Articulating Coordination of Human Activity - the Activity Domain Theory

Lars Taxén

Original Publication:

Lars Taxén , Articulating Coordination of Human Activity - the Activity Domain Theory, 2004, 2nd International workshop on Action in Language, Organisations and Information Systems ALOIS-2004,2004, 45.

Postprint available at: Linköping University Electronic Press
http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-43481

Articulating coordination of human activity - the Activity Domain Theory

Lars Taxén

Campus Norrköping, Linköping University
Department of Science and Technology
SE - 601 74 Norrköping, Sweden
{lars.taxen@telia.com}

Abstract
In this paper we present a new theory for the coordination of human activity, the Activity Domain Theory. Human activity is seen in the light of cooperating practices which need to be coordinated. The central idea in the theory is to integrate coordinating elements of a practice into a coherent whole which we call the activity domain. The ontological foundation of the theory is the praxis philosophy in which signs, shared meaning and the construction of social reality are emphasized. The origin of the theory is in the Ericsson telecommunication company where it has been gradually refined over more than a decade by the author. Recently the theory has been applied in the coordination of the development of the 3rd generation of mobile systems. This application included the development of a global information system supporting the coordination. We describe the theory, its development and some of its impacts on the Ericsson practice. We also discuss possible implications of the theory for information system development and organizational theory.

Key words: integrating framework, coordination, practice, information systems, activity domain theory, telecom application

1 Introduction

The aim of this paper is to present a new theory for the coordination of human activity, the Activity Domain Theory (ADT). The ADT was developed by the author in his professional work at the Ericsson telecommunication company over a period of more than 10 years. At present the theory has been applied in the Ericsson setting only. However, the aim of the ADT is bold: to provide an integrating framework for coordination which can be utilized for analytical and constructive purposes, including information system (IS) development. It is also our ambition that the theory will open up new lines of research in organizational theory.

Product developing organizations are facing a turbulent reality today due to increased product complexity, diversification of organizational functions and an ever increasing rate of change. An example of this from Ericsson is the 'anatomy' shown in Figure 1. The anatomy shows the dependencies between the development tasks (square white boxes) in one of the nodes in the 3G network. Each task, which is called a 'work package', develops a certain functionality. The development is carried out in the same order as the actual system 'comes alive', hence the term 'anatomy'. Thick arrows show the datum for a particular integration and verification of the packages. Small dots indicate the status of a package such as 'in design', 'in test', 'ready', etc. The thin lines mark dependencies between the packages. The ovals signify basic services in the node like registration of the location of the mobile, calling to the mobile, answering a mobile call, etc. In most cases the functionality is provided by software where the total number of source code lines may be of the order of millions.

The coordination of a development task like this one is not possible without IS support. Between 5,000 to 10,000 items must be tracked with respect to status, versions, dependencies, etc. Besides managing items related to the telecom system itself, other types of items such as requirements or engineering change orders must be controlled. Moreover, the development

task is constantly revised due to changed customer requirements, new insights, errors discovered, available resources, etc. The technical challenge of developing IS support for this kind of application is indeed considerable.

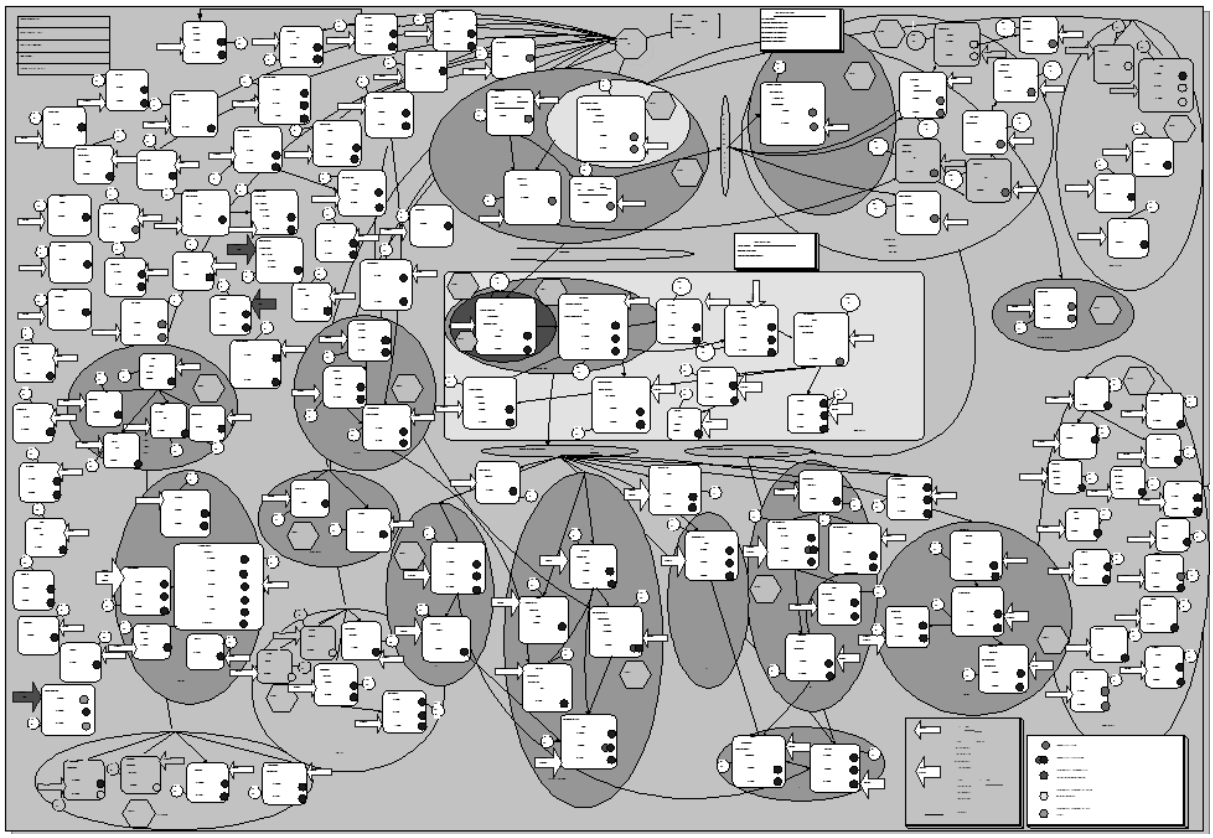

Figure 1: The anatomy of a node in the 3rd generation of mobile systems

However, the most arduous task in this context is to establish a shared meaning among the actors concerning coordination (Taxén, 2003). First, there must be a shared meaning about what should be coordinated and how. There must be an agreement about which items are crucial for coordination, how these should be characterized and how they are related to each other. Often, new abstract concepts are introduced, something which is particularly difficult to acquire a shared meaning about (March & Simon, 1958). Second, the actors may be geographically dispersed, have different roles, come from different traditions, speak different languages, etc. Third, the contents and structure of coordination will change according to new insights, new demands from the market, new tools and methods supporting coordination, etc. Finally, signs signifying the coordination, such as the anatomy in Figure 1, must acquire shared meaning among the actors.

Coordination conceived as above implies that both individual, social and technical aspects must be considered. When reflecting over human activity, usually an individual or a systemic perspectives is taken as the Unit of Analysis (UoA). However, as a long discourse has shown, neither of these approaches are entirely satisfactory (e.g. Vološinov, 1986/1929). The individual perspective tends to ignore trans-individual phenomena such as social institutions and the structural properties of language. On the other hand, the systemic perspective easily downplays individual phenomena such as action, meaning and everyday utterances.

In order to overcome this dilemma the *practice* has been suggested as a proper UoA where the the individual and systemic may be reconciled. In this approach the practice is considered to be the primary generical social thing (Schatzki, 2001:1). This reflects an ontology where the

"social is a field of embodied, materially interwoven practices centrally organized around shared practical understandings." (ibid.:3). Practices are considered to be a materially mediated nexus of activity where the "forms of individual activity depend on the practices in which people participate." (ibid.:11). Thus, both the individual human mind and social order are to a significant extent considered to be constituted within practices.

The broad conception of a practice in Schatzki et al. (2001) has been delimited to 'workpractices' by Goldkuhl & Röstlinger in their Theory of Practice (e.g. Goldkuhl & Röstlinger, 1999). The workpractices is a type of practice where actors / producers produce an outcome for clients of the practice. The workpractice emphasizes the productive character of a practice; something is produced based on certain prerequisites. In the rest of the paper we will understand 'practice' in this more restricted way.

The practice approach enables us to conceive human activity as cooperating practices which need to be coordinated. The central idea in the ADT is to integrate coordinating elements of a practice into a coherent whole which we call the *activity domain*. Thus, the label 'activity domain' is simply the denotation of a practice when structured according to the ADT. The point of departure of the theory is *praxis* defined as "... the arena for the metamorphosis of the objective into the subjective and of the subjective into the objective." (Kosík, 1976:71). From this very general conception of a practice, a set of basic assumptions about human activity are defined. These assumptions become guiding principles in the formation of the activity domain. One of these assumptions is that the activity domain is a sign-mediated constructed social reality which includes both individual, social and technical aspects.

The activity domain is constituted by a set of elements which can be operationalized for particular types of practices such as the development of complex systems. By operationalization we mean that the elements of the theory are translated into elements which can be manipulated, measured or observed in a particular practice in order to influence this practice. One such operationalized element is the IS. Thus, the IS is considered in the context of the activity domain rather than as an isolated element de-coupled from the practice where it is used. Moreover, the activity domain is embedded in a larger context where other activity domains provide prerequisites for and uses the outcome of the activity domain.

The paper is organized as follows. First we discuss how coordination may be apprehended in terms of activity domains. This is followed by a description of the ADT, its constituting elements and how these may be operationalized for usage in product developing organisations. After discussing the research design we describe how the development of the ADT came about. This is followed by an account of some of the results from applying the theory in the Ericsson practice. The paper ends with a discussion of the implications of the ADT for future research from both a theoretical and practical point of view.

2 Coordination apprehended as activity domains

Although coordination is easily recognized when it breaks down, no established definition of coordination seems to exist. For example, Larsson (1990) lists nineteen different definitions and Malone & Crowston (1994) report on eleven definitions. Malone & Crowston also emphasize that the study of coordination must draw on a variety of disciplines including organization theory, management science, computer science, economics, linguistics and psychology (ibid.:88). A detailed survey of various interpretations of coordination is given by Melin (2002) who also adds the area of informatics as a relevant discipline. Moreover, in their

Theory of Practice Goldkuhl & Röstlinger emphasize the coordinative role of communicative acts like assignments, agreements, commitments, requests, etc. (e.g. Goldkuhl & Röstlinger, 1999).

A suitable point of departure is provided by Malone & Crowston:

> *"Coordination is managing dependencies between activities"* (Malone & Crowston, 1994:90)

This definition indicates that something is done by someone. Coordination is an activity in itself which has other activities as its work object. This means that there are two type of activities involved. These may be called 'non-transformational' and 'transformational' ones respectively. Transformational activities transform objects from one condition to another, while non-transformational activities transform non-coordinated activities into coordinated ones. In order to reconcile this way of understanding coordination with the practice approach we suggest that both types of activities are framed by the practice (see Figure 2):

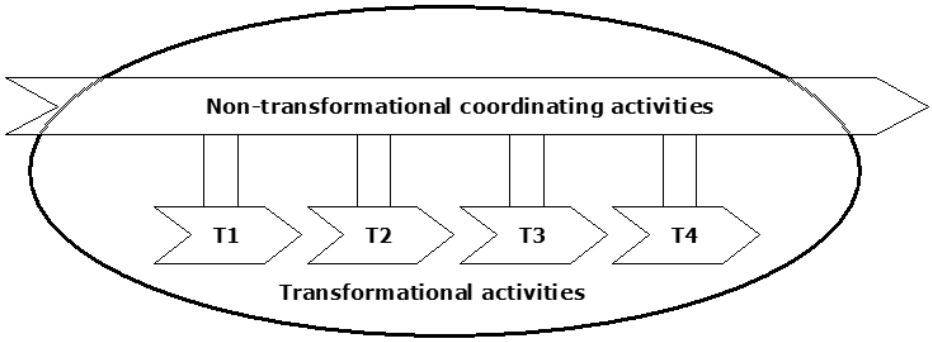

Figure 2. Two types of activities in a practice

We may now focus on either the transformational or non-transformational activities. In either case certain elements will be in the foreground while others will be in the background. This bring us to the central idea in the ADT: the activity domain is the facet of the practice which are brought to the foreground when the non-transformational activities are in focus. This means that the activity domain emphasizes such elements of a practice which are vital for coordination and downplays other elements. Exactly which these elements are and how they are conceived of differ from practice to practice depending on the type of practice, its historical evolution, etc.

The transformational activities may be conceived of from two different perspectives. In the context of coordination they appear as 'black boxes' within which actors transform an object from one state to another. The internal details of this transformation are not relevant in the coordination context. However, if we 'open up' the black box, a transformational activity may be seen as taking place in a practice of its own where we find other non-transformational and transformational activities. Thus, the activity domain may be apprehended as a recursive construct which can be applied both horizontally to networks of cooperating practices and vertically at any level within a practice.

So far we have established a foundation for the understanding of coordination in terms of two types of activities and cooperating activity domains. From this 'bridge-head' we may now proceed to include aspects. This is done in the next section.

3 The Activity Domain Theory

A central tenet in the ADT is that the perceived reality in a practice is a socially constructed reality (e.g. Searle, 1995). By this we mean that the meaning of any relevant phenomena in the practice is a result of social interaction processes among the actors in the practice. As in pragmatism the most important criterion by which a certain action is considered valid or not is its *usefulness* (Wicks & Freeman, 1998). For example, it may be suggested to use a certain concept like 'anatomy' in an software development practice. If this leads to successful outcomes, 'anatomy' will be recognized in that practice. 'Anatomy' will appear in ISs, documents, e-mails, etc., and gradually acquire significance among the actors. Ultimately, 'anatomy' will be apprehended as a reality as solid as buildings, tools, etc. This is valid for all phenomena regardless of whether they can be characterized as essentially material or abstract in nature.

The social reality thus constructed is to a certain extend a shared reality. Even if the individual actors conceive of the reality differently depending on their individual experiences and backgrounds, some shared meaning about the reality in the practice must be achieved. Otherwise, coordinated action is impossible.

Based on these considerations, we have chosen to ground the ADT in the *praxis* philosophy (e.g. Kosík, 1976; Israel, 1979). This can be characterized by the following basic ontological and epistemological assumptions:

a) There is an objective world which exists independently of human beings. However, in praxis human beings relate to that world.
b) Human action is socially oriented and a premise for the individual understanding of the world.
c) The genesis of human knowledge is the interaction between humans and their environment. The knowledge and capabilities of humans are located in the individual, but they emerge in interaction with the particular situations in time and space in which the individual engages during her lifetime.
d) The interaction between an individual and her environment is dialectical in nature. The individual acts intentionally to change the world and is in turn changed by the consequences of her actions through reflection and further actions (e.g. Berger & Luckmann, 1966).
e) The interaction is mediated by various sign systems, of which language is one (e.g. Innis, 1985). The signs signify which phenomena are perceived and interpreted as relevant in a certain context. The dialectical nature of the interaction means that the sign system both enables and constrains the interaction. The sign system itself changes as a result of the interaction.
f) Intersubjectivity is an inevitable consequence of the social interaction among humans. This interaction is taking place in a certain context which is a determinant for the intersubjectivity (Vološinov, 1986/1929).

This means that signs are fundamental in the ADT. Signs mediate between the individual cognitive system and the outside world, regardless of whether the signified phenomena can be classified as natural in origin, a human artefact or an element of the social reality. Knowledge is achieved through signs and the codes into which they are organized. Cognition, or semiosis, is "the building up of structures of signs from experience. We create a personal world, an Umwelt, that determines what we perceive and know." (Cunningham, 2002). A sign always

has a physical aspect, the signifier, which is associated in the brain by some phenomena, the signified aspect:

> *"... any item of nature, technology or consumption can become a sign, acquiring in the process a meaning that goes beyond its given particularity..."* (Vološinov, 1986/1929:10)

A consequence of this stance is that there is always a material, physical aspect as well as a signifying aspect of any phenomena we perceive. This means that there is no ontological difference between objects we conceive as essentially physical like a hammer, or objects we perceive as essentially symbolical like a bank-note. They both have a material and signifying side. The only difference lies in the relative weight of these two aspects.

3.1 The constitution of the activity domain

The activity domain construct is derived from on the basic assumptions and the practice perspective as follows. In the activity domain *actors* are working together. They have a *motive* for coming together, which is the reason the activity domain exists. Starting from certain *prerequisites* the actors work on an *object* in order to produce a certain *outcome*. The object is the main driver for organizing the activity domain.

The activity domain is constituted by the following elements:

- *Stabilizing core*: The actors in an activity domain share a common ideology, by which we understand any wide-ranging systems of beliefs or ways of thought. The ideology stabilizes the activities in the activity domain and includes elements like norms, values, routines, rules, etc.
- *Contextuality*: In an activity domain the actions are focused and situated. By 'context' we mean the set of circumstances and conditions which surround and determine an idea, theory, proposition, or concept (Gershenson, 2002). This means, for example, that a certain phenomena will be apprehended and characterized differently depending on the context in which it appears. For example, a piano is conceived of in very different ways depending on whether it is in context of the concert hall on or in the context of being moved to another location.
- *Domain transition*: Activity domains interact with each other. In doing so prerequisites and outcomes may be conceived of differently in the different domains. If so, there is a need for a translation and interpretation in the transition between the domains.
- *Spatio-temporal orientation*: In the activity domain the actors orient themselves spatially and temporarily. The spatial orientation concerns which phenomena actors perceive as relevant in the domain and how these relate to each other. The temporal orientation concerns the order of activities in the domain. The spatial and temporal dimensions are interrelated in the sense that a change in one dimension impacts the other dimension.
- *Instrumentality*: In the activity domain actors use instruments to perform the activities. This kind of instrumentality is called 'tool-instrumentality' by Goldkuhl (2001). The instruments can be essentially material or social in character, like a hammer and a law.
- *Experiential learning:* The capabilities and knowledge of actors in the activity domain are achieved in the iteration between reflection and action (Kolb, 1984).
- *Communicative acts*: Communicative acts are performed by the actors in order to reinforce coordination (e.g. Goldkuhl & Röstlinger, 2002). Such acts may be assignments, agreements, commitments, requests, etc.

In Figure 3 the constitution of the activity domain is illustrated:

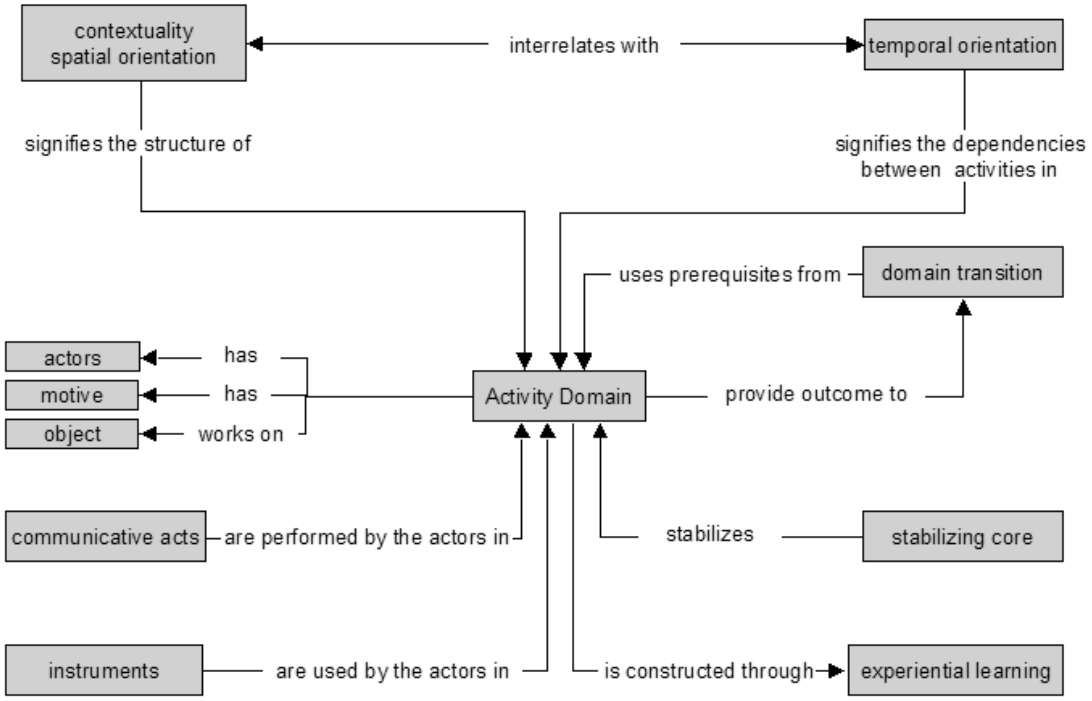

Figure 3. The constitution of the activity domain

3.2 Theoretical grounding

The ADT is grounded in several theories reported in the literature. Its main source of inspiration is Activity Theory (AT) (e.g. Engeström, 1999) from which the idea of an integrating construct for human activity is taken. In AT this construct is called the 'activity system'. Many of the basic assumptions concerning human activity are similar between ADT and AT, for example, the focus on the dialectics and historicity. The specific elements of actors, motive, object and outcome are also collected from the AT.

Most of the constituting elements of the activity domain are grounded in an analysis of the sign-mediated interaction between the individual and her environment. In this analysis we make use of a model for the cognitive system in higher living organisms proposed by Gärdenfors (2000). In this model the cognitive system is structured into three strata: the connectional, conceptual and symbolic ones. The connectional stratum is associated with the neural network in the brain, the conceptual one with the conceptual forming capabilities of the organism and the symbolic one with the linguistic capabilities of humans.

The target for the analysis is to identify commonalities in several or all of the three strata. Since such commonalitites are spanning the spectrum from individual biology to human language we conjecture that they are important determinants in human activity and thus should be included in the theory. An example of such a commonality is 'situatedness'. In all strata the situation in which the organism is engaged in is a determinant for her knowledge acquisition. This commonality is manifested in the ADT as 'contextuality'.

A detailed account for this analysis, which is grounded in findings from cognitive and linguistic sciences, is given in Taxén (2003). The key role that signs play in human activity is

mainly inspired by the works of Vološinov (1986/1929). The importance of communicative acts in coordination has been emphasized by Goldkuhl and others (e.g. Goldkuhl et al., 2002; Habermas, 1984; Searle, 1969).

3.3 Operationalizing the ADT - the Framework

The ADT is meant to be a general theory which is valid for any type of practice. However, in actual settings the generic elements in the theory must be translated into elements by which the practice can be influenced. For practices which, like Ericsson, uses ISs as instruments this is manifested as a 'Framework' which is constituted by the following elements (Taxén, 2003):

- A *context model* which operationalizes the spatial orientation and contextuality elements in the ADT. This model signifies the context of the activity domain by articulating types of relevant phenomena, how they are characterized and how they are related to each other. When this model acquires a shared meaning it enables the actors to orient themselves in the activity domain, rather in the same way a map does. In the literature models designations like `information model', `data model', `business model', etc., can be found. We apprehend such models as various types of context models, thus highlighting their contextual nature. The anatomy in Figure 1 is an example of an instantiated context model[1]. The notation used in the context model is preferable an object oriented one since this facilitates the signification process.
- A *transition model* which operationalizes the domain transition element. This model is an elaboration of the Specification Based Data Model suggested by Gandhi & Robertsson (1992, 1995). The purpose of this model is to signify how ideologies in different activity domains interact. Basically, this is a mapping and interpretation operation. For example, the status of the work packages in Figure 1 is determined by the statuses of a number of items internal to the work package such as documents.
- A *process model* which operationalizes the temporal orientation element. This model signifies the dependencies between the activities in the activity domain which corresponds to the definition of coordination according to Malone & Crowston (1994:90). The notation used for the process model is called Information Flow Diagrams (IFD) which is a special type of entity based process models. In Figure 4 an example of such a diagram is given.
- A *domain core* which operationalizes the stabilizing core element. This core holds articulated items of the ideology which provide stability to the activity domain, for example routines, rules, standards, etc.
- *Information systems* which operationalizes the instrumentality element. Thus, we regard ISs as instruments which support the activities in the domain. The models and the domain core are implemented in the ISs. These constitute in relation to each other an *IS architecture*.

The constructive aspect of an activity domain implies that the context, transition and process models as well as the domain core and the ISs are constructed in concert with each other. Moreover, this is done simultaneously with the emergence of the shared meaning among the actors. To achieve this the experiential learning element in the ADT is operationalized as a *domain construction strategy* which can be summarized as follows. A representative group of users and IS designers suggest a first version of the models and the domain core which is implemented in the ISs. The implementation is tried out in practice in, for example, an

[1] By `instantiation' we mean that value assigned instances have been created from the type descriptions in the models. It is beyond the scope of this paper to discuss this in detail.

ongoing development project. The experiences are reflected upon by the group and modifications to the models and the core are suggested and implemented anew.

In this iterative process, the models, the domain core and their implementations in the ISs are conceived of as composite signs which gradually acquire shared meaning among the actors. The close interaction between users and IS designers means that the distinction between users and designer roles are blurred. They are all actors in the construction of the activity domain.

As a consequence the ISD process is re-focused from the construction of individual ISs to the construction of the activity domain where the IS is but one of its constituting elements. Moreover, the activity domain is regarded as being in a state of constant evolution. The IS, as well as the other elements, will never be 'finalized'. This means that the ISD process should be conceived of as a continuous redevelopment process which is active as long as the activity domain exist. A similar approach is suggested by Truex et al. (1999).

4 Research approach

As described in the next section the ADT was elaborated during a long period in the Ericsson practice by the author. This means that the research can be classified as a longitudinal, action research case study (Yin, 1989) stretching from the early 1990s until 2003. Action research has been characterized as "[the] continuous interaction of theory and practice." (Baskerville & Wood-Harper, 1996:240). The practice aspect in the action research is the Framework and its impacts. The theoretical aspect is the ADT which remained vague and unarticulated until a more conscious interaction between theory and practice took place as a result of the authors' Ph.D. studies. Thus the 'action' side of the action research was dominant until 1998 when the 'research' side became more prominent.

Concerning the impacts of the ADT reported in Section 6, altogether 18 interviews were performed with different stakeholders in the 3G development such as project managers, method developers, configuration managers, IS developers, etc. These interviews were recorded, transcribed and analyzed with a slightly modified Grounded Theory (GT) approach (Strauss & Corbin, 1998). More details can be found in Taxén (2003).

5 The development of the ADT in the Ericsson practice

The Activity Domain Theory was elaborated in close interaction between practice and theory (for details, see Taxén, 2003). Usually a certain element in the theory was triggered by a need in the Ericsson practice. For example, in the early 1990s the Information Flow Diagrams (IFDs) appeared as an alternative way of modeling processes. One example of such a diagram from 1994 is given in Figure 4:

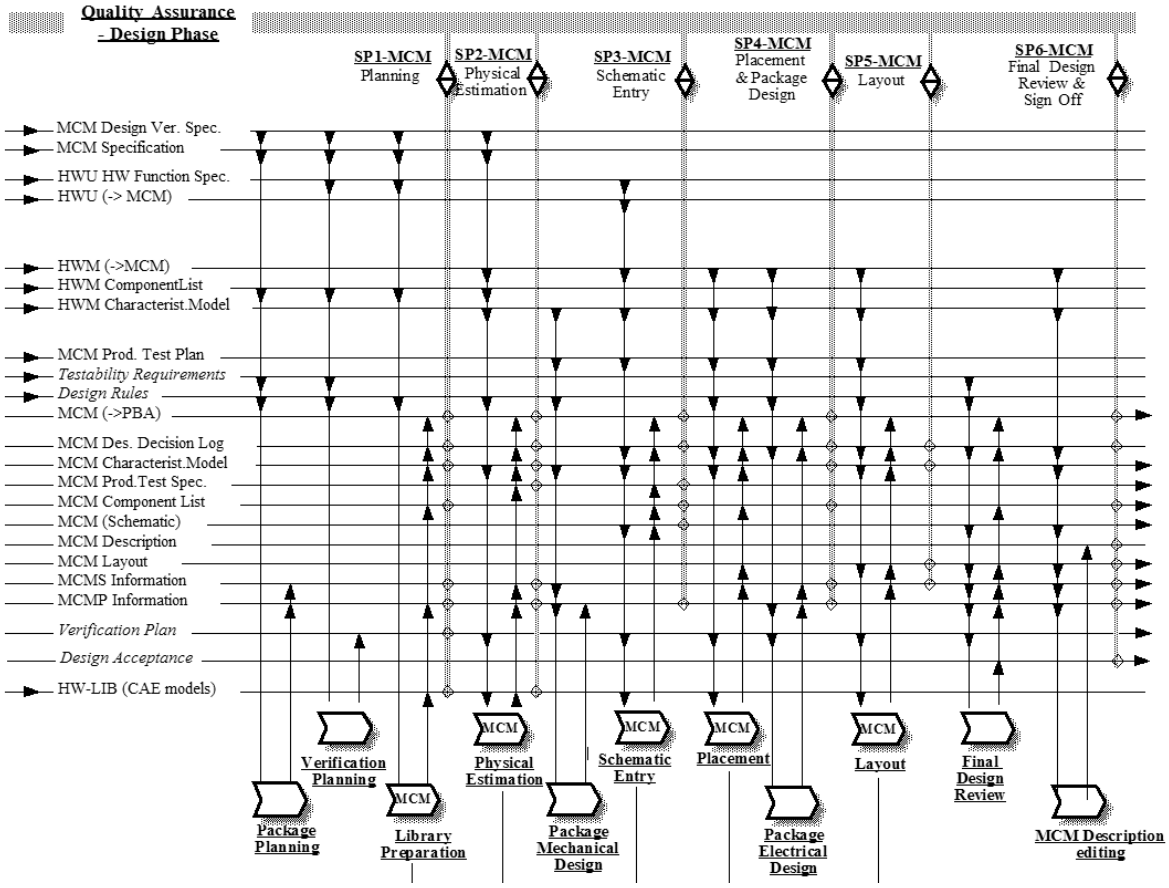

Figure 4. Information Flow Diagram for Multi-Chip Module design

This type of process models turned out to have certain merits that the traditional, activity based models lacked. For example, the life cycle evolution of each data element (shown as horizontal lines) was clearly visible. Also, the dependencies between activities were easy to see. The process model was printed on a large sheet of paper and put on the wall in the project room. This meant that all actors involved had the same picture of the task and could easily orient themselves by this picture. Also, the progress was notified by simple cues such as marking in different colors which activities were ready.

When reflecting over these experiences it turned out that the IFDs belonged to a certain class of process models called Entity-based Process Models (Humphrey & Kellner, 1989). Moreover, a striking insight was that a very complicated design process could be coordinated by a comprehensive picture on the wall. No sophisticated tools were needed. It only mattered that the actors involved had some shared meaning of the picture. Thus, its signifying and coordinating qualities were of prime importance. These observations gradually matured over the years and were eventually incorporated in the ADT as the temporality element and a focus on signs and their mediating roles in the coordination of human activity.

This pattern was repeated for other elements of the ADT. Between 1990 and 1998 the elements of the Framework were gradually shaped by practical experiences. The ADT was articulated in the author's Ph.D. studies between 1998 and 2003 along with further articulation of the Framework in the Ericsson practice. In Figure 5 the development of the ADT is illustrated:

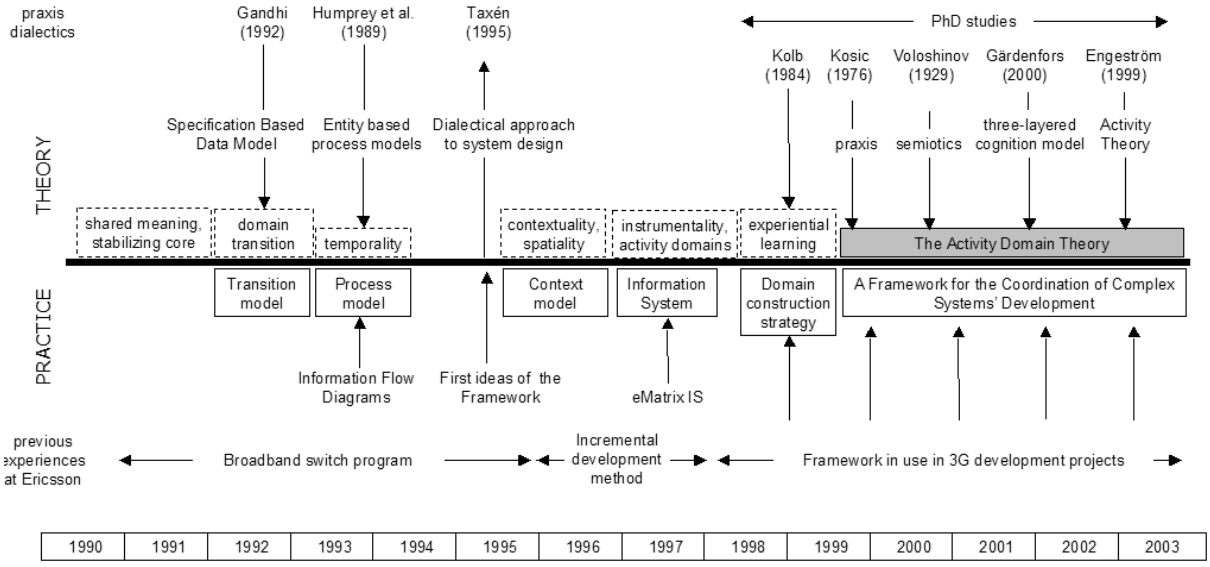

Figure 5. The development of the Activity Domain Theory

Besides the appearance of the IFDs some other major landmarks were:

- The theoretical background was the author's interest in the praxis philosophy and dialectical reasoning which made it possible to regard events taking place in practice from a certain perspective. The practical background was more than twenty years of personal experience from the Ericsson development practice.
- In the late 1980s Ericsson initiated a large program (the broadband switch program) aiming at replacing the successful AXE switching platform. This program was however never completed and eventually it was closed down in 1995. Several of the elements in the ADT originate from this project, for example the IFDs discussed earlier. The importance of shared meaning became clear after the unsuccessful effort to introduce a new organizational language comprised of a multitude of new concepts (more than 120). Another failure was the attempt to replace the well established product identification rules with a completely new set of rules. This pointed towards the stabilizing core element in the ADT.
- Another landmark was the Specification Based Data Model presented at a conference by Gandhi & Robertson in 1992 (Gandhi & Robertson, 1992, 1995). This influenced the element of domain transition in the ADT. Since this model focuses on the borderline between contexts it provides a mean to control a complex development task consisting of heterogeneous system elements.
- The experiences from the dialectical thinking and the broadband switch program were reported in Taxén (1995). At the same time the first ideas of the Framework were sketched in an internal Ericsson report.
- Between 1996 and 1997 the author participated in a project aiming at the replacement of the traditional waterfall oriented method of developing software with an incremental development method. The actors in this project had severe problems in agreeing about what an increment was. Not until the context model was introduced the understanding started to slowly converge. Here the ADT elements of contextuality and orientation began to take shape. The context model signified the context of incremental development and enabled the actors to orient themselves in this context.
- In 1997 the author introduced the eMatrix Product Data Management (PDM) system for supporting the coordination of incremental development tasks. The main reason for

choosing this IS was the ease by which the implementation could be changed. This was important since there was still no commonly held meaning about what constituted incremental development. Also, it became painstakingly clear that it would be an overwhelming task to enforce the same interpretation on all development units at Ericsson. Thus, the ADT elements of instrumentality and activity domains began to emerge.

- In 1998 the author started his Ph.D. studies. The same year the first, large project started to use the IS and the context model in defining requirement management and engineering change order management. This was done in an ongoing iteration between discussing the context model and trying it out in the actual project by implementing it in eMatrix. In one year approximately 500 implementation changes were made. This experience emphasized experiential learning as the only realistic way to establish a shared meaning. This in turn pointed towards the interpretation of the context model as a reality which was constructed socially by the actors to suit the needs of a particular development practice.

To summarize, the ADT was developed in close interaction with the development practice at Ericsson. Thus, unlike some other approaches in IS development, the ADT was not appropriated from a 'grand' theory such as Structuration Theory (Giddens, 1984) or Actor Network Theory (Latour, 1992).

6 Empirical results

Between may 1999 and mid 2002 the number of projects impacted by the Framework rose to around 140, distributed over more than 20 development sites worldwide. During this period four coordination domains were constructed. As indicated in the following statement from one of the project managers, the impacts on the Ericsson practice were profound:

> *"Especially for the execution part I think we would not have been able to run this project without the tool. I think if you simply look at the number of work packages, the number of products that we have delivered, the number of deliveries that we have had, if we would have had to maintain that manually, that would have been a sheer disaster. [...] we had some, only in my part of the project, some 200 work packages or work packages groups or whatever you want to call them, deliveries, on the average 2-5 subprojects within them 5-10 blocks being delivered, just keeping track of that [...] would have been a hell of a job."*

Other identified effects were (Taxén, 2003):

Domains are constructed in different ways

In spite of being in the same company and having the same purpose, the four domains constructed were quite different. For example, the context model in each domain had virtually no items in common. This is a clear indication that establishing a common domain for the entire company is an arduous task. The effort of achieving shared meaning is simply too large.

Balancing between centralism and decentralism

Here 'balance' refers to the balance between what should be centrally controlled by corporate units and what should be left to the local autonomy of decentralized organizational units. A key issue in the coordination of complex systems' development is to find a proper balance between the extremes of total centralism and total decentralism. As long as this is not in place, the organization is destined to oscillate between these equally destructive antipodes.

The four activity domain were independently constructed since no central authority existed which could enforce a proper balance. The original intentions in the Framework aimed at a federation of activity domains. This was however not achieved. Instead, the balance shifted from total decentralism all the way to total centralism in the aftermath of the turbulence in the telecommunication business between 2001-2003. However, it remains to be investigated if this shift indeed provided the expected benefits in terms of efficiency and cost savings. On the contrary, recent research results indicate that organizations which are able to maintain a proper balance will be strongly armed to manage the inevitable change process (e.g. Davenport et al., 1992; Sawhney & Prandelli, 2001; Sage, 2001).

One IS for coordination provides major advantages

The results show that the same IS may be used in the entire activity domain. Such an arrangement has a number of advantages as compared to the traditional use of several ISs:

- Interfaces are not needed between the ISs.
- A number of ISs can be replaced by one.
- The data will be consistent. Unique information elements will be stored in one IS only.
- Complete traceability is achieved between the items defined in the context model.
- A homogeneous world-view is provided which alleviates the construction of the activity domain.
- Changes are more easily implemented in one IS than in several. The IS implementation can evolve with the evolution of the needs of the activity domains.

This does not imply that there is only one IS for all tasks in the organization. There will still be a need for specialized ISs, for example for software code configuration management. Thus, a number of interfaces are still needed. However, these interfaces will not be internal to the activity domain but rather situated on its borders.

Responsibilities and assignments became transparent

There were several indications that the transparency of the distribution of responsibilities increased. This benefited the project in a push and pull manner. First, it became more difficult to escape responsibilities since the control of dependencies showed very clearly who was responsible for a particular task. Second, a greater awareness of everyone's responsibility made it easier to create a shared meaning, something which is nicely captured in the following statement by a methods and tools coordinator in one of the 3G projects:

> *"Before every role maintained a piece of information it was responsible for. But in the end all pieces put together, they should build an overall picture and what eMatrix enables us to get, this full picture also to cross the border and see "aha this is information somebody else in another role thinks is connected to this one" that is a complete picture of the overall view and not just the limited view the person is responsible for. That is the main benefit I think."*

Raised attention to the effort of achieving shared meaning

The results indicate that the effort of achieving shared meaning is usually not elicited in organizations. Since shared meaning is difficult to measure the cost of achieving it will not turn up in balance sheets. However, this cost might well represent a substantial, if not the major part of the overall cost of providing coordination support for development projects. If this cost is not considered erroneous decisions may be the result. For example, in choosing

between a federated IS architecture and a centralistic one, the cost of achieving shared meaning may be crucial. Thus it is important to elicit this cost and find strategies of how to reduce it.

7 Discussion

In this section we will discuss the practical and theoretical implications of the ADT.

7.1 Practical implications

The results indicate that the ADT is capable of informing the coordination of complex systems development in situations characterized by uncertainty, instability and complexity. The actors in the constructed domains had different roles such as project managers, requirement managers, configuration managers, test managers, IS developers, etc. Together they gradually evolved a support for coordination that were previously not attained in the Ericsson history. For example, tracing any coordination item to any other item in the same IS had not been possible earlier. Moreover, the functionality implemented in the eMatrix system was far beyond previous PDM implementations that had been going on for several years in the company.

The main reason for these achievements can be traced to the ontological positions taken in the ADT. By regarding the reality in a practice as a constructed one the actors may shape this reality according to their needs. This approach makes it possible to address some of the deficiencies in the current understanding of coordination (Larsson, 1990:6 ff.):

- Abstract interdependencies are possible to coordinate since they acquire significance among the actors in the construction of the activity domain. New constructs are manifested in the models and the IS and tried out in actual usage in ongoing projects.
- Informal coordination is achieved in the interaction between the actors in constructing the activity domain and crystallized into action prescriptions manifested in the models and the IS.
- The preparedness to change the activity domain makes it possible to manage turbulent and complex situations. Much less emphasis is put on pre-planned coordination. Rather, the planning process is regarded as an ongoing process. Moreover, since the construction of the coordination is taking place in the practice which is coordinated, the separation in time between design of the coordination and its application is narrowed down.
- Self-coordination is inherent in the activity domain construct. The actors in the domain are the ones that construct the domain. Top-down coordination is re-focused to agreements between activity domains about what is necessary in order for them to cooperate.

The IS development (ISD) process suggested by the ADT can be characterized as evolutionary, process mode oriented and non-linear according to the classification given by Iivari & Lyytinen (1998). An evolutionary process implies that the IS is constantly changed due to modified requirements, changed scope, new insights, etc. A process mode orientation emphasizes continuous learning and frequent re-planning during the development. In a non-linear ISD process analysis / design phases such as requirements analysis, specification, architectural design, detailed design and implementation proceed concurrently rather than in a sequential fashion.

This type of ISD process needs certain prerequisites. First, the IS must be exceptionally easy to modify. If the effort to make a simple change is substantial, the evolutionary ISD process will be hard to maintain. Second, the predominant rational planning paradigm must be abandoned. It is not possible conceived the ISD process as a rational process which can be planned in advance and followed strictly. Changing the IS implementation several hundred times in a year must not be regarded as a requirements engineering failure. Rather, constant modifications should be considered as a key enabler in the construction of the activity domain.

An ongoing debate in the IS community concerns the focus of the ISD efforts. Benbasat and Zmud (2003) has issued a call for 'Returning to the IT Artifact'. They "... recommend that greater attention is given to the IT artifact rather than to structure, context, or other phenomena that lie distant from the artifact" (DeSanctis, 2003:360). This is not the way suggested by the ADT. Rather, the IS / IT artefact is considered as but one element in the construction of the activity domain. Only so can the interrelationships with other elements, such as processes models, context models, domain core, etc., be managed. Moreover, a focus on the IT artefact easily risks to emphasize the technical character of the artefact while ignoring its role as a composite sign which needs to acquire a shared meaning among the actors in the activity domain.

7.2 Theoretical implications

The practical results achieved from the ADT means that the theory is relevant and valid in at least one application area: that of coordinating the development of telecommunication systems at Ericsson. The question concerning its transferability to other areas needs further research. However, according to the view that theories are `used' rather than `verified / falsified' the ADT has established a `bridge-head' in a domain of discourse (Alvesson & Sköldberg, 1994 - referring to Toulmin, 1953 and Stegmüller, 1973). The domain of discourse is the domain within which the theory can be assumed to be applicable, much in same the sense as a rule is applicable. In our case this domain may vaguely be denoted `IS applications in organizations'. The continued research strategy consists of successively determining the transferability of the ADT to, for example, other product developing organizations or other types of IS applications such as transaction systems.

Ericsson started out as a manufacturing company in the industrial era which was stable, highly predictable and comparatively easy to plan. However, the Ericsson experience over the last decade may be seen as paradigmatic example of the reality facing organizations today. In order to theorize about this reality issues like turbulence, change, complexity and diversification need to be observed. One implication of the ADT is that it directs the attention to critical elements in such a theory development. Shared meaning, experiential learning, contextuality, domain transition, orientation in space and time, domain stabilization and communicative acts are elements which, according to the Ericsson experience, are necessary to include. The ADT is one attempt to integrate these elements into a consistent theory.

We believe that continued organizational research should be carried out along the lines indicated by the ADT. Coordination lies at the heart of any organization which produces values for its clients, whether that takes the form of products or services. By taking the practice as the Unit of Analysis we claim that it is possible to reconcile the individual, systemic and technological perspectives and thus advance the discourse regarding individual agency or systemic structure supremacy. However, this requires that signs and interactions are

given a more central role in the theory development. This is fully in line with Vološinov when he states:

> *"By its very existential nature, the subjective psyche is to be localized somewhere between the organism and the outside world, on the borderline separating these two spheres of reality. [...] the organism and the outside world meet here in the sign"* (Vološinov, 1986/1929:26)

8 Conclusions

We have presented the Activity Domain Theory as a viable integrating framework for coordination in situations characterized by uncertainty, instability and complexity. The theory has demonstrated its capability to inform the establishment of activity domains for the coordination of extremely demanding applications in the Ericsson company. These applications included the implementation of global IS support for the coordination.

The results show that taking the practice in the form of the activity domains as its Unit of Analysis is a feasible approach towards solving the contradiction between the micro and macro perspective. So far, the Activity Domain Theory has only been demonstrated in one setting. However, the results indicate that the theory may be a very useful theory, both for analytical and constructive purposes, in situations where coordination of human activity is of primary importance. Moreover, the theory raises the attention to critical issues in organizational activity which may open up new lines of research.

References

Alvesson M, Sköldberg K (1994) *Tolkning och Reflektion - Vetenskapsfilosofi och kvalitativ metod*, Studentlitteratur (in Swedish), Lund.

Baskerville R, Wood-Harper T (1996) A Critical Perspective on Action Research as a Method for Information Systems Research, *Journal of Information Technology* 11,1996, pp. 235-246.

Benbasat I, Zmud R W (2003) The identity crisis within the IS discipline: Defining and communicating the discipline's core properties. *MIS Quarterty*, 29(2), 183-194.

Berger P, Luckmann T (1966) *The Social Construction of Reality*, Reprint by Penguin Books, London 1991.

Cunningham D J (2002) Semiotic inquiry in education. *Teaching & Learning: The Journal of Natural Inquiry and Reflective Practice*. 17, pp. 23-30. Available at http://www.und.edu/dept/ehd/journal/Fall2002/cunningham.html (Sept 2003).

Davenport T, Eccles R, Prusak L (1992) Information Politics, *Sloan Management Review*, fall 1992, pp. 53 - 65.

DeSanctis G (2003) The Social Life of Information Systems Research. A Response to Benbasat and Zmud's Call for Returning to the IT Artifact, *Journal of the Association for Information Systems*, Vol. 4 No. 7, pp. 360-376, December 2003.

Engeström Y (1999) Activity theory and individual and social transformation, in Engeström Y, Miettinen R, Punamäki RL (eds. 1999) *Perspectives on Activity Theory*, Cambridge University Press, Cambridge UK., pp. 19 - 38.

Gandhi M, Robertson E L (1992) A Specification-based Data Model, *Indiana University Computer Science Department Technical Report TR344*, Indiana University, Indiana. Available at http://www.cs.indiana.edu/ftp/techreports/index.html (Oct 2002).

Gandhi M, Robertson E L (1995) SDBM as a Model for Codesign Data, in Rozenblit J and Buchenrieder K (eds.) *Computer Aided Software/Hardware Engineering*, IEEE Press, Piscataway, pp. 338-355.

Gershenson C (2002) Contextuality: A Philosophical Paradigm, with Applications to Philosophy of Cognitive Science. *Philosophy of Cognitive Science Essay*, COGS, University of Sussex.

Giddens A (1984) *The Constitution of Society*, Cambridge: Polity Press.

Goldkuhl G, Röstlinger A (1999) Expanding the scope: From language action to generic practice, *in Proceedings of the 4th Int Workshop on the Language Action Perspective (LAP99)*, Copenhagen.

Goldkuhl G (2001) Communicative vs material actions: Instrumentality, sociality and comprehensibility, in Schoop M, Taylor J (Eds, 2001*) Proceedings of the 6th Int Workshop on the Language Action Perspective (LAP2001)*, RWTH, Aachen.

Goldkuhl G, Röstlinger A (2002) The practices of knowledge - investigating functions and sources, *The 3rd European Conference on Knowledge Management (3ECKM)*, Dublin.

Gärdenfors P (2000) *Conceptual Spaces: The geometry of thought*, MIT Press, Cambridge, Massachusetts.

Habermas (1984) *The Theory of Communicative Action*, Volume One, Reason and the Rationalization of Society, Beacon Press, Boston.

Humphrey W, Kellner M (1989) Software Process Modelling: Principles of Entity Process Models, *CMU/SEI-89-TR-2*, Software Engineering Institute, Carnegie Mellon University.

Iivari J, Lyytinen, K (1998) Research on Information Systems Development in Scandinavia - Unity in Plurality, *Scandinavian Journal of Information Systems*, 10 (1&2), pp. 135-186.

Innis R (1985) *Semiotics. An Introductionary Anthology* (edited by Innis R), Indiana University Press, Bloomington, USA.

Israel J (1979) *The language of dialectics and the dialectics of language*, Humanities Press, New York.

Kolb D A (1984) *Experiential Learning: Experience as the Source of Learning and Development*, Prentice Hall, Englewood Cliffs, New Jersey.

Kosík K (1976) *Dialectics of the concrete*, Reidel, Dordrecht.

Larsson R (1990) *Coordination of Action in Mergers and Acquisitions - Interpretative and Systems Approaches towards Synergy*, Dissertation No. 10, Lund Studies in Economics and Management, The Institute of Economic Research, Lund University Press.

Latour B (1992) Technology is society made durable, in Law (ed, 1992*), A sociology of monsters: Essays on power, technology and domination*, Routledge & Kegan Paul, London.

Malone T, Crowston K (1994) The Interdisciplinary Study of Coordination, *ACM Computing Services*, Vol 26, no 1, pp. 87-119.

March J G, Simon H A (1958) *Organizations*, second edition, Blackwell Publishers, Cambridge, Massachusetts, USA.

Melin U (2002) *Koordination och informationssystem i företag och nätverk*, Linköping Studies in Information Science, Dissertation No. 6, Institutionen för datavetenskap, Linköpings universitet (in Swedish).

Sage A P (2001) *Systems Integration and Architecting: Contemporary Issues with Abundant Complexity, Managing Complexity in Product Management*, web-conference, hosted by Wade H. Shaw, April 9th, 2001.

Sawhney M, Prandelli E (2001) Communities of Creation: Managing Distributed Innovation in Turbulent Markets, *IEEE Engineering Management Review*, First Quarter 2001, pp. 6-24.

Schatzki TR (2001) Introduction: Practice theory, in Schatzki TR, Knorr Cetina K, von Savigny E (Eds, 2001) *The practice turn in contemporary theory*, Routledge, London.

Schatzki TR, Knorr Cetina K, von Savigny E (Eds, 2001) *The practice turn in contemporary theory*, Routledge, London.

Searle J R (1969) *Speech acts. An eassy in the philosophy of language*, Cambridge University, Press, London.

Searle J R (1995) *The construction of social reality*, London: Allen Lane.

Strauss A, Corbin J (1998) *Basics of Qualitative Research*, SAGE Publications, California, USA.

Stegmüller W (1973) *Probleme und Resultate der Wissenschaftsteorie und Analytischen Philosophie*. Bd II. Theorie und Erfahrung. Zweiter Halb- band. Theorienstrukturen und Theoriendynamik. Springer: Berlin.

Taxén L (1995) The Dialectical Approach to System Design, *Proceedings of Integrated Design and Process Technology*, Dec 6 - 9, 1995, Austin, Texas, pp.147-152.

Taxén L (2003) *A Framework for the Coordination of Complex Systems' Development.* Dissertation No. 800. Linköping University, Dep. of Computer &Information Science, 2003. Downloadable from http://www.ep.liu.se/diss/science_technology/08/00/index.html

Toulmin S (1953) *The Philosophy of Science*. London: Hutchinson.

Truex D P, Baskerville R, Klein H (1999) Growing Systems in Emergent Organizations, *Communication of the ACM,* August 1999, vol 42, No. 8, pp. 117-123.

Wicks A C, Freeman R E (1998) Organization Studies and the New Pragmatism: Positivism, Anti-positivism, and the Search for Ethics, *Organization Science*, Vol. 9. No. 2. March-April 1998, pp 123-140.

Vološinov, V N (1986/1929) *Marxism and the Language of Philosophy*, Harvard University Press, London. Appeared first in V.N. Vološinov, Marksizm i filosofija jazyka: osnovnye problemy sociologiceskogo metoda v nauke o jazyke, Leningrad 1929.

Yin R K (1989) *Case study research. Design and methods*, Sage, London.