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Olav W. Bertelsen
University of Aarhus, Denmark, OlavWBertelsen@emailaddressnotknown

Susanne Bødker
University of Aarhus, Denmark, susannebodker@emailaddressnotknown

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INTRODUCTION

Information Technology in Human Activity

Olav W. Bertelsen
Susanne Bødker

Department of Computer Science, University of Aarhus, Denmark

INTRODUCTION

The use of information technology is penetrating a still wider part of human life, linking areas of human life and making different media and technologies converge and dissolve into new ones, broadening the scope of interest for ISD research accordingly. Various academic disciplines deal with issues related to the use and development of information technology: information systems research, human-computer interaction, computer supported collaborative work, theoretical computer science etc. As these disciplines are getting more and more intertwined and interdependent the need for an integrating conceptual basis is becoming urgent. The hypothesis behind the present collection of papers is that activity theory is such a suitable theoretical basis.

In their recent review of 10 Scandinavian approaches to information systems design, Iivari & Lyytinen (1998) point at the strengths and weaknesses of activity theory. For the strengths, activity theory is a promising background theory of social action, the concept of activity is a potentially useful concept to structure the organisational context and the research community is an expanding one. As weaknesses they claim, that the theory is very general, that there is not fully elaborated ISD approach and that the language context is weakly addressed.

In her collection of papers regarding the application of activity theory to human-computer interaction, Nardi (1996) suggests that activity theory is a powerful descriptive tool rather than a predictive theory. It offers a set of perspectives on human activity and a set of concepts describing this. According to Engeström (1987) activity theory does not offer ready-made techniques and procedures for research, rather its conceptual tools must be concretised according to the specific nature of the object under scrutiny. When Iivari & Lyytinen point to the generality and lack of fully elaborated ISD approach, the answer one the one hand might be the obvious one, namely that there isn't much more to it than the set of general concepts. Or, the answer might be to develop further the concrete tools regarding ISD. Hopefully the reader will find that this volume contributes to the identification and explanation of the few central concepts, as well as to the development of concrete tools regarding ISD.

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This issue presents a series of papers looking at information system design and use. Some of the papers look at ISD interlinked with human-computer interaction - the mediation of individual human actions by technology, developing as the user gains experiences with the particular piece of technology, as well as with the wider activity of use. The wider activity of use is covered through the concern of the collection for e.g. the changing character of work influenced by information technology, distribution of activities and the emergence of inter-organisational communities. And not least does the volume deal with design of these technologies so as to accommodate for use in the narrow as well as in the wide. Most papers have their roots in presentations by the authors at the ISCRAT Congress in Aarhus in 1998, thus sharing activity theory as an important theoretical perspective. The ISCRAT congresses are the quinquennial meeting place for a large and expanding interdisciplinary group of researchers, from artificial intelligence and mathematical didactics via work psychology to philosophy and sociology, who all share an interest in activity theory and socio-cultural research. Many of the authors of this special issue find their main field of interest in Participatory Design or Information Systems, Human-Computer Interaction, or Computer Supported Cooperative Work; fields which all address the emergent activities of ISD from interdisciplinary perspectives.

Integrating use and development

Common to the activity theoretical studies of IS is that information systems are looked at in use and not in isolation. The studies look upon IS from the point-of view of how they mediate particular activities. Looking at IS in use sometimes means a focus on the narrow use activity and the handling of the computer artefact, typically in the HCI studies. In other cases the context is much wider, e.g. focussing on the web of activities of use and design. One of the forces of activity theory is, however, that it allows for studies of all these levels of activity to be combined, applying one and the same set of concepts. These many levels of analysis are the particular focus of this volume: We are concerned with a particular kind of artefacts - Information systems, and the activities that they shape (use) and in which the are shaped (design).

Engeström & Miettinen (1999), maps out the relationships of activity theory to most resent theoretical trends in the social sciences, including pragmatism, symbolic interactionism, actor-network theory, Wittgensteinian approaches, including situated learning and semiotics. It is of little surprise to readers of SJIS that these traditions have played important roles in attempts to reframe ISD research. Interestingly, it is largely these very same theories that have found their way into other fields of studies concerned with the emergent activities of ISD (Human-Computer Interaction, Computer Supported Cooperative Work), as alternatives to traditional cognitivist and behaviourist approaches. Examples of this in HCI are Nardi's (1996) as well as Plowman et al (1995) combination of activity theory and ethnomethodology. In CSCW Bücher et al. (in preparation) have moved along a similar path, relating also to actor-network theory. Star (1996) has worked to combine symbolic interactionism and activity theory in CSCW and in information systems design, and Engeström & Escalante (1995) have combined activity theory and actor-network theory in their study of design and use of a public information system.

Star (1996) illustrates how empirical studies of work practice originating from symbolic interactionism, and the activity theoretical approach to understanding historical and material specificity

"afford" each other, politically, aesthetically and scientifically through their insistence on anti-idealism, anti-individualism and a dialectical model of development. She points out that:

> "Two things are occurring quite rapidly in the modern world. The first is the failure of rationalism to account for or to prescribe people's behaviour (which is not new), and what is new, a large interdisciplinary movement in the academy and in the sciences that is documenting this state of affairs. The second is the rapid rise of information technologies, which are insinuating themselves into the conduct of work, being integrated with each other in new kinds of international networks, and also being embedded with each other to produce a newly complex state." (ibid, p. 310)

She ends by saying:

> "I believe that jointly activity theory, interactionism, and information-systems research have some important insights to offer scholarship and development. We know that, in spite of the failure of rationalism, the world does not fall apart. We've begun to understand that the absence of a monolithic voice does not mean chaos or babble, but pluralism, and that requiring translation." (ibid. p. 313)

ACTIVITY THEORY IN ISD RESEARCH

Whereas Star (ibid.) points to the potential of applying activity theory in ISD, Ivari and Lyttinen (op cit.) imply that activity theory hasn't yet made as a great impact within the ISD community as it has in other computing disciplines dealing with human use and design of information technology, e.g. human-computer interaction, computer supported collaborative work and participatory. However, the direct focus on pluralism and the role of cooperation between users and designers has made important contributions to our understanding of ISD as a whole (Bertelsen 1996, 1998, Bardram 1998, Mogensen 1994, Sjöberg, 1994, Timpka & Sjöberg 1994), and several groups have presented interesting results as regards the application of activity theory to traditional ISD, e.g. the work on requirements by Turner et al. (1999) and works on executive information systems by Hasan et al. (e.g. 1997).

Work in line with the present issue has been reported in a number of books, not least Nardi (1996) and Engeström & Middleton (1996). In the Scandinavian tradition of ISD research, activity theory has been an important theoretical foundation for a large number of Ph.D. students and senior researchers since the late 1980s. As discussed e.g. by Bødker (1996), Engeström's change-oriented approach to work development (Engeström, 1987) provided a new conceptual framing of the Scandinavian participatory design tradition, the collective resources approach.

Looking historically at the developments of activity theory in ISD, the work of Kuutti (1991) and Bødker (1991) made their early impact primarily in human-computer interaction, not least through the researchers respective collaboration with Liam Bannon (Bannon & Bødker, 1991, Bannon & Kuutti, 1993). Originally this work was seen as a rather "exotic" alternative theory to cognitive science. However, some of the ideas have later been picked up by influential figures such as Don Norman, and developed further e.g. in Nardi (1996) and by the next generations of students in Aarhus, Oulu and elsewhere. Kuutti, as well as younger researchers such as Bardram (1998) have been instrumental in bringing activity theory to studies of computer supported cooperative work

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(CSCW). This move has been rather fruitful both because it extended the scope of analysis to include the entire activities of use, and because activity theory in this context met with other theoretical frames such as ethnomethodology and actor network theory, not least through the work of Star (1996), Suchman (1996) and Shapiro (1994).

Despite Iivari and Lyytinen's claim, we find that Activity Theory has become one of the theoretically sound voices that are heard in ISD research. In the following we will go into further detail about what it has to offer.

ACTIVITY THEORY AS A CONCEPTUAL BASIS

Activity theory takes motivated activity as its basic, irreducible unit of analysis. This unity implies that human conduct cannot be understood as the mere aggregation of behavioural atoms, and that consciousness is rooted in practical engagement in the world. In relation to ISD, computer artefacts have to be understood in their context of use, as embedded in meaningful activity.

Human activity is mediated by socially produced artefacts, e.g. tools, language and representations. This means that in their immediate relation to their surroundings, human beings extend themselves with artefacts that are both augmentations of and external to the person.

Activity can be understood as a systemic structure. Activity is object-oriented: it is a (possibly collective) subject's active engagement directed towards an object. This engagement is socially mediated by the community in which the activity is embedded or constituted. Changing parts of the systemic structure disturbs the balance or the entire structure.

Activity is realised through conscious actions directed to relevant goals. Actions are realised through unconscious operations triggered by the structure of the activity and conditions in the environment. The same act can change between the three levels in the course of learning and due to changed condition. When the guidance for an act is transformed from conscious interaction with external objects into an unconscious internal plan of action, internalisation takes place. Externalisation takes place when activity with one generation of an artefact is crystallised into the next generation of the same artefact.

Mediational role of artefacts

Computers everywhere in everyday life *mediate* our daily activities, whether these are in relation to things or other human beings. Activity theory has been concerned with this kind of mediation by a variety of mundane tools (See Kaptelinin, 1996) and of information technology (Bødker 1991, 1999, Bannon & Bødker, 1991, Bannon & Kuutti, 1993, Bertelsen, 1997). Activity theory gives a useful handle for understanding the mediators, and how they are shaped, in a dialectical relationship with the changing practice of use: In literature, Bardram (1998) has discussed common plans in a hospital ward, Bødker (1996) a filing and accounting system for a public office.

Activity theory has served well to inform analyses of IT-based artefacts in use, in particular in work. A wide array of methods and tools support this perspective, from historical analyses and ethnographical studies to schemes for focus shift analyses. Similarly, activity theory is getting a foothold for understanding design activities, structurally and processually (Bødker 1999, Koistinen, in prep., Korpela 1994). The change-oriented perspective on IT in use implies direct demands on how we do design, so as to accommodate for further change. And it needs to address further the

technical constitution of the artefact. Bertelsen (1997, 1998) has started to address issues of why object-oriented technology seems appropriate for an activity theoretically inspired design process. It seems to be one of the really big challenges for an AT informed design, how far one may actually be able to go? How close to technology? How design-oriented?

The Finnish developmental work research tradition (Engeström et al. 1996) offers for the time being the most complete methodological approach to activity theoretical work analyses and design, emphasising the continuous development of work. In the developmental work tradition, IT may be one instrument of such development, as described by Helle (this volume). However, Helle's paper is in a sense an exception within the tradition in that very few examples, thus far, have addressed the issues of IT in use and design. And little has been said about IS as a proactive instrument of change. This forces practitioners such as Korpela et al. (this volume) to seek their own approaches based in the theoretical frame of developmental work research.

IT in a web of activities

In much activity theoretical research the unit of analysis is, in one way or other, a particular work, or educational, activity, with its community of practice, actors, rules, division of work and tools, such as that of journalism discussed by Helle (this volume). In particular instances this analysis is expanded to several interlinked activities - be these interlinked historically, in what Engeström (1987) calls activity systems, or in other ways. When moving the focus from activities to IS as mediators of activities, we are faced with certain theoretical possibilities:

First of all, what allows us to generalise our investigations beyond sheer individual use of technology is praxis. By anchoring an analysis in *praxis*, the historically developed ways and means of groups of people undertaking a particular activity, we are able to balance the analysis between the general and the particular. Furthermore, as it is often the case with IT design, we need to explore an artefact that is not yet there, and the existing praxis is a valuable starting point for that (Grønbæk & Bødker 1996).

Existing praxis is historically shaped, and activity theoretical analyses help create links between the past, the present and the future, that are important for ISD. Bertelsen (1996) has analysed how praxis is crystallised and transformed in the case of a checklist used in planning a music festival. Ruhleder & Star (1994) have made similar analyses.

Studies of IS in use need to focus on the narrow use activity and the handling of the computer artefact as well as the wider context of use and design. One of the forces of activity theory is, however, that it allows for studies of all these levels of activity to be combined. It allows us to change scale and study connections on multiple levels of activities where IT is used and designed, without establishing a permanent hierarchy in the analysis (Raithel 1996, Bardram 1998).

(Bødker 1999), using Engeström's (1987) notion of an activity system summarizes how a computer application may have positions in a variety of activities in the web of design/use activities. As discussed by Engeström (1987) as well as by Mathiassen (1981) it is the tensions or contradictions between these positions that are the source of change.

In the same way as activity theory allows for a focus on the interlinking between design and use, it has developed a general focus of attention to technical solutions that crosses boundaries between activities, or support several coexisting activities simultaneously (Engeström & Escalante

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1996). In this special issue, several authors make use of combining Star's (1989) notion of boundary objects with an activity theoretical concern over interlinked activities. In other literature, actor network theory has been used in a similar vein.

Heterogeneity

Heterogeneity as a conceptual frame of analysis has come out of actor-network theory, and in the context of IT, not least of the work by Star (1996) (see also Law 1999). However, it is also profoundly embedded in all the studies of webs of activities that have been born from taking activity theory out of a pure educational context into situations of learning, etc. in work. One early example is Engeström and Engeström's (1989) work with doctor-patient joint construction of a patient diagnosis, where they point to the profoundly different understandings and models, that the two carry of the decease. Another example is Bødker & Grønbæk's (1996) analysis of cooperative prototyping. The focus on heterogeneity points to the profoundly different conditions that various groups (and individuals) have for participating in activities of design and use of information technology. Korpela et al's work (this volume) on systems development in Nigeria points to these condition at the global level, Spasser (this volume) and Fitzpatrick (this volume) for specific communities of work.

Development

The most distinct feature of activity theory when compared to other materialist accounts in computer science, is the emphasis on development. Because human activity is historically constituted and constantly developing, human use of technology cannot be meaningfully understood in terms of stable entities. Rather than labelling levels of consciousness, activity theory gives an account on the dynamics of and between such levels (Bannon & Kuutti, 1993).

Activity theoretical analyses have served as a basis for studying how people operationalize their use of artifacts of various sorts, including technology (Bødker 1991, Beguin & Rabardel (this volume) Bærentsen (this volume). Bærentsen's (1989) analysis of the development of hand weapon goes beyond that in presenting an analysis of the historical development of hand weapon interlinked with the development of their use as well as their context in terms of conditions of use.

However, Engeström's seminal work (1987) point to activity theory as a basis for development of work as such and points to a number of instruments for this, i.e. analyses of work continuously pointing towards the future as well as the past. Helle (this volume) is an example of how this tradition works regarding ISD. Bertelsen (1996, 1998), Bødker et al. (1995), Mogensen (1994) have all worked to apply this way of thinking as well as actual instruments from Engeström's work on ISD. And as pointed out by Bødker (1996) this way of thinking provides a useful theoretical underpinning to an already well-established action-oriented research tradition within ISD.

Design - use

With this volume we are particularly concerned with ISD, based on analyses of use, of present and future IS-based artefacts. As illustrated by Gasser (1986) and Bødker (1999) the use of rather rigid computer applications develops beyond pure adaptation by the users and as such, the computer application (even when built) is a source of changing practice, and from this perspective design

never seems to stop (Floyd 1987).

The interlinking between design and use, however, goes further than that. The design activity is constrained by the computer in various ways, through the actual, available materials as such through the past experiences of designers and users (Bødker et al. 1987).

Engeström & Escalente (1996) discuss the interlinked processes of design and use of a public information kiosk, illustrating how the conditions of both these processes are significant in shaping the actual application, and not least they are crucial for the success of the application-in-use.

Designers and users are in general parties in a number of interlinked, and partly overlapping activities, that we need to understand in order to make better design, and ultimately to create better IT-based artefacts. In these multi-practical design situations the experiences, resources, tools, etc. of designers meet, and sometimes clash, with those of the users, and with other involved. In our concern for the web of activities involving a particular IT-based artefact, the design activities are as such essential, and emphasise how our understanding needs to reach beyond the immediate use (Bødker 1999). In this special issue, the entanglement of design and use is addressed by Bødker & Petersen, Helle and Bertelsen.

Interdisciplinarity

Understanding and designing for IT in use in such an intricate web of activities demands from the researchers/designers a sensitivity towards technical as well as psychological, social and further matters, emphasising the interdisciplinary nature of the field. As already indicated The studies of information systems in use and design do not take place in a vacuum. In fact, most studies are as well as rooted in a interdisciplinary field of work, e.g. HCI or CSCW, also heavily inspired by other research-methodological traditions brought to those areas. Thus, activity theory has become a theoretical tool for ethnographical studies (e.g. Nardi (1996), in this volume Spasser), for participatory design (Sjöberg & Timpka 1994, Bødker & Grønbæk, 1996, Bødker & Petersen, this volume, and Beguin & Rabardel, this volume) as well as for psychological approaches (e.g. Greif 1991, and Bærentsen this volume).

THIS ISSUE

The present volume consists of this introduction, the eight papers, and the journal editors' foreword to this first special issue of SJIS.

In the paper "Design artefacts: towards a design-oriented epistemology", Olav Bertelsen explores a concept of design artefacts as a basic step in the development of a framework for production and appraisal of design-oriented knowledge, unifying concerns for use, design and research in information systems. The paper takes of from Wartofsky's (1973) theory of the historical development of perception.

Human-computer interaction is in focus in two papers, looking at the mediation of individual human actions by technology, developing as the user gains experiences with the particular piece of technology, as well as in a wider historical context.

In the paper "Intuitive interfaces", Klaus B. Bærentsen develops a notion of intuitive interfaces, based on the assumption that it puts less load on the user if interaction is based on spatial capabilities of perception rather than memory and symbolic processing. Theoretically, the paper

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combines basic concerns in activity theory with a Gibsonian approach to perception. The main example of the paper deals is about how to tune in the programs on a TV set.

In the paper "Design for learning in use", Susanne Bødker & Marianne Graves Petersen address development in use an important issue that hasn't been developed in the literature. Theoretically the paper is based Bardram and Bertelsen's (1995) account on how elements of the user interface support the development of transparent interaction. Empirically the paper is based on studies of learning to use a TV set.

The wider activity of use is covered through three papers looking at the changing character of journalism and newspaper production influenced by information technology, the distributed activities of telemedicine, collaborative publication services as emerging within botanical classification, and the general emergence of interorganisational web communities.

In the paper "Disturbances and contradictions as tools for understanding work in the newsroom", Merja Helle, introduces a study of the role of computer technology in changing journalism along a number of dimensions from substance to work organisation. The empirical study is an action oriented, long-term study of the introduction and emergent use of an editorial system in a large Finnish newspaper. The paper consistently applies a developmental work research methodology and theoretical stance. The paper concludes by pointing to the intricate series of changes caused through the combined introduction of computer technology, the action-oriented research and its participation of the journalists at the newspaper.

In the paper "Centres, peripheries and electronic communication: changing work practice boundaries", Geraldine Fitzpatrick separates out a number of dimensions of boundaries in work practices and technology, that are new in the literature. She discusses implications for design of distributed technology (electronic communication), and reflects those design implications back into the social domain. She uses the case of a telehealth project to illustrate and discuss its points. The paper mainly bases itself on Strauss (1993), and on Brown & Duguid's (1994) interpretation of communities of practice, and legitimate peripheral participation as introduced by Lave & Wenger (1991).

In the paper "Articulating Collaborative Activity: Design-in-use of Collaborative Publishing Services in the Flora of North America Project", Mark A. Spasser presents a case study of a collaborative publication services in the area of botanical classification. In this study of classification, the concepts of coordination mechanisms and boundary objects are confronted and further developed in an activity theory perspective. The empirical case reported in the paper is the collaborative publishing services supporting the Flora of North America, classification effort. In developing the resulting concept of normative boundary constructs, Spasser, fruitfully positions the concepts of heterogeneity and coordination mechanisms within the activity theory framework

Finally, two papers deal directly with design. One paper discusses the role of users in industrial design, and the other presents an approach to ISD based on activity theory, rooted in experiences ISD in Nigeria.

In the paper "Designing for instrument-mediated activity", Pascal Beguin and Pierre Rabardel develop the concern for mediation into a practical tool for design. By analysing changes in use of instruments it becomes possible to design for and better work with the processes of developing use. Their examples are drawn from the engineering field, one focusing on the introduction of a

CAD system.

In the paper "Activity Analysis as a method for information systems development: General introduction and experiments from Nigeria and Finland", Mikko Korpela, H.A. Soriyan and K.C. Olufokunbi introduce an approach to analysis in the early phases of systems development. The central point is a schematic depiction of activity systems. It has strong similarities to Engeström's triangles (1987) but differs in that it is more directly intended to be a tool for practitioners. The theoretical basis for the analytical tool is discussed, and two experiments with using the tool in realistic settings in Finland and Nigeria.

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