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Cooperative Model Production in Systems Design to Support Knowledge Management

Christoph Clases
ETH Zürich, Institut für Arbeitspsychologie

Abstract

The computer support of cooperation and knowledge production across socially distributed activity systems has become an important topic in the context of the discourse on „knowledge management". The present article will draw on concepts of cultural-historical activity theory to discuss the problem of how the notion of „knowledge" is conceptualized and implicitly implemented in computer systems to support knowledge management, often neglecting the social embeddedness of knowledge production in everyday work practices. From the point of view of cultural-historical activity theory we would propose to look upon the generation of knowledge as a process embedded in socially distributed activities that are constantly being reproduced and transformed in and between specific communities of practice. The concept of cooperative model production is highlighted as a means to mediate, not to eliminate, differences of perspectives involved in the course of systems design. Empirical results of a case study will be presented in which the Repertory-Grid has been used to visualize similarities and differences of potential users' viewpoints and requirements in early stages of systems design.

1 Introduction

In the course of software development, actors representing different communities of practice (Lave and Wenger 1991) are interrelated in a division of labor. These actors are contributing different kinds of expertise: expertise in software design and development on the one hand and expertise in locally established work practices which are to be supported on the other hand. These different kinds of *interactive expertise* (Engeström 1992) evoke varying perspectives and anticipations concerning the process and the anticipated features of systems to support cooperative work. We hold that *different perspectives* (between software designers as well as between software designers and anticipated users at work) involved in design should not only be looked upon as barriers but may also become potential driving factors for the development of systems to support knowledge management.

Thus we are in need of methodological approaches and practical methods to make these different viewpoints – as situated constructive critiques towards the anticipated use and benefit of computer systems – explicit in the course of software development. This holds especially when a participatory design strategy (Floyd 1993, Muller and Kuhn 1993, Trigg and Anderson 1996) is pursued as software development represents a field of negotiation in different settings and political arenas (Gärtner and Wagner 1996). The concept of „cooperative model production" (Raeithel and Velichkovsky 1995, Raeithel 1998) will be introduced to identify methods and means helping to inform software designers and users in stages of "co-construction" (Wehner et.al. 2000) about possibilities to visualize, i.e., to symbolically objectify, and communicate similarities as well as differences in perspectives involved in the process of software design. Outcomes of an empirical study on the experience-based elaboration of software requirements for knowledge management will be presented. In this study the Repertory-Grid technique (Kelly 1955) was used to make visible common and divergent perspectives on the anticipated new software to support the tracing of knowledge gained and experiences made across R&D-projects.

2 Computer Support for Knowledge Management

Knowledge management in recent years has become a popular topic in organization sciences (Nonaka 1994, Davenport and Prusak 1998, Tuomi, 1999). In this discourse „knowledge“ is often not only identified as the new dominant production factor in post-fordistic societies but as a product on its own. Thus - from an economic perspective – knowledge needs to be *located and estimated* in order to determine its exchange value. From this perspective, „knowledge“ may easily become reified as an isolated entity abstracted from its practical, process- or problem-driven actualization in situated actions (Suchman 1987).

Linked to the discussion on systems support for knowledge management an interesting discourse about the creation of „organizational memory information systems“ (Stein and Zwass 1995) has been going on in the last decade. „A Corporate or Organizational Memory can be characterized as a comprehensive computer system which captures a company's accumulated know-how and other knowledge assets and makes them available to enhance the efficiency and effectiveness of knowledge-intensive work processes“ (Kühn and Abecker 1997, p. 929). In the research domain of Computer-Supported Cooperative Work (CSCW) a much more modest approach is proposed, i.e. to *augment* organizational memory by the design of CSCW systems. Ackerman (1994) argues in favor of a perspective on organizational memory that keeps in mind organizational, technical, and *definitional* constraints that are of relevance for the development of software tools. In a further critique it has been proposed to shift the perspective on „organizational memory“ towards processes of „active remembering“ (Bannon and Kuuti 1996). The authors here refer to literature in which the predominant use of the metaphor of organizational memory reflects an understanding of memory as a passive storage space for information and knowledge.

From the point of view of work psychology, we argue against a technology driven, functionalistic approach to knowledge management and in favor of an understanding of everyday activities. We promote a process oriented approach to knowledge management, taking into account micro political implications and tensions brought about by different actors, perspectives, goals and motives involved. In our case study that will be discussed towards the end of this paper, we have dealt with these very definitional constraints in early conceptual stages of software development by eliciting requirements for a project database to support knowledge management practices.

2.1 Conceptualizations of „knowledge“ and „memory“ – implications for systems design

A way to make clear our conception of knowledge is to oppose it to still dominant approaches in the cognitive sciences, based on the physical symbol systems hypothesis (Newell and Simon 1972) focusing on symbolic representations of the „outside“ world „in the head“, i.e. in cognitive structures of individuals, and leading to the dichotomies that reproduce the Cartesian gap between mind and body, between cognition and world. These dichotomies have been widely criticized, especially because of the separation of culturally embedded social practices from cognitive processes.

In the literature on computer support for knowledge management we often find quite inconsistent arguments about the concept of knowledge, however, the implicit effort to *locate* and *fix* units of knowledge (e.g. as propositions related to rule-based production systems) seems to be a common characteristic. If we shift the focus from attempts to spatio-temporarily locate („ready made“) *knowledge* here or there, inside or outside people's heads, to a perspective that is interested in practices of *knowing* (Blackler 1995) we take a completely different stance to the unit of analysis. Then the process of actualizing, transforming and generating new knowledge could

only be understood, when we analyze the situatedness of work practices in a socially distributed activity system in which practices of knowing are embedded (see figure 1).

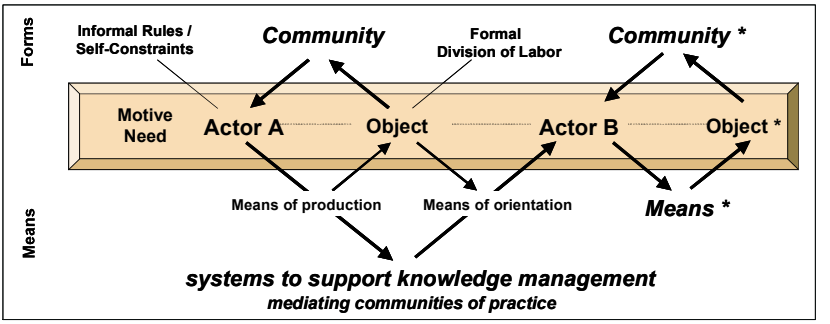

Fig. 1: CSCW systems mediating between socially distributed activity systems (based on Engeström, 1987; Raeithel, 1992)

The implications for the design of computer support for knowledge management connected to the tradition criticized above are quite far-reaching. If those premises are referred to as the design of „organizational memory information systems", organizational memory becomes a repository in which knowledge is „stored" and from which knowledge may be „retrieved" – across different contexts – when needed in the very same condition as it has been produced, i.e. has been „transferred" (better transformed into information) into a database. In this case the most significant tasks for the computer support of knowledge management would be to acquire knowledge entities and to optimize the storage, navigation and distribution of these separable units of knowledge in databases. The critique here is not that some of these systems (expert systems, intelligent agents, etc.) would not fulfill certain useful purposes, however, if they are taken as the „whole story" the embodied, contextual, socially distributed and process-related character of knowledge and cognition is being neglected.

2.2 Socially distributed activity systems and the production of knowledge

From the point of view of activity theory we would propose to look upon the generation of knowledge as a process embedded in socially distributed activities that are constantly being reproduced and transformed in and between specific communities of practice. Thus, the generation as well as the actualization of knowledge would be bounded to specific contexts and strongly depend on shared understandings that emerge from the practice in which joint activities are embedded.

Engeström (1987, p. 78) and Raeithel (1992, p. 407) have proposed similar schemes to represent Leont'ev's (1978) basic differentiation between activity, action, and operation in a conceptual framework modeling a *socially distributed activity system*, which is proposed to be used as the key unit for analysis of work practices. One of the core ideas of activity theory is that human activity is *mediated* by societal forms as well as operative means. Figure 1 is based on these schemes and visualizes computer systems as mediating the joint activity in or between communities of practice.

The figure shows that the joint activity evolving between different actors is mediated – on the level of societal *forms* – by informal rules, self-constraints and a certain division of labor that historically evolve in communities of practice. On the other hand, the interaction between actors in computer-supported work places is being structured – on the level of operative *means* – by the characteristics of the specific software in use. The software will provide actor A with *means of*

production, i.e. features to generate certain *objects*, which will then be represented for Actor B by the use of the system providing *means of orientation*. The artifacts produced may be looked upon as symbolic externalizations of a specific practice. Therefore, when using a system that is to support knowledge management practices, Actor A has to transform her experiences made and *knowledge* gained into a certain document. For Actor B, this externalization of a specific practice in the first case appears as *codified knowledge,* i.e. *information* that *might be useful* in another context. Depending on the way in which the context of generating the information is presented, Actor B will be more or less able to put it into perspective. In other words: Knowledge may not immediately be „transferred" but is *transformed* by processes of codification and interpretation. Thus, knowledge may not be fixed once and for all. A design philosophy that is committed to the insights of activity theory should take into account the diversity of meanings across socially distributed activity systems „providing technical support for their ongoing, local negotiation" (Agre 1995, p. 188).

As Ackerman (1994b) pointed out, the design of CSCW systems to augment organizational memory faces *definitional constraints* due to varying redefinitions of what should be considered as a – maybe already existing – system augmenting the organizational memory within a specific company. When it comes to the design of software to support the generation and exchange of knowledge, one way to conceptualize an organizational memory is to provide a „common information space" (Bannon and Bodker, 1997) which may serve as a boundary object between different viewpoints resulting from the varying situatedness of work practices. Following Star (1989), boundary objects are: „(..) weakly structured in common use, and become strongly structured in individual site-use. Like the blackboard, a boundary object ‚sits in the middle' of a group of actors with divergent viewpoints" (Star, 1989, 46). When using the blackboard as a metaphor, the question arises how to structure the blackboard in order to cope with the necessities of local and common use, and how to make visible and negotiate the requirements for a software system in order to anticipate which „chalk" would serve as a good complement.

3 The Research Methodology: Cooperative Model Production of System Requirements

Co-construction as a form of joint activity (Wehner et.al. 2000) may be described as a process of questioning well-established practices and negotiating possible new forms of activity: „(..) in co-construction an attempt is made to generate organizational solutions that transcend single cases. Co-construction, as a specific form of expansive cooperation, differs in its underlying structure from coordination and cooperation because the focus of attention now lies in the common redefinition of roles, work objectives, and patterns of interaction" (Wehner et.al. 2000, 990).

In order to explore system requirements from the point of view of its potential users, the *repertory grid technique* based on personal construct psychology (Kelly 1955) has been chosen. Kelly has based his considerations on the consideration that cognitive as well as emotional-motivational processes are related to personal construct systems, which should be themselves looked upon as condensations of a life-long learning process. These personal construct systems are related to socially shared meaning systems and enable us to orient ourselves in the world, to act, to decide and to develop personal theories about specific life domains. As personal construct systems at the same time generate expectations and anticipations they are not only helping to orient ourselves in various context, however, they also open up and at the same time reveal potentials for future action (Bannister & Fransella, 1986). Therefore, *a construct system consists of* subjectively relevant differentiations – our *personal constructs* – which we apply to *elements* of our everyday life like other persons, specific roles, situations or certain objects. As the Rep-Grid also helps to investigate in subjectively perceived similarities and dissimilarities of certain elements (in our case these elements will be means to communicate experiences and knowledge across dif-

ferent R&D-projects), the methods supports the visualization of differences on which everyday decisions are based. The repertory grid supports the cooperative modeling of subjective viewpoints and thus helps to visualize and communicate varying perspectives on a specific problem domain (Raeithel and Velichkovsky, 1992). In the last decade, scholars in personal construct psychology have repeatedly demonstrated the possibility to make tacit knowledge (Polanyi 1967) explicit by applying the repertory grid technique (Gaines and Shaw 1992). The repertory grid is a research method on the border between qualitative and quantitative research methods. On the one hand, repertory grids model the individual perspective of our respondents as the elicited constructs represent the subjective differentiations and evaluations with respect to the elements in question. On the other hand – due to *the systematic evaluation of all elements on all constructs* leading to a matrix of elements and constructs – the resulting grid structures may also be analyzed by applying statistical procedures.

4 The Case Study: Visualizing System Requirements for Project-to-Project Transfer in Knowledge Management

In the following section an empirical example will be presented of how concrete practical questions in systems design may be supported. In an interventionist project we have supported the process of cooperatively modeling the requirements for a new software by drawing on the experiences of its potential users. The objective has been to make visible similar as well as diverging points of view in early, conceptional stages of the design process.

The research presented here is going on in a medium-sized company (about 200 employees) which is part of a larger holding for which R&D projects as well as service projects dealing with core technologies are being realized. Two members of our research institute are part of a core team that has been established to re-define what knowledge management would mean for this specific company and to develop innovative knowledge management practices, that are related to the requirements of everyday work. Preceding analyses revealed that the transfer of experiences made and knowledge akquired in the course of R&D-projects was looked upon as a severe weakness within the company. The exchange of experiences across projects, groups and departments is further complicated due to the fact that employees are distributed across various company sites. Within the core team, the idea was born, to augment, support and trigger new forms of project-to-project transfer by developing a project database. However, the decision was taken not to start chosing or developing a specific technology before the perspectives of employees were taken into account. In order to work out requirements for this project database 16 employees – representing various hierarchical levels and departments of the company – have been interviewed using the Repertory-Grid. The idea therefore has not been to identify knowledge that might be transferred into contents of a database, but to generate system requirements by contrasting anticipations towards a project database with evaluations of well-known practices of communication and documentation of project-related knowledge.

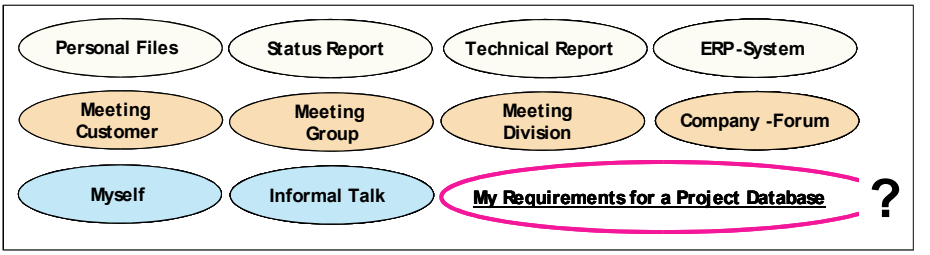

Figure 2: Elements of the Repertory-Grid-Study

The requirements for the project database should be developed in comparison with and in contrast to well-known organizational and technical means to support project-to-project transfer in the company. Thus, in total 11 common elements were defined (see figure 2), one of them called „my requirements for a project database“ in order to grasp the expectations towards the new system. The personal constructs that have been elicited in the course of the interviews consist of conceptual oppositions in the wordings of the interview partners. Thus, as highlighted above, each construct comprises two conceptual poles and represents a subjectively relevant differentiations between the elements that define the problem domain. In the graphical visualization (figure 3) – a biplot based on the computation of a principal component analysis of elements and constructs for the elicited grids – distances and angles between elements (indicated by squares) may be interpreted. The results for all 16 interviews are being presented in the biplot representing the two main dimensions that explain similarities and differences perceived along all 11 elements. This biplot represents the common meaning space across all interviews. The closer angles and distances, the closer the correlation. The two statistically most important dimensions explaining the variance in the grid are visualized. Similarities and differences between the elements are due to our respondents evaluations based on their personal constructs. A qualitative analysis of all personal constructs lead to aggregated codes that explain the main directions in this meaning space. We allowed all respondents to relate both poles of a construct to a specific element in order not to force them to apply a strictly dichotomous way of thinking.

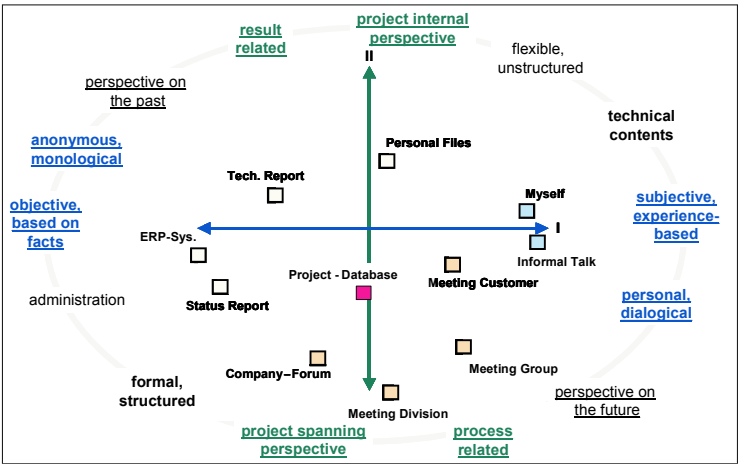

Figure 3: Dimensions 1 and 2 (n=16), explaining most variance across elements and constructs

The results – across all respondents – reveal, that in relation to the two most significant dimensions, the element „(my requirements for a new) project database“ is the most ambivalent element of all. Especially when interpreting the first dimension of the biplot (explaining most variance across all elements), it becomes obvious that the constructs formulated represent the tension between requirements that highlight *subjective, experience based* and *personal, dialogical* aspects of project-to-project transfer on the one hand and constructs that in contrast adress issues like an *anonymous, monological* style, and *objectivity* and the wish that the database is *based on facts*.

As to this first dimension, the company's „ERP-system“ is judged – across all respondents – in a complete different way: It is viewed as objective, and based on facts, however, it is not perceived as allowing any subjective, experience-based or personal aspects, which especially holds true for „informal talk“. The second dimension may be explained by the contrast between a project internal and project spanning perspective as well as by the contrast between process and re-

sult related aspects of project-to-project-transfer. There is a tendency to be identified that the interview partners prefer a support that is process-related and focusses on a project spanning perspective.

Comparing the structure of all Repertory-Grids by cluster analyses it has been difficult to identify clearly distinct clusters. However, two sub-groups could be identified (see figure 4). The comparison of these two local meaning spaces (each of them representing three respondents) shows that members of Group A look upon a new project database as a kind of file system with a strong focus on clear formalization and structuration. The primary end of such a database should be the storage of documents with an objective, more past-related and concluding character.

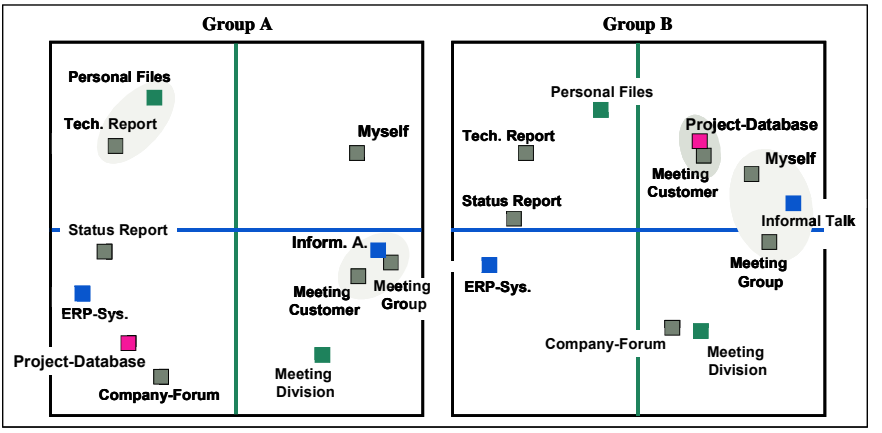

Figure 4: Comparison of two sub-groups

The requirements formulated by our interviews partners representing group B look for a system for dialogical use in everyday R&D with strong focus on flexible handling and use. They want the project database to have a strongly process- and future-related and experience-based character.

One of the main ideas of the cooperative model production is, that it is *not* meant to be used as a means for expertocratic diagnostics (Raeithel, 1998). On the contrary, the idea is to bring together different types of (methodological and field related) expertise in order to cooperatively work out external symbolizations of subjective perceptions. That is why we used the graphical visualizations presented here in the core team to give on the feedback of formulated user requirements. The heterogeinity of results showed, that „definitional constraints" – in this case with regard to the „requirements for a new project database" as a means to augment organizational memory – could also be observed in this case.

As a concrete result of our research, the core team in charge of promoting knowledge management projects within the company re-considered its approach taken so far and started to re-define its task: The discussion about how to organizationally embed a project database was triggered again. The need for a broader understanding was formulated in order to take into account the experience-based requirements. At the same time it became obvious that the concrete „embedding" of a new project database in the overall knowledge management processes still needed more clarification. The overall idea to implement a new software to support knowledge management is still pursued, however, it has become clear, that the conceptual integration will need some more time, before a concrete choice could be made. Time and work that will hopefully avoid some of the pitfalls mentioned above and enable an implementation that takes into account the perspectives of various actors.

5 Conclusion

When summing up the considerations brought forward in this paper we may conclude that in the design of new computer systems to support knowledge management as a work-practice on its own there is the need to take into account similarities as well as differences in the perspectives of actors, acknowledging the diversity of meanings and contexts especially when crossing boundaries of socially distributed activity systems. From our point of view the computer support for knowledge management practices should rather help to mediate than to reduce differences between actors' perspectives and locally evolving work practices. This would be a question of improving means for co-constructing perspectives representing different communities of practice and to commonly produce symbolical externalizations of core aspects of their work practice.

Software design for knowledge management implies a step across the border by exploring the worlds of thought and practice of different actors involved. From our point of view the effort to communicate perspectives of different actors involved does not need to follow the aim of harmonizing and integrating all perspectives involved in a one-best-way. On the contrary, the development and the implementation of tools for knowledge management will always induce unpredictable changes in work practices within the overall activity system. A newly developed software for mediating joint activity does not only represent a new means to some specific ends, but always has the potential to set free new ends in its actual, often unforeseen forms of use. Thus far, software development represents an open-ended process, as long as it not conceptually restricted to the laboratories but reaches out in real-world settings by taking into account experiences, perspectives, and knowledge arising from practical use.

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Adressen der Autoren

Christoph Clases
ETH Zürich
Institut für Arbeitspsychologie
Nelkenstr. 11
8092 Zürich
Schweiz
clases@ifap.bepr.ethz.ch