Towards Incorporating Computer Applications in Cooperative Work Arrangements

— An activity theoretical approach

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Abstract: In this paper some first steps are taken toward a framework for design of computer systems which are incorporated in cooperative work arrangements. The framework is later to be used in further empirical studies. The framework emphasises work, and how individual work relates to cooperative work and the work arrangement it is part of. Activity theory is taken as a basis, and is developed by discussing how the computer is incorporated in all aspects of human activity. Further studies will examine the important question of how the different roles of the computer are to be integrated.

1 Introduction

Many approaches exist which address cooperative work, as well as the role and design of computer applications embedded in cooperative work. This paper adds a framework for further design of computer systems incorporated in cooperative work arrangements based on activity theory.

We want to focus on the actual work in which the computers are incorporated. Also, we want to focus on individual work and its relations to cooperative work and the work arrangements it is a part of. We find activity theory interesting in this respect and elaborate on this approach below. Other relevant theoretical approaches, like structuration theory (Kling and Jewett 1994) and research on articulation work (Strauss 1985; Schmidt and Bannon 1992; Schmidt 1994) are used to develop the notion of incorporation.

As system developers we need a framework to understand and observe, as well as to structure and make representations of our understanding of the complex nature of cooperative work. The framework should be abstract in the way that it lets us apply various theories covering different aspects of cooperative work we find crucial , and the interdependence between these theories. Such aspects are: Individual work, articulation of work, cooperation and communication, and inter-human relations and conflicts. And because work has to be continuously adapted to the changing environment, it is also necessary that the framework takes learning, construction and reconstruction into consideration. Their common feature is the human being, in the sense that each aspect being directed towards actions of the individual worker and her relationship to the surrounding community. The framework should also be abstract so that it does not restrict observations and empirical studies too much. On the other hand, the framework should be concrete so that it lets us structure the complex nature of cooperative work; the objective being to design computer-based artefacts which mediate crucial aspects of cooperative work.

Yrjö Engeström (1987) has developed a model consisting of three dominating aspects of human activity. These aspects are: Production which describes the individual's relationship to an object of work, distribution which describes the community's relationship to the object, and last exchange (communication) which describe the individual's relationship to the community. These three aspects form a systemic whole, in the way that they all are mutually dependent.

This model is useful as an analytical viewpoint for understanding and structuring the complex nature of cooperative work. The model let us use various theories in relation to the three different aspects of the situated nature of human actions, without eliminating the aspects we find crucial for cooperative work. In combination with the basics of activity theory - a human activity is always medi-

ated by artefacts, and thus the three aspects of human activity - the model is our point of departure for the conceptual framework presented in this paper. The framework lets us understand cooperative work as both an individual and a collective phenomenon, and is a means to understanding the role and design of computer-based artefact which mediate human activities.

We allow our framework by discussing how to apply different metaphors in the design. Believing in metaphors in design of computer systems, new challenges arise when trying to make useful systems supporting cooperative work arrangements. The issue of how communication, coordination, learning, and the web of tasks to be performed in a cooperative work arrangement are to be supported is a difficult one. Taking each aspect of the cooperative work arrangement, some metaphors that can guide the design may come up. However, the challenge is the combination of many metaphors into something which is usable and understandable in some setting.

Related work includes Kuutti (1994), where the concept of activity is used to generate a classification (matrix) of basic types of work support based on the structural part of activity and the different roles an individual can have toward artefacts in an activity; an active role, where and when to use them etc. (ibid.). In relation to design he uses the matrix to analyse organisational situations in order to locate places where computer applications could be used, moreover for studying different avenues along which more mature and efficient support for work might proceed (ibid.). The work carried out by Kuutti is fruitful for understanding cooperative work in terms of activity theory.

Kuutti (1994) takes the incorporated role of the computer into consideration. However, he is more engaged in considering the different aspects of cooperative work separately. He does not consider cooperative work as a web of work activities, i.e. as an incorporated whole. Thus, the computer's role in this relation is not based on an incorporated perspective in the way the perspective is described in this paper.

2 Fundamental perspectives on Information Systems and Cooperative Work

When it comes to the challenge of design of computer systems that will be used in cooperative work communities, some basic perspectives on information systems and cooperative work need to be clarified.

2.1 The humanistic perspective on Information Systems

Our understanding on computer-based artefacts has its basis in what Nurminen (1988) has named The Human-Scale Information System (HIS). The most important difference between HIS and other perspectives on information systems (e.g. system theoretical and socio-technical perspectives) is the fact that the individual worker and the individual level of work is emphasised. This is an obvious difference from social science, which usually prefer to observe large social groups. An humanistic perspective, which HIS is based on, allows space for the individual to be considered as an active and autonomous being, with her own goals and meanings. The individual is the performer of a given action, and information transmission and - interpretation, and knowledge are always directed to the individual's actions in a given work situation. Thus the individual's actions are situated, in the sense Suchman (1987) defines the term: Actions are always situated in particular social and physical circumstances and that situation is always crucial to action's interpretation. In the humanistic perspective, the computer-based artefact is considered a tool for the purpose of the individual's work tasks. Thus, the individual work task and the computer-based artefacts is considered to coincide - as agents in an incorporated whole situated action.

However, the emphasis on the individual and her actions, can cause a dilemma not considering the community of praxis surrounding the individual (Nurminen 1988). An individual do not function in a total isolation, and the meaning of her actions can not be understood or explained without a collective notion of reality and of actions within that reality. Information and knowledge, and their meaning are not the private property of an individual and in her mind, but are influenced by and influence social actions. Communication and coordination with one's fellow workers are considered as a part of the work itself. The relationship between individual and collective work can be considered dialectical (cf. Berger and Luckmann 1966). Individual work can not be explained or understood

without taking into account the community of praxis, and even less can we imagine a social practice without considering its individual actors.

Thus, the computer-based artefact is not only considered as a tool mediating the individual work-tasks, but also as a medium mediating the relationship between the individual and her community of social praxis surrounding the individual worker and her actions.

These perspectives on information systems has to a large degree been the inspiring source for our understanding of cooperative work and the role of the computer-based artefacts in such arrangements. The next sub-sections present crucial aspects of cooperative work influenced by these perspectives.

2.2 The crucial aspects of cooperative work

Individual work, and inter-human relations and conflicts, are two crucial aspects related to the individual worker and her actions to the situated work community. In addition, we consider learning as a necessary underlying assumption for the development of the work community as a whole.

Individual work and articulation of work

In any cooperative work community, the individual worker shifts between individual and cooperative activities, depending on the situation at hand. The boundary between the individual and cooperative work is dynamic, and individual and cooperative work are mutually constituting and delimiting each other (Schmidt 1994). However, individual work has to be articulated in some way to get the whole work done (Schmidt and Bannon 1992; Schmidt 1994). The term 'articulation work' refers to putting together tasks and task sequences in order to accomplish the work (Strauss 1988). According to Schmidt (1994) and Schmidt and Bannon (1992), articulation work has to be taken seriously in CSCW because of its coordination aspect: make individual work available for the cooperative work community, and because there are almost inevitably unexpected contingencies that alter the tasks and operations (Strauss 1985). Articulation work is thus an important aspect of understanding cooperative work as interdependence in work (Schmidt 1994). The term 'interdependence in work' does not necessarily indicate that the individuals are working on the same tasks at the same time, or sharing the same material

and resources. The term also indicate that the individual workers need to coordinate or articulate their activities and work-tasks in some way to get the whole work done.

However, articulation work can not be considered as the only aspect of cooperative work, but may be one crucial aspect in a in incorporating whole of cooperative work.

Inter-human relations and conflicts in work communities

«A community of practice is a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice» (Lave and Wenger 1991, p. 98). Communities - which are considered analogous to community of practice - do not necessarily imply co-presence, a well-defined, identifiable group, or socially visible boundaries. (ibid.) Work communities can be understood in terms of more informal boundaries of work, but do imply participation in any system of actions about the members shared understandings concerning what they are doing and what that means in relation to the objective of their cooperation. However, the members of a work community may have different interests, make diverse contributions to their actions, hold different goals and viewpoints and have various functional roles. Because of these differences directed towards the individual member, cooperative work may be a frame in which latent conflicts can come into light (see e.g., Borum and Enderud 1981 in their study of system development projects).

Cooperative work is thus a complex whole action involving an intricate pattern of interactions, governed by social roles and inter-human relationships (cf. Easterbrook 1993). Inter-human conflicts are then not understood as the opposite of collaboration, but as a inevitable part of the whole process of cooperative work, sometimes reducing stagnation and promoting change, but at other times disrupting successful cooperation.

Our basic view on cooperative work may come into a contradiction with the widely used term 'group', much applied in the CSCW-literature. The term is used to designate almost any kind of social interaction or is used to designate a relatively closed and fixed aggregation of people sharing the same goal (Schmidt and Bannon 1992). The group-perspective considers co-operative work as a small, stable, homogeneous and harmonious «collection» of people. The

shared-goal perspective and group perspective have a close relationship to each other in the way that they both consider a cooperative work arrangement as something outside the individual.

«something that is definitionally, independent of individuals but which has pertaining affects on their behaviour» (Fulk, et al. 1992 p. 9).

The individual of the co-operative work process may have different motives and goals that may be very personal, or represent their organisational unit. These different goals and motives of the co-operative work process may contradict to the goals and motives of the official cooperative work settings. In practice cooperation, coordination and communication within a cooperative work arrangement «may reflect pressure, constraints or acquiescence to power as much as shared goals» (Thompson and McHugh 1990, p. 18).

The relationship between individual and social development

Work has to be continuously adapted to the changing environment, and the development of the work community as a whole. Individual development of knowledge and competence, play a current role in this respect: Learning - which is a precondition for human development (Vygotsky 1978) is an individual matter of fact, but influences and is influenced by a social and participation framework. The individual worker makes a contribution to the development of the work communities, and thus indirectly to her own development and learning process, (cf. Engeström 1987). Learning is then an integral and inseparable aspect - and one of the characteristics - of work practice (Lave and Wenger 1991). This means that «learning must be understood with respect to a practice as a whole, with its multiplicity relations - both within the community and with the world at large» (ibid., p. 114).

Based on such a perspective, learning is considered a bridge between the development of individual knowledge and competence, and the development of work communities as a whole.

3 The three aspects of human activity

The main concept of activity theory is human activity mediated by artefacts. An activity is a concept connoting the function of the individual in her interconnection with the surroundings. The artefacts mediate an activity in such a way that the relation between the indi-

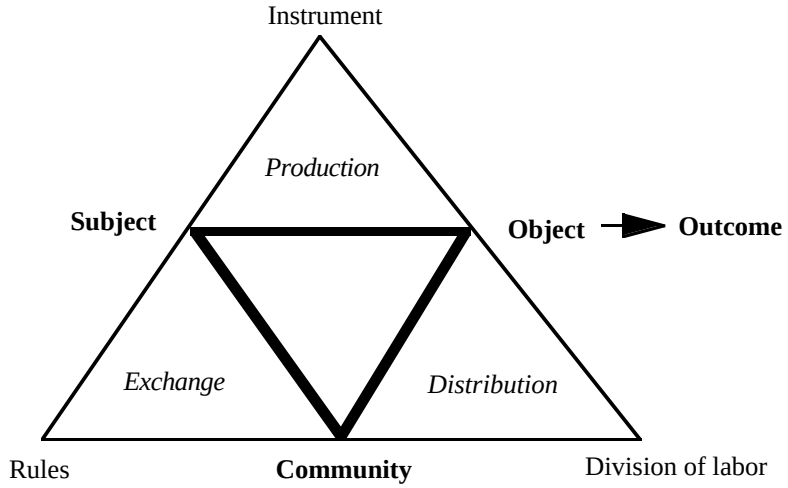
vidual and the material world is established (Leontjev 1983b). Activities are not isolated units, but are influenced by other activities and changes in their environment.

The strength of activity theory in respect to design of computer application, is that every aspect of human activity is mediated by artefacts, including computer-based artefacts.

Engeström (1987) has developed a structural model with basis on the concept of activity, and has embedded cultural mediated relationships to it. Cultural mediation is in his model dealt with by replacing binary relationship with mediated relationship (Kuutti 1994). According to Engeström, the simple structure of the specific human activity - the work activity or the productive activity (Leontjev 1983a) - is not sufficient to explain the relations between individual and her environment: «Human activity is not only individual production. It is simultaneously and inseparably also social exchange and societal distribution.» (Engeström 1987, p. 144). Engeström has then introduced two new mediated instruments - rules and division of labour. The subject's (human beeing) relation to the community is mediated by rules, and is termed exchange. The relation between the community and object is mediated by the division of labour and is termed distribution. In other words, human activity always takes place within a community governed by a certain division of labour and certain rules. Each of the mediated terms - instrument, rules and division of labour are historically formed and imply further development.

The three dominant aspects of human activity are thus production, distribution and exchange, and will be presented in relation to cooperative work in section 4. The graphical model illustrating the mediating terms and the aspects is shown in Figure 1.

Figure 1. The structure of human activity , (Engeström 1987)



4 Understanding cooperative work arrangements in terms of activity theory

In section two, we presented the following aspects, crucial for cooperative work:

- Individual work
- Articulation of work
- Inter-human conflicts
- Learning as an inseparable and underlying factor of work, and a precondition for development of work communities

With basis in activity theory, Yrjö Engeström (1987) has developed a model for human activity which we find current in this respect. The model is an analytical viewpoint for human development, which Engeström considers as «necessary and always present ingredient of learning» (ibid., p. 157). He also emphasises the dialectical role between social and individual development in his zone of proximal development, which he defines as the «distance between the everyday actions of individuals and the historically new form of the societal activity that can be collectively generated as a solution to the double bind potentially embedded in (...) everyday actions» (ibid., p. 174). Engeström extends the study of learning beyond the context of pedagogical structuring, and taking into account the conflictual nature of social productive practice - work. According to Engeström, learning and work can not be considered as two inseparable aspects.

The learning aspect of work is an underlying assumption for our framework, but we will not consider learning further, but focus on the three dominating aspect of human activity - and its relationships - which we find current in understanding cooperative work.

We have brought up crucial factors for understanding cooperative work as interdependence in work. The crucial factors are individual work and inter-human relations (including conflicts).

To design, we need to structure the complexity of cooperative work. At the same time, the framework can not simplify this complexity in such a way that the crucial factors not are taken into consideration. Engeström's model is useful in this respect.

The aspect of exchange describes the subject's - understood as an individual with her own experience, knowledge, skills, professional and social background - relation to a community. This community is understood as the cooperative work arrangement, i. e. those who shall work together to reach an outcome. One example of a community is an IS development project, where the superior work is to develop computer applications. A characteristic feature of such cooperative work arrangements is that they consist of individuals from different disciplines, with different professional backgrounds and experience, and has different organisational identity. The communication and interaction among these individuals are mediated by rules. These rules may be formal and informal rules of communication bounded by the work arrangement itself and the structure and cultures of the work organisation. These rules may vary between the different representing disciplines, and may itself be sources of conflicts.

Since the aspect of exchange considers communication between individuals of a work arrangement, inter-human relations and conflicts are implicit taken into consideration.

According to Karl Marx, work is shaped by the demands of a specific system of production (Thompson and McHugh 1990). Work and production are thus closely related to each other. The aspect of production is understood as the individuals' relation to work tasks that have to be done within a cooperative work arrangement. These relations are mediated by various kinds of tools, signs, traditions, theories, methods, techniques, etc.

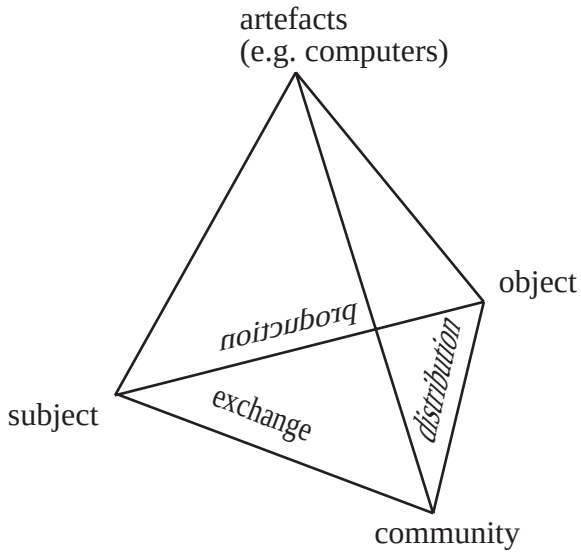
The last aspect of Engeström's model is distribution, which is the relation between cooperative work arrangement and the whole work to be done. This relation is mediated by the work organisation. The

work organisation can be understood as a frame of power and control in relation to organisational hierarchies and functional roles. Power and control are necessary factors in any division of labour, to articulate both individual and cooperative work tasks of a cooperative work arrangement. But power and control can also have a negative consequence in the way that these functions can represent filters to keep the harmony of the work organisations (Borum and Enderud 1981), and can represent a «hamper» in the process.

4.1 The notion of incorporation

The interconnection between these three aspects is crucial in understanding cooperative work as interdependence in work. In any cooperative work arrangement, neither of these aspects can be considered separately, because they all influence each other continuously. Interhuman communications and interactions mediated by rules, may influence the way individual and cooperative work is carried out. Individual and cooperative actions may influence and change and whole work organisation, and the work organisation influence these actions. The work organisation also influence what kind of instruments that is used in work processes, and the instruments may in turn influence the work organisation and division of labour. Figure 2 shows our idea of artefacts, in this setting most notable the computer, penetrating every aspect of a cooperative work arrangement.

Figure 2. Computer applications as artefacts in cooperative work



Relatively many researchers and designers within CSCW assume that cooperative settings are closed rationale systems. Rationale systems describe collectives which are oriented toward the pursuit of relatively specific goals and exhibiting highly formalized social structure (Kling and Jewett 1994). Closed systems means that all key influences on behaviour come within the identified organization. In this sense a closed rationale system is a task system where upper management guide subordinates toward clear goals through explicit strategies (Ibid.). Within this perspective on cooperative work it make sense to talk about computer support. Designing a system for support require that system analysts and designers understand the work practices, schedules, resource constraints, and other contingencies of the people who will use the new computerized system. We believe that this is only possible within a perspective of rationale systems.

A totally different approach of design is introduced by Kling (1994), called Web-analysis. Web-analysis locates computer system and people in relationship with other people, organizational settings, and technologies on which they depend. Web-analysis makes it possible to examine how computers and people «work» and how they can effectively be changed and sustained. The main point is to look at compter-systems, people, resources, etc. as part of a infrastructure. When looking at computer-systems as a part of an infrastructure, it make sense to use the term incorporate instead of support. When talking about a computer-system incorporated in a social setting, the importance of the computer-system impact on social behaviour is emphasized. We use the term incorporated instead of support, because we see computer-systems as something that both impacts and are beeing impacted by social behaviour, most important in this setting, work.

This framework for understanding cooperative work and design of the incorporated role of computer based artefacts in relation to cooperative work, should be considered as a guide. The model is - like its basis, Engeström's model - very abstract, and can then not be considered as a completed model for design. However, this is also the strong point of the model, in the sense that various theories (the theory of structuration (Giddens 1990), transaction cost theory (Ciborra and Olson 1988), articulation work (Schmidt and Bannon 1992) can be applied within current aspects to structure the analysis. Studies

from various fields of research and observations can also be used in suitable aspects, to understand the usage of different computer applications.

5 Our framework as a guide for metaphorical design

Interpreting the most common metaphors used in design of computer systems in the light of our framework, yields a different meaning to them.

Traditionally, design based on a perspective emphasising the user's confidence in work is often based on a tool-metaphor. In the UTOPIA-project (Bødker, et al. 1987; Ehn 1988) the basic idea was that tools for craftsmen should be the basis for development of computer systems. The basic idea was that computer based applications should be designed on basis of the traditional practical understanding of tools and materials used within a given craft or profession. The computer applications are considered as tools like hammers, trowels, knives, etc. The attention for the craftsman is related to the work and not the tool applied. Similarly, the computer application as a tool, should allow the user to concentrate on the goal of her actions and not on the tool used to carried out her actions.

Another design metaphor applied, relevant for CSCW, is the medium-metaphor. This metaphor considers the computer applications as medium for communication among individuals or organisations that wish to be interdependent in some way. The computer applications based on such a perspective are based on various theories understanding verbal communication. Examples are traditional e-mail systems and the Coordinator (Winograd and Flores 1986).

5.1 New interpretation of the metaphors

In cooperative work processes, the workers are continuously involved in numerous work tasks - both individual and cooperative. The worker shifts continuously between these various activities depending on the current situation. The intertwining of these work tasks and communications creates a web of work tasks for both the individual worker and the work arrangement. There are mutual constraints among the nature of cooperative work, the ways in which it is divided among work group members, the modes of interactions

and communications required to make division of labour appropriate, and the individuals' conflicting needs for both cooperative and solitary activities to accomplish their assigned portions of work.

These factors of work and cooperative work indicate that a separate tool-perspective or medium-perspective not is sufficient in design of computer systems for cooperative work. Computer applications have different roles in different situations, and these roles are not necessarily identical (Reder and Schwab 1990). The computer applications have then to be incorporated in various cooperative work tasks to offer future users a confident, flexible and effective cooperative work process.

In the context of cooperative work, the medium perspective can be useful to understand the mediated role of computer applications in the relation between subject and community. The tool-perspective can be useful to understand the mediated role of the computer applications in the relation between subject and object. And the system-perspective can be useful to understand the mediated role of the computer applications in the relation between community and object.

The underlying assumption for Engeström's model is that every human activity must be related to social praxis, and that artefacts influence and are influenced by social praxis. The interconnections between all the aspects of human activity, underline interdependence in work, and that the artefacts (including computer based applications) are penetrated into each of the aspects.

The computer has different roles in different cooperative work aspects and that these roles are not identical. It is important to consider the computer as a mediating artefact for individual work, inter-human interactions and communications, organisational performance and control, and the relation between all of them at the «same» time. With this in mind, we emphasise that design of computer applications has to be related to the human activity as a whole.

The tool and medium metaphors get a different meaning when interpreting them in terms of our framework. They must be interpreted in the light of the fundamental assumption that all aspects of an activity form an organic whole. This implies a new interpretation of the metaphors. The toolness of the computer now becomes an intrinsic part of the other metaphors, making it hard to understand in isolation.

This work will be furthered by empirical studies of use of Lotus Notes and other products used in cooperative work arrangements, to allow our framework.

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