Designing and Learning: joining the concepts in work practices

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ABSTRACT
Information and communication technologies are the new power for innovation in organizations nowadays. However the technology by itself is not able to promote improvements in organizations, which depends on how the employees learn and make sense of the technology in their workplace. In this paper we argue that the learning process in organizations could be tied to the design process that results in computational tools to be embedded in work practices. The approach integrates Participatory Design (PD) and Organizational Semiotics (OS) techniques in a coordinated work involving designers, users and the Human Resources (HR) department of the organization. This approach is illustrated with the design of the Pokayoke system highlighting its relations with learning opportunities.

Keywords
Design and learning, Participatory Design, Organizational Semiotics, Learning in a lean organization

Introduction
Information and communication technologies are the new power for innovation in companies nowadays. At the same time, the organizations have to face new challenges, as these new technologies change the work practices and increase the needs for training.

The effectiveness of a technological artifact at the organizational context is dependent on the capability of the employees to perceive it as a vehicle to improve their work practices or establish new ones. Activities to improve this capability, including training, are not the regular attributions of designers. Nevertheless, articulation between designers and the staff in the organization can promote learning during the design process. In this paper we address the concept of “learning” referring to both an outcome and a process. We illustrate the main ideas by showing how the design process of a computational tool for the workplace could promote learning situations. The computational system described is neither a system for training nor a software to automate the current work practices, but a system that is part of an intended organizational context in which learning is necessary to establish new work practices. A shared understanding of the organization, including its formal and informal aspects, and a method to represent the organizational context and its relations with the system being designed are necessary.
The approach we are proposing integrates Participatory Design (PD) and Organizational Semiotics (OS) techniques in a coordinated work involving designers of the system, workers and the Human Resources (HR) department. This approach promotes the direct participation of the organization personnel in the development of the system during the PD activities using methods and formalisms of OS. It shows the transition from what is learned from the work practices (in the PD activities) to the design of an intended organizational context (using OS methods and formalism).

The proposed approach is being adopted as a result of collaboration and partnership between the Nucleus of Informatics Applied to Education NIED-Unicamp, a research center in our University and the Delphi Automotive Systems in Jaguariúna, Brazil (Nied 1997, 2000). This manufacturing organization adopts principles of “lean production” to manufacture components of automotive systems. In a lean system, the role of the worker goes beyond his/her particular work tasks, including also the search for quality in the production process. Lean organizations usually promote programs that stimulate a continuous learning process, through a better comprehension of their work practices in the whole scenario of the organization. In other words, the workers must “learn while working”, to be able to promote continuous improvements in the production (Deming, 1992).

Computational tools that enable the integration of teams in cooperative work and promote constructivist learning can provide a good scenario for learning in lean organizations. Nevertheless the technology is not able to promote learning by itself. In this work we explore the need to ground the idea of learning in organizations in concepts which connect the theoretical and the experiential. Our intent is to articulate the conditions under which learning situations may occur not only during the use of the system, but mainly through cooperation during the design process of systems for the work context. Three main issues are discussed:

- The acceptance of the system by the user. As discussed by Grudin (1994), the success of a system to support workgroup activities is not guaranteed by the technology itself, but it is directly influenced by its acceptance in the workgroup. How to promote system’s acceptance?
- Conditions for cooperative design. Organizational programs that motivate the participation of users in workgroup activities and in discussions about their work practices are necessary for learning. How to promote cooperation through the design process?
- Opportunities offered by the system in future training activities. It should be figured out how to use the system as a tool to improve current and future training activities. How to envisage the system as a learning tool?

The paper is organized as follows: the second section presents the background for the work: concepts from Participatory Design and Organizational Semiotics. The following section presents the design of the Pokayoke system and discusses how learning activities were coordinated in the whole design process. The last section concludes.

Theoretical Background for the Work

The methodological approach adopted in this work integrates Participatory Design (PD) and Organizational Semiotics (OS) techniques in a coordinated work involving designers, users and the Human Resources (HR) department of the organization.

The Participatory Design approach was developed initially in Scandinavia and it employs a variety of techniques to carry out design with the user, rather than for the user (Muller et al., 1997). The Participatory Design approach stresses the importance of democracy in the workplace to improve the work methods, the efficiency in the design processes (with the users backgrounds and feedback), to improve the systems quality, and “to carry on” formative activities (Muller et al., 1997). In Participatory Design these objectives are achieved through the direct interaction of users with designers during the overall cycle of development, in which the users have some control over design decisions.

The collaboration of the users during the whole process of design provides information and feedback to the designers. Furthermore PD activities improve the quality of the resulted system through a better understanding of the user’s work and the combination of different backgrounds of the practitioners during the design process (Braa, 1996).

In order to develop a common view of the technology and of the organization, exploring new organizational structures, systems requirements, and constructing prototypes of new systems, we combined the use of PD with...
Organizational Semiotics methods. OS is defined as “the study of organization using the concepts and methods of Semiotics” (OSW, 1995). Organizational Semiotics is one of the branches of Semiotics particularly related to business and organizations (Liu, 2000). The study of the organization is based on the observation that people affect all organized behaviors through the communication of signs, individually and in groups.

Organizational Semiotics is more than a tool to develop information systems, it can be used to understand and improve the organization (Liu, 2000). A set of methods proposed by Stamper (1973) enables to study the use of signs in organizations and their social effects. The two main methods of OS used in this work are the Semantic Analysis and the Norm Analysis. The Semantic Analysis delineates the area of concern of an organization and identifies the basic patterns of behavior (affordances) of the agents. The Norm Analysis describes how an agent can judge a situation and take actions.

More than the sum of PD and OS, the proposed approach seeks to achieve the conditions necessary to foster learning with a CSCW system by starting with learning during the design process of the system. This implies in having OS models as object of discussion during participatory activities and presupposes the HR involvement in the process.

Designing and Learning in the Workplace

The POKAYOKE System

Pokayoke is a CSCW system prototype constructed with the aim of exploring this new approach to design and learning in organizations. The Pokayoke system supports problem solving and decision making in the context of a manufacturing organization that adopts the lean production paradigm.

Pokayoke is based on a procedure conducted in the factory to analyze and implement corrective, preventive, security, and health actions, known as “five steps”. The objective of the five steps procedure is to define a systematic method for dealing with problems in the routine of production. Every time that an unconformity is identified, an action must be taken to correct it and to make difficult a new occurrence of it. Also, every time that a situation of potential unconformity is indicated, an error proofing (Poka Yoke) action should be carried out.

Figure 1 shows a snapshot of the main screen of Pokayoke system prototype, in which the problems being discussed and their respective stages in the “five steps” process are shown to the workers.
Tools to support the problem solving process are distributed in different phases of the process, for example: Ishikawa Diagrams are used at the step three, brainstorming at the step two and three, and 5-why at the step three. These tools are embedded in the system and are combined with asynchronous communication artifacts.

**Learning by designing Pokayoke**

The PD techniques used with OS during the development of Pokayoke were Starting Conference, Ethnographic practices, Artifact walkthrough, Hierarchical Object-Oriented Task Decomposition, Icon Design Game, Future Workshop and Prototyping (Muller et al., 1997). The choice made of these techniques was based on their application at different phases of the system development, the possibility of applying them in the work context, and their potential of stimulating reflection and collaboration during design. The HR participated during the application of the PD practices and the definition of learning situations. The results of the use of the PD techniques were documented and used to create the semiotic models for the system. These models, on their turn, were used as object of discussion in new participatory practices.

To illustrate the use of this approach we present some examples of situations occurred during the Pokayoke design process. One of the discussions involved the variety of methods that were previously used in problem solving at different sites of the factory. The participation of workers from different sites in the PD activities has promoted the reflection about the actual work practices at each site. It also triggered a process of establishing a unique problem solving method for the whole factory, with the cooperation among the work groups. The semiotic methods supported the participatory discussion of diagrams that model these new practices, their relations with the technology and the implications in the design of the system. The HR activities carried out stressed the importance of a unified method to solve problems, the engagement the workers should have in the organizational problem solving, and the possibilities of cooperation through the software tool.

Another example of situation occurred during the design activities involving the consideration of expansion in the number of the workers that have access and participate in problem solving. As the systematic methods for problem solving in its paper based form had its use restricted to few employees, some questions had to be answered regarding its expansion through the computational tool: “How could we encourage the participation of all the workers?”; “How could we promote the collaboration/cooperation in the problem solving process?”

The answers to these questions involved a joint effort of designers, workers and HR staff. For example, on the one hand the HR department is not able to create a strategy of distributing bonus for the workers who contribute in the solution of problems if the designers do not include in the software a mechanism to know the exact contribution of each worker. On the other hand the use of the tool in a cooperative way may depend on how this strategy is applied. This articulation between designers and HR staff occurred through the HR participation during PD practices using a shared model of the organization derived from OS.

The exploration of learning opportunities in the use of the tool was acknowledged during the design of Pokayoke. A very important opportunity that was pointed out in the activities was *the opportunity to have a training that is tied to the real practice: it is possible to base the workers learning activities on the experiences and the knowledge they acquired by working in the organization.*

As illustrated before, the work carried out during the design of Pokayoke supports the idea that the proposed approach is useful to a successful design of CSCW by the integration with learning activities in the work environment. Table 1 summarizes how PD, OS and HR participation deal with the aspects raised in section 1.

Table 1 summarizes the way each layer built with PD, OS and HR participation amplifies and makes the foundation for promoting learning through systems designed for the cooperative work context of organizations.

**Conclusion**

It has been argued that the real value of a computational system inside an organization is not its complexity or the involved technology, but its potential to improve the organization. Improvement in the organization is dependent on the learning of its employees. Computational tools that enable the integration of the work teams in cooperative work and promote learning situations can provide a good scenario for learning in organizations. In this work we proposed an approach which ties the learning process in organizations to the design process that results in the system to be embedded in the work practices.
We exploited the concept of learning referring to both the product (a computational system) and the process of designing this product. As so, to have a CSCW as a tool for learning in organizations, we should start by considering the design process of this tool as a just-in-time learning opportunity. The proposed approach integrates Participatory Design (PD) and Organizational Semiotics (OS) techniques in a work involving designers, users and the Human Resources (HR) department of an organization. The approach showed its usefulness to deal with aspects of design and learning of Pokayoke, a CSCW system designed for a lean production organization.

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<tr>
<th>Participatory Design</th>
<th>Organizational Semiotics</th>
<th>HR Participation</th>
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<tbody>
<tr>
<td><strong>User’s Acceptance</strong></td>
<td>The users can change the system during its development, they have influence in system design</td>
<td>Facilitate the communication among designers and users, and both can have a better understanding of the social context of the work</td>
</tr>
<tr>
<td><strong>Cooperation in design and designing for cooperation</strong></td>
<td>The user participate in the construction of the system, facilitating his/her understanding of the system objectives</td>
<td>The semiotic model can be used in the PD techniques to drive discussion to the domain ontology and system objectives</td>
</tr>
<tr>
<td><strong>Learning opportunities brought about by the approach</strong></td>
<td>The PD activities can be used to carry on learning activities during the design</td>
<td>The OS methods provide artifacts that capture aspects of the work practices and of the software model, to be used in participatory activities</td>
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</table>

*Table 1.* The proposed approach and the use of cooperative tools for learning

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