interface, as for example the coordinators' functions and anonymous collaborations. The idea involved in this prototype is that any one should have the chance to participate in the problem-solving process: managers, machine operators, suppliers and customers.

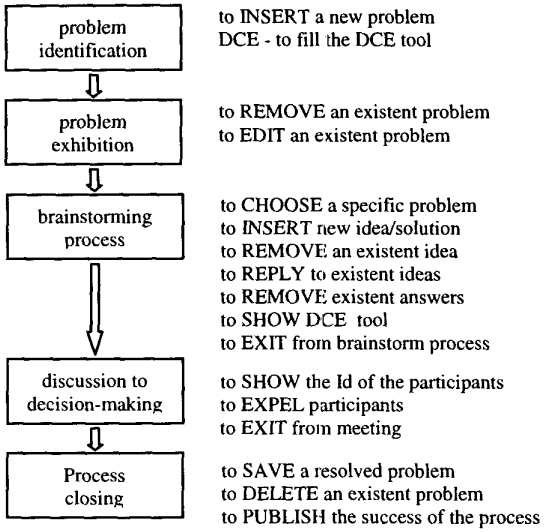

Fig. 2. *Andon's functions structure*, resulting from the application of Artifact Walkthrough and HOOTD techniques

Fig. 3 shows the Brainstorming process. This process can be carried out synchronously or asynchronously. Thus, a meeting for discussion of previously discussed ideas and solutions already existent in the system could be scheduled.

Although it is not common to "reply" to an existent idea in a brainstorming process, it is very common in the domain of electronic communication tools. Thus, we implemented a function that permits comment, critique or agreement with another person's contribution.

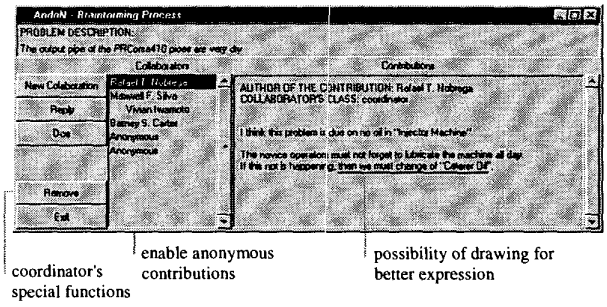

Fig. 3. Snapshot of the interface of the brainstorming

Fig. 4 shows the window which represents the "fish-spine tool". This is a formal representation to situate the problem in the real problem-solving process. All the internal or external people involved in the organization are allowed to participate. In this activity the possible causes of the problem are divided into five variables: *machine*, *raw material*, *labor*, *environment* and *method*.

This diagram helps in the identification of the problem and in the creation a common ground for starting the brainstorming.

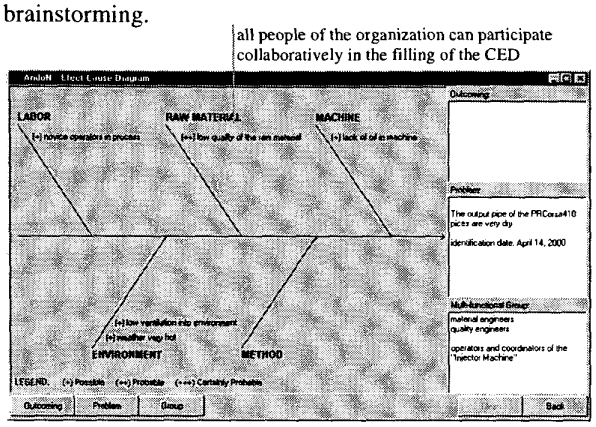

Fig. 4. Snapshot of the DCE (Effect-Cause Diagram)

6. Conclusion

The work reported here is concerned with the construction of a technological artifact which considers the culture involved in the manufacturing organization. This is motivated by our aim to contribute to the lean practices inside the factory, stimulating group work within the organization. Through this artifact we aim to enable indirect learning among the individuals of the plant, as they engage themselves in a process of exchanging knowledge during participation in problem-solving processes.

This prototype serves as a technological tool to enable the next collaborative activities and illustrates the effectiveness of the proposed methodology.

Besides helping in lean paradigm practices, we expect to collaborate with the multi-disciplines involved in CSCW systems development, with a better understanding of the process of designing interfaces for workgroups.

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