VTT SYMPOSIUM 258

Keywords: human factors, human-centred design

ECCE 2009 – European Conference on Cognitive Ergonomics

Designing beyond the Product – Understanding Activity and User Experience in Ubiquitous Environments

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Organised by

VTT

VTT SYMPOSIUM 258

Designing beyond the Product – Understanding Activity and User Experience in Ubiquitous Environments

European Conference on Cognitive Ergonomics 2009

30.9.–2.10.2009, Helsinki, Finland

ISBN 978-951-38-6339-5 (soft back ed.)
ISSN 0357–9387 (soft back ed.)

ISBN 978-951-38-6340-1 (URL: http://www.vtt.fi/publications/index.jsp)
ISSN 1455–0873 (URL: http://www.vtt.fi/publications/index.jsp)

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JULKAISIJA – UTGIVARE – PUBLISHER

VTT, Vuorimiehentie 3, PL 1000, 02044 VTT
puh. vaihde 020 722 111, faksi 020 722 4374

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Edita Prima Oy, Helsinki 2009

The qualitative differences of the effects of technological changes: case wood procurement process

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ABSTRACT

We investigate the nature of the effects of technological changes on forest work activity, focusing on the effects on forestry professionals' tools and object of work. The analysis is based on the activity theoretical approach. The forest work has transformed into a technology mediated work, and the entire concept of the wood procurement process is in transition phase, accomplished by several independent companies operating in close co-operation and using shared on-line computer systems for coordination and planning of the process. Our case proves the need of more holistic and object-oriented design approaches in technological changes. There is a need to understand the activity of the entire network, and the changes in the object of work of the actors in that network in order to enhance new operating concepts and practices that the new technology would enable.

Keywords

technological change, change of work, wood procurement, forest work, activity theory

1. INTRODUCTION

At the beginning of the 20th century, there were the man, the horse and the axe. At the beginning of the 21st century, there are the man, the computer system and the harvester, as part of the wood procurement network. What is the nature and significance of the many technological changes that have happened during the last few decades in the forest work? Development based on mechanization and rationalization of work processes has happened in a couple of distinct technological cycles and decreased the cost per unit of timber (Fig. 1). The most recent technological cycle includes the use of information technology, which has increased drastically during the last decade. What has mechanization brought to the industry besides increased efficiency? In this presentation, we investigate the nature of the effects of technological changes on forest work activity.

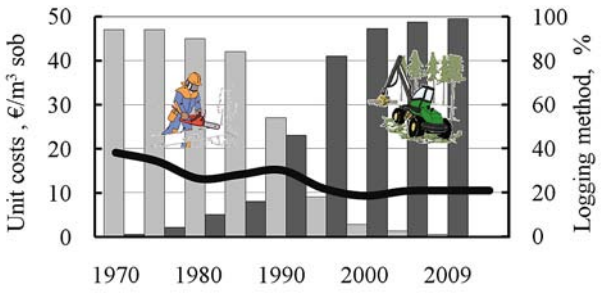

Figure 1. Real per unit cost development of logging and proportion of logging method in Finland.

The analysis is based on the activity theoretical approach, which suggests that collective work activities are motivated and defined by the object and the outcome of the activity [3]. As a case example we use procurement process and its social-technical environment. The data for the analysis is mainly collected from a developmental intervention in a wood supply district in Middle Finland, where we collectively investigated the changes in wood procurement together with the different actors in the process.

It is precisely the information technology that has enabled major organizational changes in wood procurement - among others the new division of work between the actors in the process. Technological innovations are often considered as a source of efficiency by being an improved tool for the activity. However, some technologies have the potential to start changing the whole logic of activity. In the presentation, we will focus on the effects of technological changes on forest professionals' tools and object of work through three cases, namely the work of the forest machine operator, the harvesting foreman and the forest entrepreneur. We will describe how, due to the new information technologies, the forest worker's traditional object of work - cutting and hauling the logs - has transformed into a technology mediated work, in which, besides operating the forest machine that incorporates highly advanced wood processing technologies, generating and processing of data for the collective information system has become a central part of the work. Also, we will show how the work of harvesting foreman has changed from face-to-face supervision of work and order giving out in the forest to computer-based production planning and management, which is mainly carried out in the office, and finally, we will depict how hierarchically supervised contractors have became professional entrepreneurs.

2. DATA AND METHODS

2.1 The Case and Intervention

The data was collected in a development project called "Developing the concept of wood procurement process - supporting the model of regional entrepreneurship and enhancing the well-being of forest machine operators" in 06/2008–03/2009. The project was organized as a Change Workshop intervention. A Change Workshop is a space for collective analysis of the shared work practices with the help of external interventionists, whose role is to support the learning process and not to provide any ready-made solutions. In this case the process included five 3-hour sessions. The first four of the sessions were organized at intervals of two or three weeks and the fifth one, which was an evaluation session, after three months experimenting period, during which the participants tested the ideas generated in the workshop in practice. The Change Workshop is an application of the Change Laboratory® method [2].

The intervention was based on the activity theoretical idea that in order to resolve an aggravating contradiction in the activity system (which manifests itself in problematic or unfeasible situations in everyday work) in an expansive way, the actors need to question the old activity, analyse the historical roots of the emerging contradiction, reinterpret the object of their work and build new concepts, tools, forms of collaboration and division of labor to support the new object. A central element in a Change Workshop is the concrete case material that mainly the participants but also the interventionists collect from the participants' daily work to be analyzed in the sessions. The participants were given assignments between the sessions to collect data especially about, on the one hand, the problematic situations in the work, and on the other, the innovations they have made to cope with or to overcome these problems. In the sessions we offered the participants (theoretical) models and representations (e.g. the activity system, see fig. 2) to help the participants to reorganize the concrete data and observations about the work, to see problems and dilemmas in a new light and to generate qualitatively new solutions to the problems. The participants also depicted the central elements of their work first in 1998 and then in 2008 using the activity system model. The idea was to make the changes, which often gradually sneak into the daily work, visible and more concrete. During the experimental period the participants discussed development proposals and planned the selected development tasks, and then tried the ideas in practice.

There were 10-15 participants in the workshop, a regional manager, a deputy regional manager and 6 field officers representing the forest department of a nationwide forest company, three harvesting and long-distance transportation entrepreneurs and three timber truck drivers/harvester operators. The data consisted of interviews and discussions in the workshop that were recorded and partially transcribed, visits to the to the regional forest department of the forest industry company and to a harvesting and long-distance transportation enterprise, as well as memos of the sessions and a report that were commented and checked for validity by the participants.

2.2 Object-Oriented Approach to Understand the Technological changes

We used the activity theoretical approach and the model for activity systems (Fig. 2) [1] in the analysis of the data. The core of the approach is that human activity is always object-oriented. The activity system forms a collective context and the shared object a durable motive for the more short-lived and goal-directed actions. The subject's interaction with the object is mediated through signs and tools (including material artifacts and concepts and theories), rules, community, and a division of labour. These mediators carry cultural meanings and historical development within them and thus offer stability to the system.

The elements of an activity system are in constant interaction reshaping each other. Because every activity is connected to other activities, for example those of the customers, new elements and requirements can enter an activity system causing disturbances and deviations from the customary scripts of the activity. The innovations through which the new situations are managed start then to reshape the ways of working. Thus the activity system should be considered a dynamic entity that interacts with other activity systems. The wood procurement process was analysed as a network of activity systems connected to each other by the overarching object of the entire network.

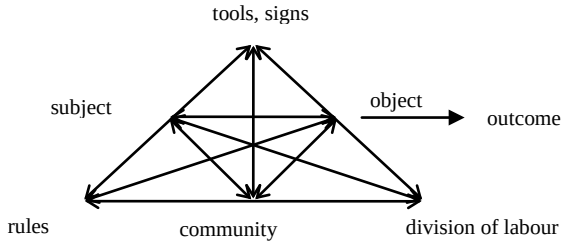

Figure 2. Model of the activity system. [1]

3. TECHNOLOGICAL DEVELOPMENT TRENDS IN WOOD PROCUREMENT PROCESS

The technological development can be divided in three main paths. First, developing the haulage of the logs, which meant replacing horses with tractors and lorries, and later, with specifically forestry designed vehicles like forwarders and timber trucks. Second, developing the logging methods and tools from manual to motor-manual devices, and finally, to the single-grip harvesters with their high-tech tools and devices and ergonomic design. The third line of development concerns the information processing and flow of information in the wood procurement process, from oral instructions of the foreman about the desired log dimensions and thinning methods to the current detailed and on-line data flow between all the participants of the process - crossing the organizational borders of the wood processing mills and the harvesting and long-distance transportation enterprises, as well as the in-firm boundaries of managers, production planners, field officers, foremen and workers.

Periodically, these development paths are overlapping, having also effects on each others' progress. In Finland, the period of the ascendancy of frame saw and axe, as well as horses, reached its end in the beginning of 1960s (see also fig.1) when hand tools were superseded by chain saw and horses with farm tractors. The second milestone was in the middle of 1970s when forwarders became more popular hauling technology than farm tractor based ones. The third milestone was the breakthrough of the single-grip harvester technology in the middle of 1980s. Only then became the harvesting by machines more effective than manual work by lumberjacks (e.g., in Finland the mechanization level of felling was only 16 % in 1985, however reaching 46 % at the end of the decade). Nowadays, practically

all harvesting is carried out by single-grip harvesters and forwarders. The usage of information technology can be seen as the forth milestone in the technological development, starting already in 70's with measuring techniques and management of crosscutting as first applications. Utilization of information technology was one of the key factors that enabled the success of the single-grip harvester, and today's shared information systems and on-line connections with up-to-date data concerning e.g. log information (dimensions, quality, quantity), transport possibilities, and digital maps of stands marked for cutting offer radically new possibilities to organize the wood procurement process. [6,7]

4. EFFECTS OF TECHNOLOGICAL CHANGES ON WOOD PROCUREMENT PROCESS AND WORK

In this chapter, we will focus on the effects of technological changes on forest worker's work activity. We will show how harvester operators', harvesting foremen's and forest machine entrepreneurs' work and tasks have transformed into a technology mediated information work with data processing as an essential part of the wood procurement process.

Organizationally, the forest industry companies used to take care of the entire procurement process from forest to the factory. The forest departments of the companies bought the stands marked for cutting, planned the harvesting schedules, and organized both the haulage in the forest and the main log haul to the sawmills, pulp mills etc. industrial users. The forest workers were employed by the forest industry companies and the forest machinery was owned by contractors who worked under close hierarchical supervision of the foremen of the forest company.

During the last decade, there have been major changes in the organization of the wood procurement process, especially concerning the division of tasks and responsibilities of the actors in the process. The major driver of this development has been the implementation of IT systems and mobile technology, which have formed an integrative planning, control and information network covering the entire wood procurement process from forest to the mills. This change into a network-based co-operation can be observed in the changed tasks of harvester operator, harvesting foreman and entrepreneur, all closely connected to each other.

Until the end of the 90's, the main tasks of harvester operators and forwarder drivers were timber harvesting and hauling. They got the instructions for work from harvesting foreman of the forest industry company, usually face to face at the worksite. The work resulted to cut-to-size logs piled at roadside landing. Though during the decades the tools developed form axes to chain saws to first mechanized felling machines, the main tasks and targets remained basically the same. The new tools did make the work more efficient and safe, and improved ergonomics diminished especially the physical workload. The first applications of IT concerned measuring techniques of timber, and were used e.g. to support decision making on the most valuable combinations of log length and thickness, and thus improved the economic results of the harvesting. Still, those applications did not change the division of tasks in the forest work. [5]

The mobile and on-line information systems were intensively developed, and since the beginning of the 21st century, they allowed more and more work and interaction to be done via information systems. For example, all the instructions, information and maps on stands and worksites were transformed into the harvester cabins via telecommunications connections, and, when needed, the harvesting foremen gave clarifying instructions by mobile phones. This radically released the resources of harvester foreman to be used in other tasks than travelling from stands to stands. Their work profile changed from face-to-face foreman on the fields into production planner with duties of short term planning and reporting, mainly accomplished using computer system within offices.

The new technology has significantly affected also the work of harvester operators. In addition to harvesting and hauling, crucial work tasks include now also worksite planning, quality assurance, and feeding and processing data as well as sending it further to the information systems of the wood procurement network. This means more independent work with enlarged responsibilities concerning especially quality of work and accuracy of information. The object and target of work changed from being merely timber piled on roadside into the raw material with specific destination mill and information on that raw material to be used in the further phases of procurement process, and even in the production planning of the destination mills.

At the same time, due to the new flexible way of organizing the work the information technology offers, the role of entrepreneurs in the wood procurement process has step by step changed from contractors who worked under close hierarchical supervision of the foremen of the forest company into professional entrepreneurs. They used to take care only of the execution of harvesting and hauling, and maintenance and transportation of the forestry machines. Nowadays they also do the fine scheduling of process, including both the planning and the execution of harvesting, hauling and long-distance transportation (depending of the scope of their business). A key prerequisite for this is the shared information system of the procurement network, as all the important data concerning stands marked for cutting, short term plans and schedules are available also for the entrepreneurs. As entrepreneurs, they are also responsible of quality and quantity requirements of their assignments. The procurement process is, thus, accomplished by several independent companies operating in close collaboration and using shared on-line computer systems for coordination and planning of the process.

5. DISCUSSION

Though the effects of technological changes on work practices are largely acknowledged by the actors in the procurement process, many of the changes have been so gradual that it is hard to recognize the entire range and intertwined consequences of effects. For example, the participants of the workshop described many easy-to-see changes of their work, like increased use of computers in all tasks. Also, problems related to changes were connected to specific actions and work tasks rather to entire operation mode. As an example, the field officers of the forest company felt that the new technology-related reporting tasks hindered them from executing their field work in the forest.

The activity theoretical analysis, however, showed a significant expansion in each stakeholder's responsibilities in the process and an increase in more autonomous planning and decision making regarding the tasks. The analysis gave a deeper meaning and practical content also for the dimensions that depicted the major lines of changes. It also made the participants to realise

that even though the work that they do today is quite different from the one they did ten years ago, the interpretation of what they "should be doing" still rested on the old idea of each participant's work and professional identity. This realization gave them justification to let go of the old responsibilities and start to develop their work practices based on the new idea of work and the possibilities it offered.

We claim that the entire concept of the wood procurement process is in transition phase as depicted in the figure 3. It is precisely the information technology that allowed the major organizational change - the new division of work in the procurement process. Many tasks and responsibilities were shifted "downwards" in the hierarchy, which had started to dissolve the old hierarchical organization of work that was based on direct and personal supervision of the foremen. The material activity had already changed into network-like technology supported collaboration. But, their orientations were lagging behind in 'work in the forest' orientation. This is shown in the transitional conception where the actual lack of time was a result of the misfit between materially existing form of network collaboration supported by the technology, and the old orientation. There was a general agreement that such a change from the work in the forest to a technology supported network-like collaboration is going on. However, some participants were concerned of the possible negative consequences saying that they anyway prefer to have social relations in their work.

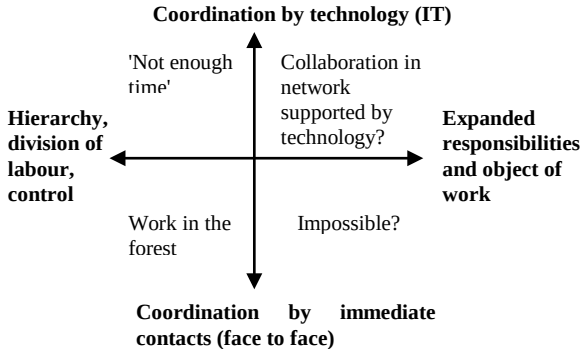

Figure 3. The change of operating concept of the wood procurement process.

The analysis of the case also brought up the critical question of designing, implementing and interpreting new technological applications and solutions. As the continuous, often as such gradual changes are implemented, at some point there is the risk of losing the benefits of the improved tools and systems. In order to get the benefits, the entire mode/concept of operation should be changed - the activity system, or the entire net of activity systems, should be analyzed and developed in relation to its historical developmental path. Treating the changes as merely of changes of tools will not be sufficient if there would be a need for change of the object of work and the activity system. For example, in our case, the chain saw and the early harvesters were predominantly changes of *tools*, though they had remarkable positive effects on ergonomics, managing of work load and efficiency of work. However, introducing the information technology changed radically the *object* of work: instead of just cutting of trees and logs, the new object of work included also information processing concerning both the stands of timber marked for cutting and the logs. This result is also in line with Pérez [10] and Freeman & Louçã [4] and many other researchers' claim that the possibilities of IT may not be fully exploited if it is treated just as another improvement of tools, instead of radical new technology requiring also social innovations, new kind of production concepts, and new structures of organisations and institutions.

Norros (et.al) [8] has proposed in their writings on ecological design concept and later, on joint intelligent systems approach [9] that the design should focus on the level of activity and systems instead of action and tools. They emphasize designing systems in usage, i.e. designing practices. This is especially important in case of information technology. Our case well proves this need of more holistic and object-oriented design approaches. It is not enough to design user-friendly interfaces on the bases of current work actions; instead, there is a need to understand the activity of the entire network of, e.g., wood procurement process, and the changes in the object of work of the actors in the network that the technological developments bring about in order to enhance new operating concepts and practices that the new technology would enable.

6. ACKNOWLEDGMENTS

The project was financed by Metsäteho Oy and Metsämiesten Säätiö. The field study was carried out in one of regional forest departments of Metsäliitto Osuuskunta. Participating of harvesting and long-distance transportation companies was essential.

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