INFRASTRUCTURES FOR LEARNING

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Ethnographic Inquiries Into The Social And Technical Conditions Of Education And Training

THESIS

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To do research is fortunately not such a solitary process as it can be to write up a dissertation. In my work with this doctoral dissertation I have benefited from the help, inspiration, good will, and guidance of many colleagues and friends.

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The work presented in this dissertation could not have been carried out alone. Several of the chapters presented here are the result of close collaboration with some of my colleagues and publications co-authored with some of them. I will go through this successively. Parts of Chapter 5 are based on a paper I have written with Barbara Wasson called *The ethnography of distributed collaborative learning* (Guribye & Wasson, 2002). Parts of Chapter 6 is based not only on the research done for my own Masters thesis (Guribye, 1999), but also on the efforts of the entire DoCTA project (Wasson, Guribye & Mørch, 2000). The analysis of the interactional processes (see Chapter 6) in this chapter is based on an article I have written with Eskil Andreassen and Barbara Wasson called *The organisation of interaction in distributed collaborative learning* (Guribye, Andreassen & Wasson, 2003). The analysis presented in this paper was also compared with and partly based on the empirical material gathered by Eskil Andreassen as part of the work for his Masters thesis (Andreassen, 2000). Chapter 7 is based on a paper written together with Geir André Bakke (Guribye & Bakke, 2001). The analysis is based in its entirety on empirical material collected by Geir André Bakke as part of the work with his Masters thesis (Bakke, 2002), and the analysis presented in Chapter 7 is a reworking of our original analysis. Chapter 8 is written with the starting point in an article I wrote with Grete Netteland (Guribye & Netteland, 2003). The analysis we made for this article was based on both my own fieldwork at Telenor, and Grete's data collection from the

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Frode Guribye

CHAPTER 1 – INTRODUCTION

Under rennestensristene, under de skimlete murkjellere, under lindealleenes fuktige røtter og parkplenene:	Beneath the gutter inlets, beneath the mouldy brick basements, beneath the moist roots of the linden alleys, and the park lawns:
Telefonkablenes nervefibre. Gassledningenes hule blodårer. Kloakker.	The nerve fibres of telephone wires. The hollow veins of gas pipes. Sewers.

- Rolf Jacobsen, 1933.
From the poem "Byens metafysikk" [The metaphysics of the city][1]

In this poem Rolf Jacobsen writes about the 'hidden life of the city', how the "iron vested viscera of the city / labours", and how these "invisible chains of copper and iron / bind us together" – across neighbourhoods and socio-economic strata. We are surrounded by visible and invisible installations, objects and arrangements that we commonly refer to as different infrastructures: urban infrastructure such as pavements, sewers, water supplies; communications infrastructure such as telephone wires, computer networks, roads, etc. Infrastructures comprise a foundation for how we go about living our lives.

There is an ongoing fusion of telecommunications and information technologies. Where there previously were stand-alone information systems and more or less independent applications, there are now interconnected and networked systems that can be referred to as information infrastructures. In contemporary society the global economy and the processes of globalisation, which involves major social transformations, information and communication technology (ICT), especially the Internet, is playing a crucial role (Walsham, 2001). Some even claim that the interconnectedness is a defining characteristic of contemporary society, using terms such as *the network society* (Castells, 2000).

To adapt to such societal transformation, it is argued, there is a need for changing the models of education and the modes of learning. "In the emerging information society,

[1] My translation

an educated person will be someone who is willing and able to consider learning as a lifelong process" (Fisher, 2001, p. 8836). The model of lifelong learning is more than providing training for employees at the workplace, and more than adult education. It involves for each individual to constantly, throughout their lives, learn and adapt to new demands. This involves a shift in focus from providing educational institutions and a curricula to a responsibility for each individual to be 'willing and able' to learn. In addition, "lifelong learning refers to a society in which learning possibilities exist for those who want to learn" (p. 8838). Implicit in this argument is a view that learning will (and should) be de-institutionalised. There are few reasons to believe, however, that this will be the case. The institutions that administer and manage education and schooling – schools and universities – are robust and serve an important role in democratic societies. What is more, new institutional forms of learning are emerging. Enabled by networked computers and a globalised economy, learning is being commodified and a global market for selling and buying education and learning material is being established. The use of ICT and new media is seen as key in providing such possibilities. This is evident in the rhetoric accompanying e-learning. "It [e-learning technology] eliminates the barriers of time and geographical distance. (…) It also offers learning-on-demand opportunities to individual employees while reducing training time and cost" (Zhang & Nunamaker, 2003, p. 208). Notwithstanding this rhetoric, the emergence of large-scale infrastructures such as the Internet is undoubtedly contributing to creating a change in the way education and training are organised and what opportunities institutions have when delivering and managing content and curricula.

Such new models of education and training are also paralleled by a trend towards pedagogical models involving collaboration, such as problem-based learning (PBL). New pedagogical ideologies, especially constructivism, have had a major impact on pedagogical thought and practice. These ideas and ideologies have been central also in the application of ICT in relation to learning practices, and new domains for studying and developing technologies that incorporates such ideas have emerged, for example the field of Computer Supported Collaborative Learning (CSCL).

The study of ICT in relation to learning practices is an interdisciplinary endeavour, placed somewhere between educational research, psychological research, information

systems research, and sociological research[2]. In this regard there are theoretical and methodological concerns that have been subject to debate over the last decades. One such concern is how to deal with the technical and material basis of human practices. Bruno Latour (1987; 1993) has criticised studies within the field The Sociology of Scientific Knowledge (SKK)[3] for their insufficient dealings with the material and technological aspects of scientific practices. According to Latour, technology has in such studies been "black boxed". He also suggests that this critique is relevant for sociology in general. When analysing practice, Latour argues that it is not enough to account for the social actors and the relations between these, and he goes on to identify "the missing masses" of sociology, namely nonhuman actors (including technology). His mission is to "show researchers in the social sciences that sociology is not the science of human beings alone – that it can welcome crowds of nonhumans with open arms" (Latour, 1996a, p. viii).

Studies of Human-Computer Interaction (HCI) and Information Systems (IS) have traditionally been informed by the cognitive sciences. The information processing paradigm (Newell & Simon, 1972), for example, and models of rational behaviour and decision-making, with more recent extensions (e.g., Anderson, 1995) have functioned as a main theoretical framework for studying people in interaction with technology. In the common caricature of this tradition, computers and humans are symmetrically modelled as information processing devices by means of the computer metaphor. The criticism of this approach to HCI and IS research is well documented (for a thorough treatment see Bannon, 1991; Suchman, 1987; Winograd & Flores, 1986). Interestingly, this criticism is somehow the opposite of Latour's criticism of sociology. In these fields the leveller had to be tipped the other way – humans had to regain their role in a world of technological objects. Star (1995) notes that in much IS research "it is not humans who have been privileged at the expense of nonhumans, but vice versa. It is computers and automation that have occupied a privileged position vis-à-vis human beings, often because of the inadequate social analysis held by computer movement advocates" (p. 13). Hence, when analysing the use of computers and information systems, there is a need for an understanding of the relation between

[2] Some fields of research have also been established at the intersection of these disciplines, such as CSCL and what is referred to as the Learning Sciences.
[3] I use SSK here in its widest form. Other names have been used for this field, such as the sociology of science. See Shapin (1995) for an overview.

humans and technological artefacts that incorporates these concerns. Such an understanding will provide the basic premises for studies of how ICT contributes to transforming the social and technological conditions of learning practices.

The main focus of this dissertation is how information and communication technologies are introduced and used in order to change or transform learning practices, in particular in a set of specific institutional practices, namely education and training.

With this backdrop I ask the following overall research questions:

- How is ICT introduced in order to transform learning practices?
- How does the introduction and use of ICT change the conditions for learning?

These questions are further pursued through asking some more specific questions:

- How is the introduction and use of ICT realised through the interaction of the participants?
- How is ICT incorporated into existing institutional arrangements?
- What organisational concerns and agendas are related to the introduction and use of ICT in learning practices?

In order to provide rich answers to these questions I will, based mainly on Star & Ruhleder's (1996) understanding of infrastructure, put forward the notion *infrastructures for learning* as an analytical backdrop and as a way of giving emphasis to the interconnectedness of artefacts, and of how such artefacts are intermeshed with technological, institutional and social arrangements. I will also present and analyse three empirical studies of the introduction and use of ICT in three different institutional settings. The first case study focuses on the realisation of a particular infrastructure for learning with regard to how a group of students organise their work in a distributed collaborative learning scenario. The second case study focuses on the introduction of a web-based tool into an existing inter-organisational arrangement. The third case study looks at the different organisational concerns and agendas that are taken into consideration when introducing and using an infrastructure for learning in a large telecommunications company that were moving into new headquarters.

The main aim of this thesis is thus to contribute to the understanding of how ICT is introduced and used in order to transform learning practices. While the overall research, in this way, aims at contributing to the understanding of the relationship between learning practices and infrastructure, another goal is to illustrate this through empirical studies that, in their own right, serve as analyses of actual practices. These practices, I would argue, are not only important building blocks in the overall discussion, but the analyses of these cases present empirically grounded results, that are valuable in themselves. The two first case studies, for example, also address the phenomenon of distributed learning practices mediated by ICT.

The rest of this dissertation is organised in the following way. In the next chapter (Chapter 2) I specify further the themes of inquiry that will be pursued in this thesis. This is done by looking at the concept and phenomenon of networked learning. Further I give an overview of two relevant fields of research CSCL and computer supported cooperative work (CSCW). In Chapter 3 the theoretical foundations of this thesis are explored in detail, giving an account of central concepts that are used in this thesis and discussing two views on the relation between humans and technology. Chapter 4 starts with a discussion of different views on ICT and infrastructure. Then three different studies are examined more closely to illustrate how the notion of infrastructure has been used in relation to empirical studies. The chapter ends by introducing and discussing the notion of *infrastructures for learning*. The next chapter (Chapter 5) elaborates on how infrastructures for learning can be approached methodologically and the research methods that have been applied in the empirical studies made as part of this thesis. In Chapter 6 the first of three case studies (Case 1) is presented and analysed. The analysis concerns how a group of students organised their work in relation to a new infrastructure for learning. Then, the second case study (Case 2) is presented in Chapter 7. In this case study I analyse how a web-based tool is introduced into an inter-organisational arrangement and how this new tool relates to the infrastructure for learning. The third and final case study (Case 3) is presented in Chapter 8. This case study looks at a large telecommunications company that introduced a learning management system (LMS) and a number of online tutorials to offer the employees training when relocating to a new workplace. The focus of the analysis is on what concerns that were prevalent when introducing and using this infrastructure for learning. In Chapter 9, the three different case studies are discussed

further and building on this I elaborate on the relations between infrastructures for learning, pedagogy and design. The final chapter (Chapter 10) provides a summary of the work and give some possible implications of the previous case studies and analyses.

CHAPTER 2 – THEMES OF INQUIRY

'E-learning', 'online learning', 'flexible learning', 'computer-based training', or 'Web-based training', are all terms that are being used to say something about how technology are used to support learning. Even though these terms are not theoretically precise and many of them have connotations to a rhetoric found in much management literature, they denote a loosely defined set of phenomena. A more accurate alternative is that of *networked learning* (Steeples & Jones, 2002; Jones, Dirckinck-Holmfeld & Lindström, 2005). Jones & Steeples (2002) define networked learning as "learning in which information and communications technology [ICT] is used to promote connections: between one learner and other learners, between learners and tutors; between a learning community and its learning resources"(p. 2; see also Banks, Goodyear, & McConnell, 2003). The definition focuses on the interactions ICT can create both between learners and between learners and the various resources available. When elaborating on this definition, Banks, Goodyear, & McConnell (2003) argue that "using online materials is not a sufficient characteristic to define networked learning" (p. 1). They claim that there has to be some human-human interaction to qualify as 'proper' networked learning. This criterion favours a specific mode of interaction (between learners and between learners and instructors). It can be argued, however, that downloading course content from the Internet (using online materials) is a form of interaction between different human actors, where the interaction is mediated by content and medium. This is a mode of interaction which resembles that between the author of a book and its readers. The interaction relies on the connections created between learners and the resources, but ultimately it is also a connection created between human actors, even though it is seemingly unidirectional. Hence, in the following I will not use this criterion to identify what counts as networked learning. Instead I will use the cited definition of networked learning as a denominator for the objects of my inquiries. I will look at some instances of networked learning. These instances vary according to what kinds of interaction there are between the participants, the kind of institutional setting, and the number of participants, but falls within the above definition of networked learning.

Jones and Steeples (2002) argue that the definition sets focus on the social dimensions of learning and that their understanding of networked learning is based on a social theory of learning, rather than individualistic theories of learning. In addition, it is *not* (in opposition to common explanations of, for example, 'e-learning') a definition that focuses solely on the benefits of using computer networks to 'enhance learning' or create more efficient learning. As Jones and Steeples put it "There is no necessary connection between the increasing use of computer networks and learning" (p. 2). This is also in line with the focus chosen in this thesis. Rather than assuming a positive correlation between the use of ICT and learning, I want to explore how the introduction of ICT contributes to creating certain conditions for learning, not examine to what extent learning has taken place.

Nevertheless, the view of networked learning discussed here is, of course, motivated by a certain "pedagogical commitments and beliefs about learning" (Banks, Goodyear & McConnell, 2003, p. 2). Pedagogical models such as collaborative learning, and theoretical underpinnings such as a view of learning as participation in practice (e.g. Lave & Wenger, 1991) are examples of such commitments and beliefs. The relation between theories of learning, pedagogical models and the use of ICT is a theme that is central to this thesis. This will be discussed in detail in a later chapter (chapter 9). In the rest of this chapter I will explore two fields of research within which this thesis can be placed, computer supported cooperative work (CSCW) and CSCL.

Cooperation, Coordination and Design in Computer Supported Work

At the crossroads of social science and the study of technological systems several fields of research have emerged over the past decades. In the 1960's focus was very much on automatization, with concerns such as the deskilling of the workforce and the fear of automatic systems taking over people's jobs (see Bowker, Star, Turner & Gasser, 1997). More recently, CSCW has been established as a field of interdisciplinary research that concerns how computer systems are used in cooperative work (Bannon & Schmidt, 1991). The field CSCW can be seen as a specialization within IS Research, focusing especially on the use of groupware (Ellis, Gibbs & Rein, 1991), but also as a shift away from the somehow narrow focus of Human-Computer Interaction (that traditionally focused on a very limited set of actions and operations

such as keyboard strokes, and usability for individual users). With the spread of networked computing, researchers within CSCW began to pay attention to organisational and cultural issues at the workplace (e.g., Orlikowski, 1992). Still, much attention has also been paid to applications that support the work of small teams (Grudin, 1994a). More generally, the relation between work and technology is fundamental issue in CSCW research. Suchman and Trigg (1991) elaborate on this relationship:

> Because of the intimate relation between work and technology, the development of the artifacts with which people work and the development of their work practices go hand in hand. Available technologies afford certain resources and constraints on how the work gets done, and peoples' ways of working give the technologies their shape and significance (p. 65).

There has been a quite balanced focus on success stories and technological 'failures' in CSCW. Grudin (1988) gives a list of reasons for why groupware systems fail (see also Markus & Connolly, 1990). These reasons are paraphrased by Heath & Luff (2000), and include:

> the disparity between who actually does the work and who receives the benefit from the system; the ways in which groupware and CSCW systems often formalise roles and responsibilities and are insensitive to informal organisation in the workplace; the fact that CSCW systems may be insensitive to the flexible and contingent character of work and organisational procedures; and the relative failure of management to recognise that in many cases the success of the system is dependent on wide-ranging organisational change (p.14).

These aspects of the implementation and use (or lack of use) of groupware, also points to some more general concerns within CSCW. The critical stance taken against relying on formal representations of the work process in design of CSCW systems (Suchman, 1995; Star & Strauss, 1999) is one such concern. Another is the relation between organisational change and the introduction and use of CSCW systems (e.g., Orlikowski, 1992b).

Many studies in CSCW are design oriented research in the sense that they ultimately want to inform the design of the computer systems that support cooperative work. As Schmidt & Bannon (1992) put it:

> CSCW is basically a *design oriented research area*. (…) Thus, the objective of social science contributions to CSCW should not be to cash in on the new wave and do what they have always done but rather to explore exactly how insights springing from studies of cooperative work relations might be applied and exploited in the design of useful CSCW systems (pp. 5-6, italics in original).

Schmidt & Bannon thus offer a quite limited agenda for what research in this area should concern[4]. They note, however, that such analyses require researchers and technologists to "extend out from a strict technical focus and investigate how their artifacts are, or could be, used and appropriated in actual settings" (p. 6). Thus, a strictly analytical agenda is (at least implicitly) rejected. Nevertheless, the way this design orientation is pursued in much CSCW research can be rather limited:

> detailed design guidelines are typically absent from the standard format of CSCW conference or journal papers, which tend to offer a description of a case study, followed by an 'implications for system design' section at the end of the paper in which a number of highly generalisable or semi-intuitive recommendations are made (Plowman, Rogers & Ramage, 1994, p. 313).

Adding a section in a research article discussing quite general design implications does not necessarily solve the problem of how to contribute to the design of technological systems[5]. There are other models for how studies with mainly an analytical agenda can inform design in the long run (e.g. Bowker, 1998). For example by offering an alternative understanding of the conditions of cooperative work, and detailed descriptions of particular practices where technological systems are used, this can feed into the design of such systems.

The variety of CSCW research is also reflected in the conceptual frameworks adopted in CSCW studies. A number of studies have, for example, taken up an activity

[4] Such a view on what the agenda in CSCW research should be can be seen in relation to the close ties between the Participatory Design community and CSCW (Bannon, 1997).
[5] Lindwall & Lymer (2005) makes a similar argument for design in CSCL.

theoretical framework[6] (see Kuutti, 1991; Engeström & Middelton, 1996). Owing much to Suchman's (1987) groundbreaking book, many have also adopted a perspective flavoured by ethnomethodology (e.g., Dourish & Button, 1998; Heath & Luff, 2000; Crabtree, 2004). The notion of work as a situated activity is key from such a perspective, as articulated by Suchman & Trigg (1991):

> By this [work as a situated activity] we mean that work activities in every case take place at particular times, in particular places, and in relation to specific social and technological circumstances. From this perspective the organization of work is a complex ongoing interaction of people with each other and with the technologies that are available to them (p. 65).

Another central theoretical influence is symbolic interactionism (Hughes, 1958; Blumer, 1969; Strauss, 1978) and the workplace studies undertaken from this perspective. In particular, the work of Anselm Strauss (1985; 1993) has been taken up and informed for example notions of articulation work (e.g., Gerson & Star, 1986; Schmidt & Simone, 1996; Star & Strauss, 1999).

These different conceptual frameworks are not necessarily mutually excluding[7], but in many respects they put emphasis on different aspects of CSCW. One such difference is to what extent they include the institutional aspect of practice (as for example activity theory). Suchman's work, for example, is much more concerned with the gritty details of work processes.

Another major theme in CSCW is that of coordination of interdependent work activities[8] (see Schmidt & Bannon, 1992; Schmidt & Simone, 1996). This is related to the understanding of the nature of cooperative work (see Bannon, 1997; Kling, 1991b). The notion of cooperative work does not necessarily resonate with that of teamwork, but can be more broadly defined as people working together, for example, in the same production process (see Bannon & Schmidt, 1991). Schmidt & Bannon (1992) argue that the notion of "*interdependence in work*" (p. 13, italics in original) is

[6] There is a continuous discussion on this issue in the CSCW Journal, see for example the special issue (Vol. 11, No. 1, 2000) on Activity Theory and the Practice of Design.
[7] For a discussion of the relation between information systems, activity theory and symbolic interactionism see Star (1996).
[8] Malone & Crawston (1990) introduce the notion of interdependence and discuss it in relation to coordination theory.

crucial to understand cooperative work. "Cooperative work is constituted by interdependence in work, that is, by work activities that are related as to content in the sense that they pertain to the production of a specific product or service" (p. 16). The way cooperation is defined by Schmidt & Bannon (1992) emphasises the collective dimension of work that have a shared objective that creates interdependence between the participating actors.

Sharing of information and knowledge is yet another theme that has been discussed within the CSCW community (e.g., Ackerman, 1994; Pipek & Wulf, 2003). The focus has commonly been on issues such as organisational memory and how to augment organizational memory using computer systems. As part of such efforts there has also been developed specialised computer systems (for example "The Answer garden[9]", see Ackerman & Malone, 1990; Ackerman, 1994). This also serves as an example of how issues in CSCW borders on issues of learning.

Computers, Collaboration and Learning

Computer Supported Collaborative Learning (CSCL) emerged as a field of research in the early 90's (the name was first coined at a NATO workshop in Italy, 1989 (Koschmann, 1996)). The interdisciplinary endeavours of a diverse group of researchers, coming from educational research, computer science, artificial intelligence (AI) in education, etc., comprise this field as of today. Koschmann's (1996) milestone contribution define CSCL as an "emerging paradigm", and he contrasts the research in this field against other research endeavours concerning instructional technology[10]. According to Koschmann, CSCL are distinguished from earlier research on instructional technology in that it has different theories of learning, different models of instruction, and are concerned with other research issues. The strength of Koschmann's paper is the historical description of the various research traditions, but, in light of the last ten years of research within the field, his characterisation of CSCL can be said to be quite 'programmatic', in that it paints a

[9] Ackerman (1994) and his development and studies of "the Answer Garden" is one well documented example of this within CSCW. The Answer Garden is an "organizational memory system", a system that is supposed to "augment organizational memory". This particular system is used both to make records of "an organization's knowledge (…) and supplement existing learning and knowledge mechanisms" (p. 243).

[10] The different paradigms on research on instructional technology are according to Koschmann (1996): Computer Aided Instruction; Intelligent Tutoring Systems; and, Logo-as-Latin.

picture of what CSCL *should be* concerned with, rather than taking into consideration the diversity of the pertaining perspectives and issues within the field. As Lipponen (2002) remarks, "there is still no unifying and established theoretical framework, no agreed objects of study, no methodological consensus, or agreement about the concept of collaboration, or unit of analysis" in CSCL. Bannon (1989) explores CSCL in another way, arguing that CSCL can be seen as "an 'umbrella term' which serves a useful function by bringing together under its umbrella, in meetings and workshops, a variety of researchers with different backgrounds and techniques, where they can discuss their work". An alternative interpretation of CSCL is, according to Bannon, research with a specific concern for "learning, specifically collaborative learning, and how it might be supported by the computer". Still, this is a rather general description, and the terms collaborative learning and computer support can take on quite different meanings.

Dillenbourg (1999) define 'collaborative learning' as "a *situation* in which *two or more* people *learn* or attempt to learn something *together*" (p. 2, italics in original). This is, according to Dillenbourg, a very broad and unsatisfactory definition, and he explores the way collaborative learning varies over "three dimensions: the scale of the collaborative situation (group size and time span), what is referred to as 'learning' and what is referred to as 'collaboration'" (p. 2). Another, and quite different, understanding of collaborative learning is as a more generic notion of learning as a social phenomenon, or more specifically, placing emphasis on the interpersonal aspects of learning. Collaborative learning can thus be understood as a concept that places emphasis on the construction of (shared) knowledge through interaction with others.

Collaborative learning can also be seen as a specific pedagogical model[11] or as a "model of instruction" (Koschmann, 1996) - with the underlying assumption that people learn *best* when engaged in interpersonal collaboration, which can be brought to bear upon an educational setting. In this sense collaborative learning is a normative concept with certain pedagogical implications. This is quite different from a definition

[11] I will in the following use the concept "pedagogical model" to refer to pedagogical arrangements of different kinds. The concept is used in coherence with what Koschmann (1996) calls an instructional model. Collaborative learning can in this way be seen as a pedagogical model. Later (in Chapter 9) I will discuss this with regard to what Petraglia (1998) calls a "mediating theory".

of collaborative learning as a set of situations with certain characteristics. If collaborative learning is seen as a pedagogical model, CSCL research would be narrowly concerned with studying instances where computers were introduced to support this specific pedagogy, or with finding ways in which this specific model of instruction is best supported by computers. It is thus a question of whether the notion of collaborative learning is used prescriptively or analytically. Both of these notions are present in CSCL research. Specific pedagogical models are often inspired by theories of learning (the model of 'collaborative learning' is commonly based on theories of learning that emphasise social aspects of learning). These models can, together with the given perspective on learning, be a factor in defining the research agenda (as 'collaborative learning' in CSCL). What is more, the research can be aimed at trying out (in a field trial or design experiment) and improving these same pedagogical models. Hence, there is an intrinsic relation between a pedagogical model and the research agenda, where one co-constitutes the other.

There is a variety of technologies that can support collaborative learning. On one hand, it is common to use generic tools (such as email or discussion forums) to support collaboration among participants. On the other hand, there has been developed a set of tools that try to implement certain pedagogical models or didactic features. A much cited example of the latter is that of Computer Supported Intentional Learning Environments (CSILE) (Scardamalia & Bereiter, 1996). CSILE[12], which has been implemented in different variations (WebCSILE, Knowledge Forum), are developed to support collaborative inquiry and knowledge building. When working in this environment, students are supposed to mimic or emulate the process scientific research (or at least an idealised version of scientific research) by identifying research questions and hypotheses, digging deeper into the matter by searching for more information on the topic, explicate their arguments and explanations, and finally falsify or validate their original hypothesis. The technology is developed specifically to support this process by making the students categorise their entries (with 'thinking type tags') in this system and storing this in a shared repository (database). In this way, central features of the pedagogical model are inscribed in the system. Another application, FLE3 (Muukkonen, Hakkarainen & Lakkala, 1999), uses a similar

[12] For some resent studies of CSILE, see Hewitt (2001) and Oshima & Oshima (2001).

strategy for implementing and scripting the pedagogical model (inquiry based learning)[13]. In such attempts to influence learning, by the highly integrated use of technology, CSCL can be seen as a pedagogical model in itself; that is the computer-support is an integrated part of the pedagogical model. The flip side can in such cases be that the use of technology becomes a pedagogical imperative.

The design of what is commonly labelled learning environments is a strong current trend within CSCL research. Design in CSCL is not only concerned with the forging of specific collaborative technologies, but commonly focus on the design of a learning environment, where the technological tools are but one part of the environment (see Wasson, 1997). Fjuk, Sorensen & Wasson (1999) have, for example, proposed that designing CSCL environments is a combination of organisational, technological, and pedagogical concerns.

In addition to these issues, there are different theories of learning that underlie research in CSCL. Koschmann (1996) labels these broadly as "socially oriented theories of learning" (p. 16). The influences from sociocultural theories of learning and cognition are central (and this will be discussed in the next chapter), but Koschmann also points to social constructivism and situated cognition as two other important sources. Even though these socially oriented theories of learning have been prominent within CSCL, the perspectives on learning that are used within research published in the field also include traditional cognitive theories of learning (and experiments as the main research design)[14].

Summary

Several of the central concerns and thematic issues within CSCL and CSCW are relevant for the research presented in this thesis. Still, within both of these fields of research there are diverging concerns and no monolithic agenda. In CSCL, for example, issues of pedagogy, design and theory are commonly mixed (often within a single study). In more general terms this can be seen as a tension between a normative

[13] See Arnseth (2004) for a detailed study of the use of this system. Rysjedal & Baggetun (2003) report on the challenges of integrating such a technology in a school setting.

[14] For examples of research using a cognitive perspective on learning from the latest CSCL conference (Wasson, Ludvigsen & Hoppe, 2003), see Rummel, Spada, Caspar, Ophoff & Schornstein (2003); and, Vamakoussi, Kargiotakis, Kollias, Mamalougos & Vosnaidou (2003).

or prescriptive agenda on the one hand and an analytic or descriptive agenda on the other. These issues are very much present in other fields as well. A relevant example is that of information systems research[15] (see Hevner, March, Park & Ram, 2004). A more or less deliberate mixture of such agendas can bee seen as an inherent tension in these fields.

The research in this dissertation is at the intersection of CSCL and CSCW. These two different research communities focus on different, but related issues. Still, Koschmann (1999) claims that the division of labour between these to fields is to a large extent an artificial one, and argue that CSCL should focus on collaboration *and* learning. In addition, the research rendered in this dissertation is also related to research in more broad fields such as information systems research, educational research and organisational research. This means that the findings and case studies are mainly discussed in relation to CSCL and CSCW, but also draw upon some results and findings from these broader fields.

Both CSCL and CSCW have various theoretical underpinnings. In both fields there is a concern for how the phenomenon under investigation cannot be explained with a narrow focus on psychological matters, and how the use of controlled experiments is not a sufficient method for studying these phenomena (Bannon, 1991; Kuutti, 1991; 1996; Koschmann, 1996). In CSCW the shift has been from looking at human computer interaction (with a focus on interface design) to looking at more broad patterns of cooperation and interdependency. In CSCL the shift has been to a view on learning as situated in a cultural and social context, and on technology as mediating artefacts. For both fields this represents a shift of focus to look more closely at how cooperative work and collaborative learning must be explained with reference to the social dimensions of these phenomena.

Moreover, this kind of interdisciplinary research requires a theoretical framework that integrates concerns and fundamental assumptions about both technological systems and human practice. In the following chapter, I discuss some fundamental issues and concepts comprising the conceptual framework of this thesis.

[15] Hevner, March, Park & Ram (2004) characterise this difference as two paradigms within IS research: behavioural science and design science.

CHAPTER 3 – THEORETICAL FOUNDATIONS

This chapter contains a discussion of the general relation between humans and technology. This is relevant for a theoretical understanding of how ICT mediates learning activities, and of how these technological arrangements contribute to forming the conditions of education and training. Through a discussion of the notion of mediation in the sociocultural perspective[16] and actor network theory, emphasising the writings of Bruno Latour, some of the fundamental issues concerning the human-technology link are highlighted. The discussion is also meant as a discussion of the theoretical influences of the following analyses. The theoretical influences are found at the intersection of a sociocultural perspective, actor network theory, and symbolic interactionism. In addition I will give an outline of different views on learning, and specify how I use the concept of learning in this dissertation, but first I will give an account of institutional practices.

Education and Training as Institutional Practices

"Practice! Practice! More Practice! Such are the inscriptions on the flag of the new battalion of students coming from the sociology, philosophy, and history of science" (Latour, 1993, quoted in Engeström & Middelton, 1996, p. 3). A similar trend can also be found within CSCW and CSCL. Practice has been established as the unit of analysis in studies of work, cognition, and learning and as a critique of cognitive science and its insufficient dealings with the social and cultural context of these phenomena. Still, this question is not to be brushed aside only due to its popularity, as the quote from Latour might indicate. It denotes an important shift of focus in the theorizing around learning and cognition. There are some cautions, however, that should be mentioned. There is a danger of making practice into more than a unit of analysis. It might become an explanatory principle or an issue to be capitalized upon (Vann & Bowker, 2001). There are even some researchers who tend to front the focus on practice as the solution to practical problems of information and knowledge management (e.g., Hildreth & Kimble, 2002).

[16] The label sociocultural (Wertsch, Río, & Alvarez, 1995) is an umbrella term, including perspectives such as cultural psychology (Cole, 1996), cultural-historical activity theory (Engeström, 1987), and situated learning (Lave, 1988; Lave & Wenger, 1991). There are subtle differences between these perspectives, but this is not central to the arguments presented here. In more general terms, Actor Network Theory can also be labelled as a "sociocultural perspective", but for the sake of clarity I treat ANT as a perspective in its own.

Theories of practice have been central in sociological discourse over the past few decades (e.g., Bourdieu, 1977; and, Giddens, 1984)[17]. Building on this discourse, Lave & Wenger (1991) give some characteristics of key concerns in a theory of social practice: "a theory of social practice emphasizes the relational interdependency of agent and world, activity, meaning, cognition, learning, and knowing. It emphasizes the inherently socially negotiated character of meaning and the interested, concerned character of the thought and action of persons-in-activity" (pp. 50-51). Practice in this sense, is also a way of accounting for the situatedness of action (see also Suchman, 1987), and how action is situated in a cultural and historical context. The notion of context is not meant in any simplistic sense, such as "that which surrounds", but as an ongoing constitutive element of action. From dissatisfaction with a "concept of context in a reduced form of an environment or cause" (Cole, 1996, p. 137) many have turned to the concepts of practice and activity in its place (e.g., Lave, 1988). Even though the concepts of practice and activity[18] has different theoretical roots (see Cole, 1996, for a discussion), they are constructs which share several key assumptions. Cole (1996) paraphrases Lave (1993) and lists three such uniting themes:

> An emphasis on the dialectical character of the fundamental relations constituting human experience (…); A focus on experience in the world (…); A shift in the boundaries of cognition and the environment such that, in Lave's phrasing, cognition is "stretched across mind, body, activity and setting (Cole, 1996, p. 141).

This citation focuses on the common features of these constructs (activity and practice). With a starting point in experience and the-lived-in-world, they draw our

[17] The concept practice has commonly been called upon to overcome dualisms such as structure – agency and individual – social.

[18] A major area for theorizing over the concept of activity is Activity theory (there are different directions within activity theory, or Cultural Historical Activity Theory as it is also called, see Cole (1996) for an overview.), which offers a framework for understanding and analysing different forms of human activity. Recent developments in this tradition have included concepts and models to describe activity systems (the elements that mediates between the subject, community and object of a dynamic activity system, are tools/artefacts, division of labour, and rules of interaction) (Engeström, 1987; 1999). Activity theory lends itself to the study of many different phenomena, but its main analytical advantage is perhaps when dealing with institutional, historical, developmental, or other, systemic properties of human activity, focusing on contradictions within and between activity systems.

attention towards situated actions and people acting in context[19]. This is also central to the assumptions of the perspective adopted in this thesis. Rather than having an emphasis on the nominal differences between these constructs and the differences in their origin, I will use activity and practice as synonymous throughout the rest of this dissertation (well aware of the differences).

The kind of practice I focus on in this dissertation is education and training[20]. I see education and training as specific and organised activities aimed at learning, taking place within an institutional framework, and can thus be said to be *institutional practices*. Such institutional practices must be understood in relation to a collective dimension[21]. Hughes (1984) elaborates on this notion:

> [An] idea fundamental to the study of human life, that of collective behaviour, grows out of the fact that human beings so obviously behave in response to the behavior of each other that what the individual does can be understood only by using the collectivity as a point of reference. Institutions are sometimes defined by distinguishing them from such elementary forms of collective behavior as the crowd and the primary group, whose peculiar feature is social interaction not mediated by established forms (Hughes, 1984, pp. 5-6).

The idea that we must understand actions in relation to a collective dimension, and that there are established forms that mediate these actions is central to the rest of this exploration. To see education and training as institutional practices – practices mediated by established forms – an exploration of the concept of institutions is needed.

A common characteristic of institutions is convention. Mary Douglas (1986) claims that convention is the minimal requirement for an institution, and "a convention arises when all parties have a common interest in there being a rule to insure coordination" (p. 46). Douglas, however, describes institutions as a "legitimized social grouping". The aspect of legitimacy is one that Hughes (1984) discusses in his classical essay

[19] The latter point (that "cognition is stretched out over body, activity and setting") is more generally referred to as "distributed cognition" (see Hutchins, 1995; Salomon, 1993).
[20] Training can be defined as "any set of learning activities aimed at equipping individuals with the knowledge needed for pre-defined tasks and roles" (Poole & Stevenson, 2001, p. 16299).
[21] See Engeström (1987) for a similar argument.

"Bastard Institutions" (pp. 98-105). According to Hughes, many institutions are ignored by social scientist due to their "escape from legitimate channels (…) and do not have the support of open legitimacy" (pp. 98-99). Thus, only including legitimised social groupings may not be the best starting point. Douglas' description is also in line with functionalism – the major strand of theorizing over institutions and institutional orders. In a caricature of this position, the institution is a formal social organisation with a set of roles and a set of norms that govern the actions of the institution's members.[22]

Czarniawska (1997) offers another (non-functionalist) account of institutions: "an institution is a pattern of social action strengthened by a corresponding social norm" (p. 43). Here, it is the actions of the participants that constitute the institution, but "actions, despite the stability and repetitiveness that earn them the name of institutions, change in both their form and meaning" (p. 43). This co-construction of 'the established' and 'collective action' is highlighted by Hughes (1984) in his characterisation of institution as well: "There is an order of social phenomena in which the feature of establishment and that of collective behavior meet in a particular way; namely, so that the very form taken by the collective behavior is something socially established" (p. 6). In this sense, Hughes emphasise how institutions are constituted by social interaction that are mediated by established forms. This brings us closer to the way I use the concept institutional practices in this thesis: as a way of referring to the systemic dimensions of collective action.

Engeström (1987) looks at these systemic properties as activity systems. An important constitutive element of such activity systems is the 'rules of interaction', which mediates the relation between the subject and the community. This resonates with how Czarniawska (1997) includes social norm in her definition of institutions. Still, as Engeström (1987) points out, these rules are not the only dimension that mediates human activities. Division of labour is one such dimension, and, as I will discuss in detail below, another is artefacts. The role of artefacts has also been central in sociocultural perspectives on learning (Säljö, 1999).

[22] Such functionalist explanations of institutions and social order have been criticised widely, in particular by ethnomethodologists (Garfinkel, 1967)

Artefacts and Tools

Artefacts, in the dictionary sense of the word – a material object manufactured by human beings, have been subjected to analysis in different strands of thinking. In archaeology and anthropology artefacts and their variety of overt and covert cultural meanings have played a crucial role in the explanation of ancient or somehow exotic and foreign contemporary cultures. In such explanations artefacts are often seen as tools in a certain material culture, in some ways distinct from the study of human behaviour and knowledge (Cole, 1996). The sociocultural perspective places the making and use of artefacts at the centre of the development of human cognition and thought. Michael Cole (1996) gives this characterisation of an artefact:

> An artifact is an aspect of the material world that has been modified over the history of its incorporation into goal-directed human action. By virtue of the changes wrought in the process of their creation and use, artifacts are simultaneously *ideal* (conceptual) and *material*. They are ideal in that their material form has been shaped by their participation on the interactions which they were previously a part and which they mediate in the present (p. 117, italics in original).

This citation highlights important dimensions of the role artefacts play in sociocultural practices. Artefacts are reifications of human action. Even a seemingly immaterial artefact like spoken language has a material dimension. Words that are uttered, though quite ephemeral unless recorded, have an acoustic and thus material dimension. The artefacts are not only material, but also ideal. Artefacts are carriers of significance and meaning, and these properties are somehow inscribed in the material form. This conceptual dimension points to what Wartofsky (1973) calls the "symbolic embodiments or objectifications of modes of action or praxis, *in* an objective artifact" (pp. 204-205). As Wartofsky also points out, artefacts are "already invested with cognitive and affective content" (p. 204). Artefacts, in this case, include both tools and language. Wartofsky, in the same way as Cole (1996), treats tools as a subcategory of artefacts. More importantly, the production and use of tools, over history, leaves ideal and material traces, that become crucial in the 'consumption' of artefacts. This also points to the role artefacts play in relation to the cultural and historical aspects of human activity. Lave and Wenger (1991) consider the naturalisation of artefacts as a crucial element of becoming a member in a community

of practice. "[U]nderstanding the technology of practice is more than learning to use tools; it is a way to connect with the history of the practice and to participate more directly in its cultural life" (p. 101).

Mediation

Another dimension touched upon in the citation from Cole above is the tenet that artefacts mediate human action. An early formulation of this idea is found in the writings of the Russian psychologist Lev Vygotsky. His formulation of the basic structural relation between subjects and environment is modelled as a triangular structure.

This central component in Vygotsky's writing implies that, in addition to a simple stimulus-response model as that of Pavlov, tools serve as an intermediate link between the subject (response) and the object (stimulus). Still, this should not be interpreted as a mere extension of Pavlov's model. All higher psychological processes are mediated through tools. In other words, "tools serve as mediational means, i.e., they – metaphorically speaking – stand between the individual and the world" (Säljö 1996, p. 84).

Instead of using the concept 'artefacts', Vygotsky differentiates between technical and psychological tools:

> The most essential feature distinguishing the psychological tool from the technical tool, is that it directs the mind and behaviour whereas the technical tool, which is also inserted as an intermediate link between human activity and the external object, is directed toward producing one or other set of changes in the object itself (Vygotsky, 1978, quoted in Daniels, 1996, p. 7).

More relevant for the discussion than the differentiation between psychological and technical tools[23] is the point that tools (or artefacts) "direct", or in some way alter or shape, human activities. Psychological tools mediate human activities in that they "direct" or in some way shape or alter behaviour and mind. The most important

[23] For a discussion of this differentiation see Engeström (1987, pp. 58-73).

psychological tool, according to Vygotsky, is language. Imagine how language has an impact on our thinking through properties such as grammatical rules, and terminology (cf. Vygotsky, 1987, chapter 7, for an extensive treatment of the relationship between thought and word). Still, a question remains. How do the tools direct action, or put differently, where do they direct action?

Vygotsky, in the spirit of Enlightenment rationalism, most heavily emphasised the enabling potential of cultural tools (Wertsch, 1998). Cultural tools help us think, they enable the construction of more sophisticated knowledge. Through the process of mediation, cognitive activity is enhanced. For example, an algorithm or a procedure enables you to solve a complex mathematical problem without much effort. The use of a calculator helps you easily extract the square root of a non-square number. The use of words and language enable you to express your feelings. Cultural tools have certain affordances (Gibson, 1979) that make certain kinds of action possible. Still, this is a pretty benign picture of mediation, focusing solely on the empowering and enabling role of cultural tools.

The other way mediation works is by constraining our thoughts and actions. "Any attempt to understand or act on reality is inherently limited by the mediational means we necessarily employ" (Wertsch 1998, p. 40). Wertsch further underscores that the way mediational means constrain action is usually recognised after the development of an 'improved' artefact. When you have a calculator you realise the constraints connected to the use of a slide rule. Wertsch sites Kenneth Burke to illustrate how this is evident for language; "even if any given terminology is a *reflection* of reality, by its very nature as terminology it must be a *selection* of reality; and to this extent it must function also as a *deflection* of reality" (p. 40, italics in original). In other words, through the mediational process, cultural tools simultaneously enable and constrain human action.

It is important to note that the specific use of an artefact is not given or determined in any strong sense by its functional properties, by its affordances, or through the ideal and material traces already invested in a cultural tool. The presence of a cultural tool in an activity, however, does not prescribe how it will be conceived or used. This indeterministic character of mediation is a central tenet in a sociocultural perspective.

Mediation and Action

The sociocultural perspective assumes an asymmetry when it comes to the relation between humans and artefacts. It leaves room for a special kind of human self-determination. Engeström (1999) elaborates on this issue:

> The traditional division between social sciences and psychology has created the still prevalent dichotomous notion according to which humans are controlled either from the outside by society or from the inside by themselves. In the former case, the possibility of human agency and transformation of social structures from below becomes an unexplained mystery. In the latter case, the origins of individual self-determination are attributed to the equally mysterious sources of biological urges or inherent free will (p. 29).

In opposition to such views, Vygotsky (1978) emphasises the role of tools and how they permit humans "by the use of extrinsic stimuli [mediating tools], *to control their behaviour from the outside*" (p. 40, italics in original). The way humans control their behaviour and environment is through the use and creation of artefacts. The asymmetry between the actor and the tool is evident. It is the human being who acts. Nevertheless, it should be underscored that these considerations rest on a view that contrasts that of methodological individualism, "it forces us to go beyond the individual agent when trying to understand the forces that shape human action" (Wertsch 1998, p. 24). Wertsch argues that the 'irreducible tension between agent and mediational means' is a proper unit of analysis (pp. 25-30). "Instead of assuming that an agent, considered in isolation, is responsible for action, the appropriate designation of agent may be something like 'individual-operating-with-mediational-means' " (p. 26). David-and-the-sling defeated Goliath, to give a biblical example. According to Wertsch, this implies that we cannot gain a proper understanding of mediated action by looking at the elements (agent and mediational means) in isolation. It can be done as an analytical exercise, but with an eye for how they fit together as a whole. So, the perspective assumes an analytical symmetry, formulated in opposition to 'elementaristic' approaches, where artefacts and human agents are treated as equally important in the process. When pushing the view into more ontological considerations, however, there is little doubt about 'who is doing the acting'. Wertsch is quite clear on this issue: "Indeed, in and of themselves, cultural tools such as poles

in pole vaulting and the form of syntax used in solving multiplication problems are powerless to do anything. They can have their impact only when an agent uses them" (p. 30).

Mediation is a fundamental idea when it comes to understanding the relation between humans and artefacts. In a sociocultural perspective, humans use artefacts to control their environment, but humans and artefacts are inseparable parts in the unit of analysis when analysing sociocultural practices.

Humans and Nonhumans

Actor Network Theory (ANT) has offered another, but similar, way of conceptualising artefacts. This approach has been developed in relation to a discourse with converging concerns with those of cognition and learning, namely studies of science and technology. In the field Sociology of Scientific Knowledge (SSK) there are several debates, disputes and even 'science wars'. They range from that between realism and social constructivism (e.g. Bijker & Law, 1992; Hacking, 1999), to that of internal and external explanations of science. Within this field, ANT and its advocates have been particularly concerned with the role of artefacts in scientific practices. Following this, some of the underlying assumptions of the actor network approach are anti-essentialism and anti-dualism (Callon, 1999). Among the dualisms of which they are seeking to dispose are agency – structure, actor – system, knowledge – power, and truth – falsehood (Ibid.). In addition, it is central to ANT to assume a 'radical indeterminacy' of the actor, which means that "the actor's size, its psychological make-up, and the motivations behind its actions – none of these are predetermined" (Callon, 1999, pp. 181-182).

According to Latour (1987), the proper way to understand science (in action) is to try to reconstruct the network of associations that constitute the mechanisms for explaining both the content and context of scientific practices. These networks of forces or associations – the enrolment of allies – are reconstructed by following the actors in these practices, human and nonhuman. This proposition is not limited to the realm of scientific practices. Latour explores this in relation to the construction of complex technological systems, such as a public transportation system (see Latour, 1996a), and the use of mundane artefacts (Latour, 1992). He includes in his agenda

"to find a different genealogy of artifacts" (Latour, 1999a, p. 174). With this he wants to transcend or bypass the dichotomy between 'subject and object' or 'people and things'. This is done by replacing this dualism with the pair 'humans and nonhumans'. Artefacts are to be understood as nonhuman actors. Latour describes his use of actors in the following way:

> I use 'actor', 'agent' or 'actant' without making any assumptions about who they may be and what properties they are endowed with. Much more general than 'character' or 'dramatis persona', they have the key feature of being autonomous figures. Apart from this, they can be anything – individual ('Peter') or collective ('the crowd'), figurative (anthropomorphic or zoomorphic) or nonfigurative ('fate') (Latour, 1988, p. 252n).

Latour's nonhuman actants are illustrated quite vividly in "Aramis, or the love of technology" (Latour, 1996a) where the technological system is given both a name (Aramis) and a voice (speaking to the readers of the text). He explores how "we can turn a technological object into the central character of a narrative" (p. v). The link to semiotics is explicitly stated in Latour's writings. He looks for the meanings and responsibilities inscribed[24] in artefacts (or nonhumans) as they are played out in a network of associations.

In order to illustrate and analyse such relations, Latour suggests that we "compare machines with texts since the inscription of builders and users in a mechanism is very much the same as that of authors and readers in a story" (Latour, 1992, p.236). This results in a description of artefacts as containing a script or a program of action. Programs of action are used to account for the active role artefacts play in action. A device contains a program of action that anticipates what other actants may do. Still, these anticipations may not be fulfilled as other actants may have other programs of action (anti-programs). Technology prescribes certain actions. The use of a programming language illustrates this quite clearly. The program (the text written in a programming language) is at the same time words and actions. "How to do things with words and then turn words into things is now clear for any programmer" (Latour,

[24] Latour (1987) uses the term inscriptions rather than the term representations to escape the connotations of the dualism internal – external (see also Akrich, 1992). In Latour's (1999a) words inscription is a "term that refers to all the types of transformations through which an entity becomes materialized into a sign, an archive a document, a piece of paper, a trace" (p. 306). The verb to inscribe thus refers to the process of making inscriptions.

1992, p. 255n). Programs and anti-programs can, in this way, be seen as parallel to the discussion above concerning how mediational means constrain and enable action. Another aspect related to the programs of action inscribed in nonhumans is that this form of mediation implies "crossing the boundary between sign and things" (Latour, 1999a, pp. 185-190). This bears resemblance to the above-mentioned description Cole (1996) gives of artefacts as having simultaneously a material and an ideal dimension.

Mediation as Delegation

To account for how properties are inscribed in artefacts, this has to be seen as a historical process. Over time humans and nonhumans are folded into each other. Their properties are exchanged and mixed. This process is labelled delegation. "In delegation … an action, long past, of an actor, long disappeared, is still active here, today, on me. I live in the midst of technical delegates; I am folded into nonhumans" (Latour, 1999a, p. 189). How this delegation to and disciplining of nonhumans is carried out, is illustrated through the commonplace example of the sociology of a door-closer (Latour, 1995). In this article, Latour shows how the door-closer is inscribed with the responsibility to close the door by comparing it to other ways of organising this 'hole-wall [door] dilemma'.

> I will define this transformation of a major effort into a minor one by the word translation or delegation; I will say that we have delegated (or translated or displaced or shifted out) to the hinge the work of reversibly solving the hole-wall dilemma (p. 259).

The door-closer has been inscribed with a certain program of action: to close the door. The responsibility of action has been delegated to a nonhuman. In this way Latour shows how action is not only a property of humans. Artefacts play an active part in action. The prime mover of action is not necessarily human. When an actant is enlisted (human or nonhuman) work and responsibilities can be delegated to this actant, but in this process a *translation* occurs. The presence of this new actant adds something to action. Goals and meanings are translated (changed, shifted, displaced), a link has been created that did not exist before and this link modifies the original states (goals or meanings) of the original actants. In other words, "[p]rovisional 'actorial' roles may be attributed to actants only because actants are in the process of

exchanging competences, offering one another new possibilities, new goals, new functions" (Latour, 1999a, p. 182). The roles actants play can only be said to be provisional, since they exchange properties, possibilities, and responsibilities through mediation. In the networks of associations "actants can gain strength only by associating with others" (Latour, 1988, p. 160). Action is defined by a list of performances through 'trials of strength' in various settings. It is from these trials you can derive the competencies with which actants are endowed.

> It is because humans, nonhumans, and even angels are never sufficient in themselves and because there is no one direction going from one type of delegation to the other, that it is so useless to impose a priori divisions between which skills are human and which ones are not human (Latour, 1995, pp. 269-270).

According to Latour, humans and nonhumans exchange and share properties and skills. There are no properties that are essentially human. Mediation in this sense does not imply that humans are neither superior nor inferior to technology.

A Symmetrical View of Humans and Nonhumans

Latour positions himself against Heidegger, claiming that it is useless to talk about any kind of mastery in our relation to nonhumans. We do not master technology any more than technology masters us (the latter which is Heidegger's position – we are instruments for no other end than instrumentality itself). Latour insists that there is symmetry in our relation to nonhumans. The translations that occur when actants are enlisted are also wholly symmetrical. The artefact is different with you using it, and you are different using an artefact. With respect to human self-determination and control, this view occupies another position than the sociocultural perspective. His claim is that "Responsibility for action must be shared among the various actants" (Latour, 1999a, p. 180), human or nonhuman. One might easily object to this, Latour continues, by insisting that a basic asymmetry lingers in fabrication and production. "Women make computer chips, but no computer has ever made women" (p.180). This asymmetry is also rejected. This because "Full fledged human subjects and respectable objects out there in the world cannot be [the] starting point; they may be [a] point of arrival" (Latour, 1999a, p.182). So assuming an asymmetry in fabrication

would mean accepting the already bypassed subject-object dichotomy. The argument is thus that we are as much product of our tools, as tools are fabrications of humans. Somehow in line with Donna Haraway's (Haraway, 1991) cyborgs – hybrids of machine and organism, Latour focuses on the composition of action. "Action is a property of associated entities" (Latour, 1999a, p. 182). Humans and nonhumans are folded into each other in complex ways. Actors are depicted as imbroglios of humans and nonhumans, thus the parallel to Haraway's cyborgs. Latour establishes a view of the collective where actors are hybrid, associated, and composed entities. In action, agency (understood as programs of action) is distributed symmetrically among humans and nonhumans. "In the symmetry between humans and nonhumans, I keep constant the series of competences, of properties, that agents are able to swap by overlapping with one another" (Latour, 1999a, p. 182). When treated symmetrically,

> [w]hat is true of the 'object' is still truer of the 'subject' … Purposeful action and intentionality may not be a property of objects, but they are not properties of humans either. They are properties of institutions, of apparatuses of what Foucault called *dispositifs* (p. 192, italics in original).

In this symmetry, artefacts do not have to be activated by a purposeful agent – a human subject. Any actor, human or nonhuman, may not act without acting within a "framework" – action is always "framed", to use Goffman's term (Goffman, 1974). Humans and nonhumans act within a collective – this is the meaning of Latour's symmetry of humans and nonhumans. According to Latour, purposeful action and intentionality are properties of a collective, not of a single, solitary actant. "Action is simply not a property of humans *but of an association of actants*" (Latour, 1999a, p. 182, italics in original).

The ANT approach has taken what we can describe as a semiotic turn. We can read action as text. In texts actors (or characters) move around quite freely, they easily swap places with one another, they come into being, disappear. Their status as real entities can be shifted to that of being social constructs, to monsters in a bad dream, and back again. In this way semiotics teaches us to think symmetrically of humans and nonhumans (Pickering, 1993).

ANT, with Latour as spokesman, has received massive criticism, both from outside ANT (e.g., Bloor, 1999) and from the inside (see Law & Hassard, 1999). Among the many aspects of ANT that are being criticised, the principle of symmetry[25] is one that is hit hard. Granting agency to nonhumans, to mere things, to assume that artefacts can be in possession of the same qualities and skills as humans, has been a particularly arduous point to swallow. With this symmetry lies the rejection of the subject (society) – object (nature) dichotomy. The abundance of this dichotomy all together has been the sticky point for some of the critics, for example those of the Strong Program (Bloor, 1999) for whom society is seen as one part of nature. For others, the point that is troubling is that by accepting the symmetry we would have to abandon a view of intentionality and purposeful action as a property of human beings (e.g., Pickering, 1993).

Latour's view has been labelled as a "posthumanist" stance. We no longer reside in humanism. Humans are no longer privileged over nonhumans. The way the symmetry is maintained is by depriving human actors of their intentionality rather that granting intentionality to nonhuman actants. Pickering (1993) uses the term material agency in order to account for the role nonhumans play in scientific practices. Still, he does not subscribe entirely to the symmetry. In an attempt to create a middle ground for a "posthumanist" analysis, he argues that he cannot understand practice without reference to intentional human subjects – given that we recognise human agency as temporally emergent in practice.

Others have carefully analysed the political ramifications of the view held by Latour and others within the actor network approach. Fuller (2000) describes these as "helpful nuisances and harmless radicals". He sees the "ontological levelling" of humans and nonhumans as particularly problematic.

> This point is lightly veiled in Latour's refashioning of the word 'delegation' to capture the process whereby humans and nonhumans exchange properties, which legitimates the treatment of humans as cogs in the wheels of a machine, and machines as natural producers of value (Fuller, 2000, p. 21).

[25] This should not be mistaken for 'the principle of symmetry' of scientific beliefs in the Strong Program, which states, put simply, that true knowledge and false beliefs should be treated symmetrically when studying scientists.

This eloquent critique falls under the heading that ANT has been accused of being Machiavellian (see also Engeström & Escalante, 1996), or what Latour himself has called the "death of man" critique (Latour, 1999b). This can also be said to be one of the pitfalls when reading or using this perspective to understand the role of technology. It devaluates human beings and gives technology a privileged position. Still, one can also argue that this is a typical misreading of Latour. "The name of the game is not to extend subjectivity to things, to treat humans like objects, to take machines for social actors, but to *avoid using* the subject-object distinction *at all* in order to talk about the folding of humans and nonhumans" (Latour, 1999a, pp. 193-194).

There is, of course, further criticism of this position. In two recent book reviews (Ausch, 2000; Kusch, 2002) Latour's latest contribution has been accused to resonate with Leibnizian essentialism (among other intellectual insults). In addition, the strong rejection of the subject-object dichotomy and the following analysis of the nonhuman – human relationship are brushed aside as a mere "metaphysical déjà vu" (Kusch, 2002) being Heidegger all over again. Whatever the originality of Latour's approach, there are some important lessons to be learned from this (and from its criticism), especially concerning how we understand the role of technology in practice and about how we conceive of the relation between humans and artefacts. So let's leave the trenches of the 'Science Wars'.

In addition to these critiques from the field of science studies, Engeström & Escalante (1996) offer, through an analysis of a failed technology, a (somehow biased) comparison between ANT and activity theory. The article concludes (not surprisingly considering Engeström's central role in the development of the contemporary version of activity theory) that ANT is not sufficient when trying to account for "the inner dynamics, contradictions, and dialogical interactions *within* […] each participant [node] of the network" (p. 365). In this portrayal of ANT each node in itself can constitute everything from a single nonhuman actor to a whole corporation[26]. The problem can thus be in their own use of the concepts offered by ANT, and the chosen

[26] A further discussion of these issues can be found in a symposium in the journal Mind, Culture, Activity (see Latour, 1996b; 1996c; Engeström, 1996).

level of analysis. In addition to this critique, the principle of symmetry is also mentioned as a critical difference between these two perspectives (ANT and activity theory)[27].

Mediation Revisited

The discussion of notions of technical mediation, outlined above, from the sociocultural perspective and the actor-network approach, illustrates some important aspects of the human – technology relation. Both of these perspectives give artefacts or nonhumans a central place in the analysis of human practices.

In the discussion of the sociocultural perspective, it was emphasised that, over history, the production and use of artefacts leave ideal and material traces that have an impact when artefacts are used in the present. This process is labelled mediation, and means that artefacts direct human action and thought. Technological artefacts both enable and constrain human action in a non-deterministic way. With regard to human agency, the claim is that humans control their environment from the outside, through the use and creation of artefacts. When trying to understand human action, one needs to take the mediational means into consideration, to go beyond the individual actor. This was described as an asymmetrical view on the relation between humans and technological artefacts. Put differently, the prime mover of action is human, but to understand and analyse human action we need to include artefacts in the unit of analysis since they direct action through mediation.

Latour takes this view one step further and stretches our understanding of the relation between humans and artefacts. He leaves the dichotomy between people and things behind and presents a methodology with a wholly symmetrical view of human and nonhuman actants. These actants are folded into each other over history, and they exchange properties through the process of delegation. The symmetry lingers in production and use. Even though Latour is reluctant to use the word agency, the topic of intentionality and purposeful action are still at the centre of his discussion of technical mediation. To understand intentions and purposes Latour introduces the

[27] A similar difference has also been pointed out between activity theory and distributed cognition (Nardi, 1996)

concept ‘programs of action’. Actants bring these programs or anti-programs to action, but the enrolment or enlisting of actants means that a new association has been created and this association modifies the original states, meanings, goals and properties of the actants. In order to understand action we need to look at associations of actants, imbroglios of humans and nonhumans. Latour does not discriminate nonhumans and offers a vocabulary to understand anew the relation between humans and artefacts.

There are certain conceptual differences between the two perspectives, and ANT takes a more extreme stance in relation to the methodological symmetry between humans and artefacts; the radical point of granting artefacts the same explanatory status as humans. ANT also gives more emphasis to the interconnectedness of humans and nonhumans and that all actants can mediate the actions of other actants (human or nonhuman). Still, both these perspectives take the material conditions of human practices seriously and meet the challenge of integrating this into a conceptual framework. The theoretical analysis offered above, presented and discussed two different ways of conceptualising the role artefacts play in action, without falling into technological determinism.

Notwithstanding the differences in the two approaches outlined above, both can be useful for understanding the role artefacts play in learning practices. This will be elaborated on in the next chapter (Chapter 4). In the next section I will give a brief presentation of different views on learning.

Learning and the Social and Technical Conditions of Learning Practices

There are a number of perspectives on and theories of learning. Among educational psychologists a common distinction between different perspectives is that of behaviourist, cognitivist and situative perspectives (see Greeno, Collins & Resnick, 1996, for an overview of these perspectives and their intellectual roots). Another way of conceptualising the differences in perspectives on learning is that there are two different kinds of metaphors that mediate the understanding of learning: an acquisition metaphor and a participation metaphor (Sfard, 1998). This will be discussed in more detail in Chapter 9. In this section I will give an exposé of two quite different approaches to understanding learning in order to exemplify some central

aspects and some important differences, and then explicate the focus I will take in the following chapters.

In his classic treatise, Gagné (1970) deals with what he defines as "the conditions of learning". According to his definition there are two different kinds of conditions – conditions internal to the learner (the capabilities possessed by the learner) and conditions external to the learner (pp. 22-24). More generally, Gagné sees the conditions of learning as the "sets of circumstances that obtain when learning occurs" (p. 3), and learning[28] is ultimately seen as "*change of performance"* (p. 22, italics in original). This is a prominent example of a dualistic model of learning, with a strict delimitation of 'the internal and the external'. The theories of Gagné have to a large extent influenced methods and principles for instructional design (see Gagné & Briggs, 1974). This includes decomposing complex units into instruction sequences, and choosing the right 'media type' for the presentation of the given material. Such models have also been influential in the design of computer-based systems for learning, for example, routine skills (Greeno, Collins & Resnick, 1996). More generally this falls under what Koschmann (1996) refers to as the paradigm of Computer Aided Instruction (CAI).

Differing from traditional individualist and cognitive views of learning[29], Lave & Wenger (1991) sees learning as a dimension of everyday activity and emphasise that "learning as increasing participation in communities of practice concerns the whole person acting in the world. Conceiving of learning in terms of participation focuses attention on ways in which it is an evolving, continuously renewed set of relations" (pp. 49-50). When learning is seen primarily as entering a community of practice, it implies for each actor engaged in such participation a change in identity when becoming a competent practitioner. Lave & Wenger (1991) further assert that learning is an integral aspect of activity. Learning as such is not an activity in itself, but a potential aspect of all activities. In this sense, 'learning' becomes a quite general notion, and Lave & Wenger introduces the concept *legitimate peripheral*

[28] Gagné (1970) distinguish between eight different learning types (signal learning; stimulus-response learning; chaining; verbal assosiation; discrimination learning; concept learning; rule learning; and, problem solving), which are subject to differing conditions (pp. 62-64).
[29] For an overview of the debate between situative theories of learning and cognitive theories (see Brown, Collins & Duguid, 1989; Anderson, Reder & Simon, 1996; Greeno, 1997; Anderson, Greeno, Reder & Simon; 2000)

participation as an analytical category and a way to understand the process of entering a community of practice. It describes how newcomers become part of a social practice and as legitimate participants get access to the resources in that community. At this level, learning is changes in the actor's access to resources and ways of engaging with the world. At another level, this is a way for communities of practice to produce and reproduce their competencies. Changes in these competencies and practices can be seen as the collective level of learning[30].

The role of artefacts and technologies of a practice is also central to this view on learning. This is also closely related to another strand of thinking within the sociocultural perspective. Learning in this sense is seen as having to do with "how people appropriate and master *tools for thinking* and *acting* that exist in a given culture or society" (Säljö, 1999, p. 149, italics in original)[31]. This is not meant in a simple sense, as the internalisation of the cultural given, nor as merely a matter of transmission or assimilation[32]. The mastery of artefacts (both language and technical tools) is particularly important with regard to understanding the relation between learning and ICT. Artefacts are commonly target object for newcomers entering a community of practice. Becoming familiar with the use of the technologies of a community is a key aspect of becoming a competent practitioner. This is also central to the understanding of infrastructure as put forward in the next chapter. The apparent tension of artefacts and technological arrangements being *both* target object and mediational means is crucial in this regard. In the rest of this thesis, however, learning is understood in line with Lave & Wenger (1991), but with special attention to the role of artefacts.

Another point, elaborated on by Lave & Wenger, is the difference between learning and education. Formal education does not have a privileged position in relation to learning, but is an arena or an institutionalised context where certain activities take

[30] The collective level of learning is close to what organisational theorists have labelled organisational learning (e.g. Senge, 1990).
[31] The difference between internalisation, mastery and appropriation is discussed by Wertsch (1998, pp. 46-58).
[32] The differences between these strands of thinking within the sociocultural perspective is not one of fundamental incommensurability, but rather a choice of focus. Lave and Wenger (1991) focus mostly on the "changing relations between newcomers and old-timers in the context of a changing shared practice" (p. 49). While others (e.g., Wertsch, 1998; Säljö, 1999) put more emphasis to the details of how tools are appropriated.

place, such as teaching and "intentional instruction" (p. 41). This distinction is key to the focus of this dissertation, as I want to investigate the social and technical conditions of education and training. Education and training are, in this sense, two forms of frameworks for delivering a "teaching curriculum"[33] (Lave & Wenger 1991, p. 97). This stands in contrast to an explicit focus on learning. In the following I do not look at learning *as such*, nor do I use the concept learning as an analytical category in the following analyses. Rather, I look at practices that are aimed at learning, and refer to these as learning practices (and in some instances training activities). The practices to which I am referring is also characterised by having an instructional dimension. That is, the practices are aimed at learning and there is an element of instruction, either through a set of assignments, through peer-to-peer instruction, or a top-down model of instruction from the "organisation" to the employees.

Having explored some fundamental theoretical issues and introduced a more or less coherent conceptual framework, I can further delimit the focus of this thesis. So far I have established that I want to look at certain institutional practices, and to study technology-in-use and to include artefacts in the unit of analysis.

In the following I want to look at how technological and institutional arrangements mediate certain practices, in particular how they make up the social and technological conditions[34] of learning practices and training activities. Both the concepts educational practices and training activities are meant to denote a relation to an institutional framework.

[33] Lave & Wenger (1991) distinguish between "learning curriculum and teaching curriculum. (…) A learning curriculum is a field of learning resources in everyday practice *viewed from the perspective of the learner*. A teaching curriculum, by contrast, is constructed for the instruction of newcomers" (p. 97, italics in original).

[34] I do not use the term conditions in the same way as Gagné (1970). Conditions is a term often used to denote something which we cannot control, in the sense 'attending circumstances'. According to Parsons (see Strauss, 1993), a situation (where action occurs) is composed of conditions (over which the actor has no control) and means (over which the actor has control). Strauss does not agree of this dichotomy, and in his considerations of action he sees conditions in relation to contingencies. Contingencies are unanticipated or unplanned events or circumstances usually seen as external to action, but these can also be seen as part of action if they have an impact on the course of action. Another class of contingencies is, according to Strauss, the course of action itself. The course of action may have unanticipated consequences, and these consequences become conditions for action. These contingencies of action can thus be external or internal to the course of action, and are related to the more general point of the indeterminacy of action. I use the term conditions in line with Strauss.

The actual practices I account for in the empirical studies are taking place in different institutional contexts: One in higher education; one in a network of companies (an inter-organisational network); and one in a large corporation. All the studies in some way focus the technological arrangements and resources available in these practices. A central concern in this thesis is how different technological and institutional arrangements relate to each other and emerge as infrastructures for learning. This is the topic of the following chapter.

CHAPTER 4 – ICT AS INFRASTRUCTURE

When studying technology-mediated learning from a sociocultural perspective, it is common to understand technology as a mediating artefact. This view of technology has obvious strengths in that it captures both the material and symbolic aspects of technological tools. It also gives artefacts a central place in relation to understanding human action, cognition and learning.

Säljö (1999) mentions several features of information and communication technology that are salient when it comes to using ICT as a resource for learning (pp. 152-154). One relevant feature of ICT is the capacity of simulating events and processes (e.g., Rystedt, 2002). Another feature is that ICT is a very powerful tool for visualisation and dynamical rendering of visual representations (e.g., Ivarsson, 2004). New forms of interactivity between the learner and what is to be learned is also emphasised as a psychologically interesting feature of information and communication technology. It is common in sociocultural studies of technology-mediated learning and development to focus on how information technology function as "tools for the appropriation and understanding of conceptual knowledge" (Säljö, 1999, p. 152). The insights produced in such studies are critical with regard to the understanding of these 'new phenomena' and as a source for further exploration of the sociocultural perspective.

The view of technology as a mediating artefact can, in this way, be regarded as a foundation and an analytical base from which to understand the changing conditions of learning practices brought about by the introduction of ICT. In the following, however, I argue that there is a need for additional considerations in order to be specific about the various dimensions and properties of ICT as it is related to learning practices. The specificities of ICT and telecommunication networks are not necessarily captured with a focus on single-standing artefacts.

Drawing on key studies from Information Systems research, I will introduce a view on technologies that mediate learning as an element in *infrastructures for learning*. The purpose is to give emphasis to how mediating technologies relate to a broader technological and non-technological substrate and context, and how these mediating

technologies are enmeshed in social, institutional and infrastructural arrangements. As I will try to demonstrate, this notion of *infrastructures for learning* can be related to solid theoretical foundations, and gives access to substantial conceptual resources for analysing ICT-mediated learning practices. A main objective in this chapter is thus to explore how the emerging literature on and the accompanying theorising over information infrastructure can inform our understanding of ICT-mediated learning practices. First I will look at some different perspectives on ICT and infrastructure.

Perspectives on ICT and Infrastructure

How the introduction of information and communication technology has an impact on organisational change and work conditions have been the topic of many debates. In general, the arguments around this problematic follow two main lines (Kling, 1991a). One which proposes that the introduction of computer systems have effects that empower workers through making work more interesting, varied and flexible. Others have taken the opposite position and claim that computing is an instrument for managers to increase their control of the workforce through fragmenting the work tasks and deskilling jobs. These two explanations both claim that the introduction of computer systems transform work under one 'dominant logic', but they have different answers to *how* work is transformed. Kling (1991a) argues that such explanations try to account for the phenomenon in question with too broad strokes. He proposes an alternative model where he sees the introduction of computer-based technologies as being potentially socially transformative, meaning that they "can play key roles in restructuring major social relationships – interpersonal, intergroup, and institutional" (p. 344). He emphasises that this is a *potential* transformative effect. Kling suggests several processes through which the introduction of computers may impact parts of a social order:

> Computer systems can restructure social relationships by altering the kinds of information readily available, reorganizing patterns of access to information, altering the cost and work of organizing information, and shifting patterns of social dependencies for key resources, such as computing and skilled computing staff (p. 344).

Rather than talking about "technology" and "computers" in general terms, Kling suggests that we look at the specificities of each information system and see how this is consumed in specific settings. It is under these circumstances we can begin to unravel questions of what effects computerization have on social arrangements.

Coming to terms with this issue is perhaps a question of acknowledging the complexity of the matter. As Star and Ruhleder (1996) note "People who study how technology affects organizational transformation increasingly recognize its dual, paradoxical nature. It is both engine and barrier to change; both customizable and rigid; both inside and outside organizational practises. It is product and process" (p. 111).

In debates concerning the introduction of ICT in educational settings, many of the same issues are raised. ICT is often seen as a catalyst or facilitator for changing educational practices. The introduction of ICT in these settings is often seen as an instrument for transforming the organisation of educational arrangements (for example the use of groupware for promoting collaborative learning). The question, however, remains the same. How does ICT contribute to transforming parts of the social order?

In a research commentary Orlikowski and Iacono (2001) call for IS researchers to theorise over the "information technology (IT) artefact". Through a review of a whole decade (the 90's) of research published in the *Information Systems Research* journal they identify a number of different ways that researchers incorporate a theory or conceptualisation of the IT artefact. In an alarmingly high number of these studies they found that the IT artefact, which should be a core subject matter in information systems research, was under theorised. As much as 24.8 percent of the articles are classified as having a nominal (or absent) view of the IT artefact. Another common conceptualisation of IT is the 'Tool View' (in 20.3 percent of the articles). From this view technology is "the engineered artifact, expected to do what its designers intend it to do. As such, what the technology is and how it works are seen to be largely technical matters"(p. 123). This stands in quite strong contrast to the 'Ensemble View' of technology, where technology is seen either as Development Project,

Production Network, Embedded System, or as Structure (only used in 12.5[35] percent of the articles). The common denominator of these variants of the 'Ensemble View' is that they are "focusing on the dynamic interactions between people and technology – whether during construction, implementation, or use in organizations, or during the deployment of technology in society at large" (p. 126).

The sociocultural understanding of technology as a mediating tool/artefact (as discussed in Chapter 3) is not equivalent with what Orlikowski and Iacono define as the 'Tool View' of IT artefacts. Rather, both the sociocultural and the ANT understanding of artefacts can be placed at the centre of what they label as the 'Ensemble View'.

Orlikowski and Iacono are surprised that so few actually submit to the ensemble view due to Kling and Scacchi's (1982) early critiques of the 'tool view' and their introduction of "web models" of computing. According to Orlikowski and Iacono (2001), from Kling and Scacchi's perspective

> information technology is more than just the tools deployed on the desktop or the factory floor. It is the ensemble or 'web' of equipment, techniques, applications, and people that define a social context, including the history of commitments in making up that web, the infrastructure that supports its development and use and the social relations and process that make up the terrain in which people use it (p. 122).

This socio-technical understanding of information technology has much in common with Latour's (1987; 1999a) portrayal of technology. One key difference, according to Orlikowski and Iacono (2001), is that while "Latour focuses on how new technologies come to *be;* Kling and Scacchi theorize about how new technologies come to be *used*" (p. 126). The distinction is drawn between a primary focus on development and use of IT artefacts. Traditionally, the central focus of the sociology of technology has been on the conditions under which technologies are being produced. Kling (1991a) argue that in order to understand the impact computers have on "parts of the social order", we need studies of how "computer-based systems are *consumed* – not just produced or disseminated" (p. 342, italics in original). Drawing a strict line between production

[35] The rest of the articles were distributed among two other categories: The computational view, 24.3 %; the Proxy view, 18,1 %.

and consumption of ICT, however, can be quite difficult. In some cases (e.g. when looking at participatory design) the users are engaged in the production of the technology. This is especially prevalent when we are talking about end-user tailoring (see Mørch et. al., 2004). This strict demarcation can also be problematic with regard to integration with existing technological arrangements. Even though certain applications can be off-the-shelf software, integrating such applications with the installed base may require adjustments and adaptations to specific configurations. In many cases it can be quite hard to determine where production and dissemination stops and consumption begins. When studying the introduction and use of ICT questions of consumption will, in many instances, be blended with questions that pertain to the production of ICT artefacts, especially when these artefacts are seen as part of an infrastructure (this is discussed further in Chapter 9).

A common distinction in Information Systems research is made between software applications and computer hardware with its basic system software (operating systems, drivers, and so forth). After the emergence of networked computers this split is usually referred to as infrastructure (hardware, wires, switches, hubs, protocols, system software etc.) on the one hand, and applications on the other. "The infrastructure provides the electronic highways, processing and storage sites, whereas the applications use these facilities" (McNurlin & Sprague, 2004, p. 162).

There are of course different kinds of infrastructures. Global "universal service" infrastructures such as the Internet (see Hanseth & Braa, 2000, for an example); Electronic Data Interchange (EDI) and "business sector" infrastructures that stretches over several corporations and organisational boundaries (see Aanestad, 2002, for an example); and corporate infrastructures (see Rolland & Monteiro, 2002; Rolland, 2003, for an example). The actual instances and occurrences of infrastructures are varied, but analytically, as it will be discussed below, infrastructure emerges with some general characteristics.

Infrastructure as Relational and Ecological

Infrastructure is usually seen as a substrate, an underlying foundation, a basic framework, and a permanent installation that is built and maintained. Infrastructure in

this sense is invisible, transparent and ready-at-hand. This picture of infrastructure is probably adequate for most of our daily routines and handlings of infrastructure. Still, as a topic of investigation another understanding of infrastructure is needed. Such an understanding is offered by Star & Ruhleder (1996)[36]. In their article *Steps Toward and Ecology of Infrastructure*, they use Bateson's model of levels of learning to investigate "levels of infrastructural complexity" (Star & Ruhleder, 1996, p. 111). The paper identifies several properties and dimensions of infrastructure:

- *Embeddedness.* Infrastructure is "sunk" into, inside of, other structures, social arrangements and technologies;
- *Transparency.* Infrastructure is transparent to use, in the sense that it does not have to be reinvented each time or assembled for each task, but invisibly supports those tasks;
- *Reach or scope.* This may be either spatial or temporal – infrastructure has reach beyond a single event or one-site practice;
- *Learned as part of membership.* The taken-for-grantedness of artifacts and organizational arrangements is a *sine qua non* of membership in a community of practice. Strangers and outsiders encounter infrastructure as a target object to be learned about. New participants acquire a naturalized familiarity with its objects as they become members;
- *Links with conventions of practice.* Infrastructure both shapes and is shaped by the conventions of a community of practice, e.g. the ways that cycles of day-night work are affected by and affect the electrical power rates and needs […];
- *Embodiment of standards.* Modified by scope and often by conflicting conventions, infrastructure takes on transparency by plugging into other infrastructures and tools in a standardized fashion;
- *Built on an installed base*. Infrastructure does not grow *de novo*; it wrestles with the "inertia of the installed base" and inherits strengths and limitations from that base […];
- *Becomes visible upon breakdown*. The normally invisible quality of working infrastructure becomes visible when it breaks (p. 113).

[36] See also (Bowker, Timmermans, & Star, 1996; Bowker & Star, 1999; Star, 1999)

These are properties that emerge from their analysis of infrastructure as fundamentally *relational and ecological*. "It becomes infrastructure in relation to organized practices … not as a thing stripped of use" (p. 113). Infrastructure means different things in different situations and for different people, and its boundaries cannot be *a priori* defined. With this understanding, infrastructure is seen as an ecology of tools, action and built environment. It is not simply 'a technology', but is interweaved with and inseparable from social and other non-technical elements. As such, an infrastructure is part of the technological, material and social conditions of practices. As an example, "communication infrastructures include printing, telegraph, radio, television, the Internet and the web, and movie production and distribution" (Star & Bowker, 2002, p. 151).

In their study, Star & Ruhleder (1996) looked at efforts involved in the development of a large-scale customized software – the Worm Community System (WCS), for supporting the work and collaboration of geneticists working geographically distributed. The system was to be developed as a virtual laboratory or a 'collaboratory' meant to link the efforts of more than 1,400 biologists. The biologists were working on sequencing the gene structure of a certain organism in relation to the Human Genome Initiative (an international scientific project of considerable proportions). The WCS contained a database, graphical representations (a genetic map that was periodically updated), and means for doing annotations. While most of their respondents reported that they liked the system – its ease of use and how it was developed with an understanding of the problem domain, most of them did not use the system, they had not even signed on. Many had also turned to other, simpler solutions, such as a web browser. "*Despite good user prototype feedback and participation in the system development, there were unforeseen, complex challenges to usage involving infrastructural and organisational relationships.* (p. 116, italics in original). In their analysis of this problematic, Star & Ruhleder, following Bateson's (1972) different levels of learning[37], identify three different levels (or orders) of issues that

[37] Bateson (1972) follows Russell's theory of logical types. Bateson's model distinguishes between three levels in any communicative system. The first is 'factual' statements or messages ("the cat is on the mat"). The second is the context of the message, and the context may say something about the message, so this is called a meta-message. The meta-message classifies the message. The third level is then again the meta-meta message. With regard to learning you can classify different levels: The first level is learning something; the second is learning about learning something; the third level is learning about theories of learning. In this hierarchical system the above level is *about* the lower level, and can potentially be an upward infinite regress. Bateson further emphasises that there is a discontinuity or a gulf between the different levels, like that between a thing and a word or sign that stands for it (p. 247).

appear in the development of an infrastructure. They use different levels to understand questions of context:

> Level one statements appear in our study: "Unix may be used to run WCS." These statements are of a different character than a level two statement such as "A system developer may say Unix can be used here, but they don't understand our support situation" At the third level, the context widens to include theories of technical culture: "Unix users are evil-we are Mac people" (p. 117).

The discontinuities between these different levels of issues are between different contexts, not between system and person or technology and organization. In their analysis level-one issues include "informational issues", such as knowing what the system is about and how to install it. Other first level issues are related to "issues of access" and "baseline knowledge and computing expertise". Solving issues at this level can usually be done through increasing or redistributing resources or information. These issues, however, might "become intermingled with questions of organization and workplace culture ('Unix is for engineers, not biologists')" (p. 120). In this respect, the clash of two or more first level issues can, analytically, become second order issues.

The second order issues "broaden the context of choice and evaluation of the straightforward first-order issues such as obtaining software and access to machines"(p. 120). Among the level-two issues they mention how the conventions of computing at a local site might influence technical choices. In addition, questions of whether investing resources in learning and using WCS would involve neglecting other useful programs, is included at this second level. An illustrative example is how the biologists responded to questions concerning whether they will start to use an online version of their quarterly newsletter. Some saw this as an opportunity to contribute regularly as they where competing with other labs, while some objected to this because it would break their "community-imposed deadlines on structuring work, both in terms of submitting and reading articles" (p. 122).

The third-order issues are, according to Star & Ruhleder, related to the "widest context, involving schools of thought and debates about how to choose among second

order alternatives" (p. 123). The schools of thought are seen both with regard to the scientific communities and their various local practices and histories, and to issues of how technology is integrated in this work. An example of this is how spending time and efforts on working with this system are not in line with the reward structures in the biologists' scientific careers. The only reward the use of the WCS has in this respect is the contributions it makes to each participant's work. There are no 'formal credits' for this kind of work within the discipline. This relates also to whether online publications would have the same status as printed ones.

In this way Star & Ruhleder categorized the different infrastructural barriers and challenges met in the study of the WCS. Emphasising the dynamic character of these issues, they go on to look at the discontinuities or conflicts between the different levels and address (still following Bateson) these as "double binds" or, in other words, instances of "the transcontextual syndrome" that predicated the failure of WCS (p. 129). These occur as "the gap between diverse contexts of usage", "the gap inherent in various computing-related discussions within the worm community itself", and as "the gulf between double levels of language in design and use" (p. 127). The latter is exemplified and captured in the discussion on Mac vs. Unix. This is at one level 'merely' a discussion of what operating they should choose. At another level it is a "clash of cultures between biologists and computer scientists (…) [and] representative of two world views and set of values with respect to the relationship between technology and work – the relationship between the tool and its user" (p. 128).

In this analysis of the introduction of the WCS, Star & Ruhleder address infrastructural issues in relation to the ongoing practice of the scientific community. They see how the use (and lack of use) varies over the many different sites where the system was to be introduced. The infrastructure is seen as "context for both communication and learning", allowing for taking into consideration issues of how the system are integrated with local practices and arrangements and seeing it as part of an ecology of computers, task and people.

Infrastructure as Actor-Networks

Hanseth (2000) offers another, but similar, description of infrastructure where infrastructure, in addition to being enabling and socio-technical in character, emerges as "*an evolving, shared, open and heterogeneous installed base*" (p. 60, italics in original)[38]. This literature on information infrastructure focus primarily on design issues and it is formulated mainly as an opposition to the management literature on infrastructure that commonly has a narrow focus on hierarchical models of infrastructure (e.g. Weill & Broadbent, 1998; see Ciborra, 2000, for a thorough discussion of the critiques of such a position). This understanding of infrastructure also calls attention to how information infrastructure is different from traditional information systems in that it includes non-technological components, applications, standards (such as protocols), and a collection of various technologies (see also Rolland, 2003).

Infrastructures as *enabling* is a feature easily comparable to the sociocultural view of artefacts as mediational means. The flip side of this feature is, as discussed in Chapter 3, that it limits and constrains action. An infrastructure as the Internet and the TCP/IP protocol enables a range of different services and communicative practices through everything from ostensibly simple applications such as email to complex system such as the Amadeus booking system for travel related services. An infrastructure is enabling in that it is usually designed "to support a wide range of activities; it is not especially tailored to one. It is enabling in the sense that it is a technology to open up new fields of activities, not just improve or automate something that already exists" (Hanseth, 2000, p. 57). In this way an infrastructure also allows for very different uses which illustrates the *openness* of infrastructures. In other words, infrastructure is open in the sense that "there is no strict limit between what is included in an infrastructure and what is not, and who can use it for which purpose or function" (Hanseth & Lundberg, 2001, p. 349).

In Star & Ruhleder's (1996) description (cited above), an important dimension of an infrastructure is that it has a reach or scope. Analogously, Hanseth (2000) describes

[38] See also Hanseth & Monteiro, 1997; Hanseth, Monteiro & Hatling, 1996; Monteiro & Hanseth, 1996.

infrastructure as *shared*. It is shared between actors in different communities across geographical locations and across time.

An example of how this view on infrastructure is used can be given through looking at a specific case study. Hanseth & Lundberg (2001) report on a study of the implementation of a Picture Archiving and Communication System (PACS) and a Radiological Information System (RIS) in a radiology department at a hospital. According to Hanseth & Lundberg, the implementation of such systems has traditionally been problematic and has had a high rate of failure. They further argue that a possible reason for this is "due to the variety, richness, and complexity of the work practices inside hospitals, and the interdependencies between the artifacts and technologies supporting the work practices" (p. 348). They also claim that the systems are usually seen as separate and independent, rather than as "parts of complex overlapping infrastructures" (p. 348).

In the article, they describe the practice of the radiologists in some detail, emphasising the flow of information and work tasks. In addition, they focus on the different artefacts that are used in this practice. These include the central radiological examination reports and the different radiological pictures. They also pay attention to how the reports are archived and stored, as this serves an important role in how the radiologists organise their work. The radiology department are seen as a service unit for other departments inside and outside the hospital.

At the centre of Hanseth & Lundberg's description of this setting is the radiological infrastructure, which is seen as a foundation supporting the cooperation between the radiologists and the units they serve (the "customers"). In addition to the radiological reports and pictures, the authors "include in the infrastructure the institutionalized communication forms used: the request/response communication, the daily meetings, and the ad-hoc conversations" (p. 355). This again is supported by a more general infrastructure "consisting of transporters, trolleys, shelves, tables personal callers, phones and fax machines, secretaries, other support staff (medical assistants), PACS, RIS and their computer and network infrastructure" (p. 355). Further, they look at how the different artefacts are linked together and the interdependencies between them. For example the "shelves, binders, folders, tables, mailboxes are all designed to

fit the paper order form" (p. 358). They also focus on how parts of the infrastructure are shared with other departments and how this requires a certain standardisation.

Based on their analysis, Hanseth & Lundberg, go on to identify some implications for the design of new infrastructure. Some of these are seen as challenges general to the design of all infrastructures, such as defining standards, acknowledging the momentum and irreversibility of large infrastructures. An implication of the latter is that one should change smaller parts of the infrastructure through "cultivating" these "sub-networks" and making sure they are interoperable with the rest of the infrastructure.

In this way, Hanseth & Lundberg use the concept infrastructure as a normative concept in relation to design and integration of new technology. According to them, it is key for the design process to see the systems to be designed and implemented as a set of interconnected artefacts and that these again are linked into a heterogeneous actor-network, which also include human actors.

Monteiro (2000) also elaborate upon how this view of information infrastructure is related to ANT. Informed by ANT, Monteiro explores how behaviour can be inscribed in information infrastructure by means of, *inter alia*, its various standards (see also Hanseth & Monteiro, 1997), and how we, in line with Latour's symmetry, can conceive of infrastructure as an heterogeneous actor-network[39].

Infrastructure as Resources

Kling (1992)[40] offers another, but similar, take on infrastructure. He sees computing infrastructure as a collection of resources that support working computing arrangements. These resources can be physical, technological or social. "Physical resources include the space to place equipment; technological resources include electricity and communication lines. The social resources include people skilled in using and repairing equipment and practices for allocating resources" (p. 366). He

[39] The relation between information technology and actor network theory is discussed in a recent special issue of the journal Information technology and people (2004, Vol. 17, Issue 2).
[40] This article partly builds on Jewett & Kling (1991)

also notes that in order to understand computing infrastructure no sharp line can be drawn between human infrastructure and technical infrastructure, but that these are highly interdependent. According to Kling, some resources may be relatively concrete objects (e.g. a printer, a document) or people (like skilled people to maintain the equipment). Other resources can be more intangible, such as the capacity to reproduce the more concrete resources (e.g., the ability to train participants in necessary skills, write a document, or purchase a new printer).

Jewett & Kling (1991) analyse how a research group integrated computing into their practice, and "how computerization influences the subsequent content and organization of research work" (p. 246). They use infrastructure as a concept when analysing the organisation of support for computing. Infrastructure in this case is used to denote "all the resources and practices required to help people adequately carry out their work" (p. 247). In this they also refer to the different organisational arrangements for supporting computing, including human resources, purchase procedures and the recharge system.

In their study, Jewett & Kling, look at a specific project called the Desktop Computing Research Project, which was carried out from 1985–1990 at the University of California, Irvine. The authors were themselves members of this project, and data was mainly collected through participant observation. In the description of the project they focus on the *team structure* (what kind of members, the turnover, and the variation in interest, experience, and expertise in computing), and the *physical environment* (their workplace, office resources and space). In addition they look at the *resources* they had at their disposal and to what extent they are in control over these (in terms of funding and computing services), and the *data complexity* (handling the research data they had collected, that was stored both a database and in other documents such as papers, memos and reports). The data complexity is, according to Jewett & Kling, reflected in the computing hardware and software.

Further they look at the dynamics of the project, and how "participants change equipment as well as the social organisation of access to equipment, data, and computing skills" (p. 252). In this "developmental trajectory" they, for example, went from a reliance on centralised computers running UNIX to decentralised computers

(still running UNIX) connected through Ethernet. Jewett & Kling also go to great lengths in explaining the different software they relied on (e.g. a database management system, spreadsheets, word processors and statistical packages) and how this changed over time. The process of computerization, is much more complex than choosing various system components, and this is heavily emphasised by the authors. They talk about different strategies for computerization. These "include practices of controlling access to equipment and data and infrastructure development (e.g., training, equipment repair)" (p. 255). In addition, Jewett & Kling, emphasise the skills and training of staff that are necessary to keep up with the demands of computing.

In line with Star & Ruhleder (1996), Kling (1992) also holds that infrastructure is layered and relational. What is the focal computing resource for one participant (for example the database for a database developer) may be infrastructure for other participants (for example for the participant who makes entries into the database). In this sense Kling describes infrastructure as "a relationship between focal resource and supporting resource" (p. 399). This implies that infrastructure can be transparent, 'black-boxed' and easy to use at one moment, and the very topic of an activity in another moment (see also Star & Bowker, 2002).

This is central in understanding what an infrastructure is (or *when* something becomes an infrastructure). It is a versatile object of study, and can only be identified in relation to working conditions and arrangements.

> Under some circumstances the human body becomes infrastructure, such as in the study of face-to-face conversations. Interestingly, for example in the study of body language, human emotions and situations are the infrastructure, and the target of study are facial and body muscles, posture and proximity (Star & Bowker, 2002, p. 151-152).

This citation illustrates how almost anything can be infrastructure depending on the focus taken. Accordingly, Star & Ruhleder (1996) ask *when,* not what, is an infrastructure.

> An infrastructure occurs when local practices are afforded by a larger-scale technology, which can be used in a natural, ready-to-hand fashion. It becomes transparent as local

> variations are folded into organizational changes, and becomes an unambiguous home – for somebody. This is not a physical location nor a permanent one, but a working relation (p. 114).

This shows the fundamental relational properties of infrastructure as it understood in the following. Notwithstanding the subtle differences between the three views of infrastructure outlined above, all inform the understanding of infrastructure as it will be used in the following.

Infrastructures for Learning

Hanseth & Lundberg (2001) distinguish between what they call *universal service infrastructure* and *work oriented infrastructures*. In principle, the first provides services to all citizens (this, however, disregards problems such as the digital divide and actual limitations in access to such infrastructures). The latter have the same characteristics as the first, but is, at the same time, developed to support specific work tasks and work practices (p. 365). One aspect of the concept *work oriented infrastructures* that Hanseth & Lundberg (2001) discuss is that they are (and should be) created and implemented primarily by the users in the respective community of practice based on the participants' use of technology.

Moreover, work oriented infrastructures is a concept introduced to draw "attention to the fact that these systems are developed to support specific and highly complex work tasks" (p. 370). Making this distinction, however, somehow goes against how Hanseth & Lundberg consider infrastructures to be *open*. If they are developed to support specific work tasks, how can they at the same time be open "in the sense that there are no limits for how many users, computer systems or other technical components etc. that can be linked to it" (p. 349)? This ostensible inconsistency in their definition of work oriented infrastructures is perhaps a question that only can be resolved at an empirical level. As Star & Ruhleder (1996) propose, an infrastructure has a *reach or scope*. How far it reaches or how wide it's scope is, can only be determined by empirical investigation. Thus it is still possible to talk about work oriented infrastructures as an analytical demarcation.

In a similar sense it is possible to, analytically, identify *infrastructures for learning*. As such, infrastructures for learning can, for analytical purposes, be seen as having the same characteristics as infrastructures in general, but they are at the same time designed to and/or assigned to support practices aimed at learning.

In parallel to how Kling (1992) sees *computing* infrastructure as a set of resources that supports working computational arrangements, infrastructures for learning can be seen as a set of (physical, technical and social) resources that support a certain learning practice. It is in this sense not necessarily just the technological resources that are included, but also other institutional arrangements, the physical locations etc.

In this thesis, however, I will use the notion infrastructures for learning to analyse learning practices where computing infrastructure is an integral part of the infrastructure for learning. Some questions arise in the wake of this analytical demarcation. How are infrastructures for learning separable from other infrastructures? Infrastructures for learning is an analytical notion, and what is considered part of an infrastructure can not be decided a priori, only in relation to practice. In actuality, infrastructures for learning will be intermeshed with and hook into other infrastructural arrangements, such as e.g., the computing infrastructure. Resources that support learning practices can also be used to support other working arrangements (such as a classroom being used for after school activities). With such a socio-technical understanding of infrastructures for learning, this will include infrastructural tools, social and organisational arrangements related to various ICT-mediated learning activities.

In her analysis of the implementation of a CSCL tool in a classroom learning practice Bielaczyc (2001) distinguishes between technical infrastructure and social infrastructure. She sees the social infrastructure as the "supporting social structures enabling the desired interaction between collaborators using the same tool" (p. 107). She also proposes three different aspects or levels of a social infrastructure:

> At the cultural level, issues of classroom philosophy, goals and norms are central. At the Activity Level, issues of the participant structures and culminating events are

> central. At the Tool Level, issues concerning the use and adaptation of different tool capabilities are central (p. 114).

Lipponen (2002), while appraisal of the distinction between social and technical infrastructure, criticises Bielaczyc's model of being too focused on the technological infrastructure. "[Her] model still appears to be slightly technology driven for it implies that the social infrastructure should be built around the technology; implicitly, the technological infrastructure appears to be the primary structure that is supported by some special social activities" (p. 77). It is easy to agree with Lipponen in his critique which follows along the lines of a general view of anti-determinism. Still, I would argue that this implicit technological determinism in Bielaczyc's model, as identified by Lipponen, rests on the assumption that you can draw a strict boundary between the social and the technical infrastructure, and failing to see it as relational[41]. The key is thus to see social and technical infrastructure as aspects of infrastructure in general, not as two separate entities - one built around the other. Still, the aspects constituting a social infrastructure that Bielaczyc introduces are central and can be considered part of an infrastructure for learning[42].

As mentioned above, Hanseth & Lundberg (2001) suggest that a central feature of a work oriented infrastructure is that it is designed and implemented by its users. The question of who creates an infrastructure is of course important and has serious implications for matters of control, ownership, power, and, ultimately, how an infrastructure is used. Even though, this is, as I understand it, first and foremost a recommendation for the design of infrastructure, the question is also significant for infrastructures for learning. Identifying such issues is an important step in unravelling the role an infrastructure plays with regard to learning activities. Still, at this point the notion infrastructures for learning differs from the way Hanseth and Lundberg define a work oriented infrastructure. Infrastructures for learning do not have to be designed by the users to qualify as such. Infrastructures for learning can perfectly well be designed by the users, but this is not always the case. Who the producers of the

[41] Interestingly, and more recently, Lipponnen and Lallimo (2004) have suggested that "culture of learning, learning activities (practices) and use of technology must be seen as inseparable parts of a complex infrastructure" (p. 114).

[42] Nyvang & Bygholm (2005) also discuss the relation between organisational structure and ICT as well as the goals and values of the implementation of ICT in an educational setting as the development of an educational infrastructure (see also Bygholm & Nyvang, 2004).

infrastructure are remains an empirical question, dependent on specific circumstances. How this question is pursued is also dependent on whether the primary focus is on production or use (as discussed above).

More commonly, infrastructures for learning are a collection of infrastructural tools designed by a variety of actors. This can include ordinary services such as email, simple web pages or online bulletin boards, but also highly specialised and complex tools such as Learning Management Systems (LMS) or groupware. The notion infrastructures for learning encompasses technologies designed to support, manage, organise and/or deliver training or learning activities, and the specific instances can vary between everything from groupware for use in collaborative learning, discussion forums, web based simulation games, to online tutorials. Still, all of these tools link into and are inseparable from an installed base and other technological and non-technological arrangements, and become infrastructures for learning in relation to practice.

An example of an infrastructure for learning can be taken from a, for many readers, familiar institutional context: The teaching at a university. Common elements of such an infrastructure for learning include the material resources such as auditoriums and the equipment installed there (overhead projector, audio facilities). Other institutional artefacts such as calendars and time-tables are also key elements. In addition, the supporting staff (the administration, janitors, etc.) would be included in the infrastructure for learning. If the university are using a Learning Management System to support the distribution of learning material, this is also part of the infrastructure for learning. In this case the communication infrastructure and telecommunications network would be important resources. Another central element of this infrastructure would be the books and articles included in the curriculum. The list is potentially endless, but what to include in a description is a matter of granularity and level of detail. As mentioned above, what constitutes an infrastructure is also dependent on the focus of the inquiry.

The notion *infrastructures for learning* is in the following first and foremost used as an analytical backdrop. It is meant as a general approach to understanding and studying the social and technical conditions of learning practices. Even though the

notion of infrastructures for learning have been explored in quite general term in this chapter, it is important to note that this notion only makes sense in relation to actual practices and working arrangements. It might be possible to give some general characteristics of infrastructures for learning, but the view of infrastructure propagated in this chapter implies that it only emerges as a comprehensive phenomenon to be studied in relation to practice.

An additional way of using the notion infrastructures for learning is as a normative construct: In order for learning practices to work properly you need an infrastructure for learning that transparently support these practices. A set of resources needs to be allocated to support these arrangements. This will be discussed further in Chapter 9. The next chapter discusses how infrastructures for learning can be, and have been, approached methodologically.

CHAPTER 5 – ETHNOGRAPHIC INQUIRIES INTO INFRASTRUCTURES FOR LEARNING

A major challenge for researchers studying infrastructure is how to design their studies. The ostensibly simple question of *what and how* to collect and analyse data becomes a major obstacle. To study infrastructure in relation to practice, means doing inquiries into both practices and different technologies and media. Whereas the previous chapter focused, in mainly theoretical terms, on different notions of infrastructure and how these have been applied to empirical data, this chapter focuses on methodological challenges related to studying infrastructures for learning.

According to Star (1999) "One of the difficulties in studying infrastructure is distinguishing different levels of reference in one's subject matter. This is a difficulty shared by all interpretive studies of media" (p. 387). This also fits well with the challenges I encountered in the empirical studies, and can provide a fresh look at different research designs in studies of technology and learning. In the citation below, Star identifies three different ways to interpret infrastructure:

- a material *artifact* constructed by people, with physical properties and pragmatic properties in its effects on human organization. The truth status of the content of the information is not relevant in this perspective, only its impact; or as
- a *trace* or *record* of activities. Here, the information and its status become much more relevant, if the infrastructure itself becomes an information-collecting device. Transaction logs, e-mail records, as well as reading things like classification systems for evidence of cultural values, conflicts, or other decisions taken in construction fall into this category. The information infrastructure here sits (often uneasily) somewhere between research assistant to the investigator and found cultural artifact. The information must still be analyzed, and placed in a larger framework of activities; or as
- a veridical representation of the world. Here, the information system is taken unproblematically as a mirror of actions in the world, and often tacitly, as a complete enough record of those actions. Where Usenet groups' interactions replace fieldnotes entirely in the analysis of a particular socialworld, for example, one has this sort of substitution (pp. 387-388).

According to this categorisation, infrastructure can be seen as a material artefact with a certain impact on social organisation. The second way of reading infrastructure is as a trace or a record of activities. The third view of infrastructure, Star proposes, is as a veridical representation of the world. The choice between these different interpretations of infrastructure is, according to Star, important for any study of this phenomenon, and has implications for the further steps in the analysis. They are not necessarily mutually exclusive, but it's key to keep a clear view of these levels of reference.

We can also use these categories to think about different approaches to studying infrastructures for learning. In the first, an infrastructure for learning would be seen as a material artefact with a certain impact on learning outcome. There are many studies using this approach. Traditional impact studies of new learning technologies are illustrative examples. In such studies, a given artefact is introduced and the researcher tries to measure (e.g., through an experiment) the effect the particular technology has on learning outcome. In this case, the learning technology or learning environment (for example a multimedia environment versus a text-based environment) is treated as an independent variable with a measurable effect on learning outcome (the dependent variable). The content of the learning material (information) has little importance in this perspective, only its effect.

In the second category, the content (and meaning) of the learning material becomes more important. The learning material has also to be understood in relation to the "larger framework of activities" (Star, 1999, p. 387). Still, it is not only the content of the learning material (or artefacts) that is relevant, but if interactions occur (cf., definition of networked learning in Chapter 2) in the learning environment, the content of these should also be read for their meanings and status. In this way the infrastructure itself can serve a role in the collection of data.

Studies of infrastructures for learning falling into the last category can be of quite different character. On the one hand, there are studies that take the interactions in a virtual learning environment as an unproblematic representation of the learning activity. These records are treated as a complete mirror of the entire learning process.

On the other hand, a study focusing solely on different ways to represent a certain subject matter or learning content and using this to determine, for example, to what extent they follow 'the best' didactic principles, would also fall into this category. In such a case you would not be interested in actual consequences the artefact has on social practice.

The studies presented in this thesis belong to the second category. In the first case study where I discuss how students organise their work in a distributed collaborative learning scenario (see Chapter 6), the infrastructure for learning is, accordingly, read as a trace or record of the students' activities. As the focus was on how they organised their work in relation to the infrastructural tools (a groupware system, email, and a web-based system), data was collected from these systems. This included logs of their computer-mediated communication, artefacts and texts they produced in these environments, and sometimes participating in the online interaction. The communication and interaction was seen in relation to other activities. To gain insight into their view of the processes and to hear their accounts of how this was integrated into other activities, interviews were also made with the students.

In the second case study[43] (see Chapter 7), data was collected from different sources. Interviews and participation were still the most important. Initially, we wanted a research design that used the online interactions as the main source of data. When the use of the online discussion forum proved to be very limited, we turned to other sources (interviews). It was neither possible to get access to their email, or to observe systematically how they used the telephone to contact each other within the network. Rather we had to rely on secondary accounts (through interviews) of these processes.

In the last case study (see Chapter 8) presented in this thesis, interviews were also an important source for data collection[44]. To look at how they organised the introduction and use of e-learning at the new workplace at Telenor Fornebu, we used different methods. Observations and interviews were the most important. In addition, reading and collecting different documents from the intranet also gave valuable data. I also

[43] The interviews and participant observations were done by Geir André Bakke. See Guribye & Bakke (2001) and Bakke (2002) for an overview.
[44] The data collection was done in cooperation with Grete Netteland. See Guribye & Netteland (2003), and Netteland (2003).

systematically went through all e-learning modules available in the learning management system (LMS). Being a user of these systems was key to understanding the particular infrastructure for learning. We did not, however, get access to aggregated logs from the LMS, but had to rely on information presented about these figures on the intranet, and interviews with actors that had access to these.

In this case the interpretation of the LMS and its content ('e-learning modules') illustrates well the challenges in identifying the level of reference according to Star's categorization. The LMS and the 'e-learning modules' can be seen as texts with a message, and, as such, be read as a veridical representation of what it means to use the new workplace at Fornebu. The LMS with elaborated opportunities for logging activities and interactions could also be seen as a measure of how much 'e-learning' that was done and then again use these figures as an indicator of the impact or effect (or success) of 'e-learning' (as a material artefact) at the workplace. The LMS and its content can also bee seen as a record of activities, placed in a larger framework of activities. The latter is what I do in the following analysis (see Chapter 8). Accordingly, the content of the e-learning was interpreted, but seen in relation to how the distribution and use was organised.

In this chapter I give an introduction to the methodological underpinnings of the studies in this thesis. In all studies some form of ethnographic methods have been used. I have chosen to talk about ethnographic inquiries rather than 'full-fledged' ethnographies. They can be considered inquiries into settings using the methods and perspectives of ethnography – thin, etic and more theoretically driven, descriptions rather than "thick descriptions" (Geertz, 1973).

Ethnographic Inquiries

Ethnographic research represents a long tradition for studying various forms of social processes in everyday life situations[45]. The studies rendered in this thesis draw on research from different areas where ethnographic studies have had a certain impact. In

[45] For an overview of the history of ethnography and qualitative methods, see Vidich & Lyman (2000); Tedlock (2000).

each of these areas a set of specific and general concerns for how to apply ethnography to the particular settings under investigations have been prevalent.

Ethnography or, more generally, qualitative methods have been used extensively in educational research (e.g., Burgess, 1985; Bogdan & Biklen, 1992; Jordan & Henderson, 1995), for example when studying classroom culture and interaction (see Gallego & Cole, 2000, for an overview), but also when dealing more explicitly with educational technology (e.g., Saveney & Robinson, 1996).

Within research on information systems ethnography has traditionally had a peripheral position, but has more recently gained renewed interest (e.g., Lee, Liebenau & DeGross, 1997; Silverman, 1998; Myers & Avison, 2002). The use of ethnography in Information Systems research is often combined with some kinds of interventions in the settings being studied, and has had a particularly strong hold in the area of Participatory Design and the so-called Scandinavian systems development approach (Bjerknes, Ehn & Kyng, 1987; Kaaber-Pors, Henriksen, Winthereik & Berg, 2002). In addition, there is a growing body of literature about ethnographic studies conducted in the field computer supported co-operative work (e.g., Hughes, Randall & Shapiro, 1992; for an overview see Harper, 2000). A much discussed topic is how ethnography can inform the design of technological systems for cooperative work (see Bader & Nyce, 1998, and the following comments for a debate on this issue).

Heath & Luff (2000) argue that ethnography is a fruitful approach when studying the use of technology in workplace settings. Also it can also provide a way of evaluating current systems: By unpacking the practices people rely on to make technologies work in organisational settings, it is possible to consider how particular features of systems either undermine or enhance what people do (Ibid.; see also Hindmarch & Heath, 2000). Such ethnographies are commonly conducted within the confines of an organisation or a specific workplace.

Ethnography has also had a certain impact in organisational studies (Van Maanen, 1979; Czarniawska, 1992). The study of organisations as an interpretation of organisational processes from the actors' point of view has been promoted as an

alternative to functionalist studies of organisations, or organisational behaviour as decision-making (for a thorough critique see Czarniawska, 1997).

However, 'traditional' ethnographic approaches do not readily suit the study of infrastructures for learning, and there are some inherent methodological issues with which ethnographers have to deal when entering a setting in order to study ICT-mediated learning. In this chapter I argue that, by taking these issues into consideration, ethnography becomes an adequate and fruitful approach for studying infrastructures for learning as relational to process, interaction, and practice. Thus, I focus on studying infrastructures for learning with the techniques, methods and analytical perspectives of ethnography. The next step will be to look more closely at what ethnographic research is all about.

Ethnography is a term used to denote a certain, but not homogeneous, research tradition within the social sciences. It is commonly seen as a type of qualitative research, and can refer to the techniques and methods used, but also to a specific kind of description or narrative. An ethnography can thus be, simply stated, both the study and description of human activities and culture. Hammersley & Atkinson (1995) offer this account of what ethnography is:

> We see the term [ethnography] as referring primarily to a particular method or set of methods. In its most characteristic form it involves the ethnographer participating, overtly or covertly, in people's daily life for an extended period of time, watching what happens, listening to what is said, asking questions – in fact, collecting whatever data are available to throw light on the issues that are in focus of the research (p. 1).

This account focuses first and foremost on the methods used in ethnographic research and less on the kind of description. Ethnography is often used interchangeably with the term 'field work', which means that data are gathered from a variety of means and techniques, including mainly observations and interviews, but also documents, books, transcripts and videotapes (see Burgess, 1982; Strauss & Corbin, 1990). A picture of ethnography that place more emphasis on the kind of description, is given by Tedlock (2000):

> Ethnographic research involves an ongoing attempt to place specific encounters, events, and understandings into a fuller, more meaningful context. It is not simply the production of new information or research data, but rather the way in which such data are transformed into a written or visual form (p. 455).

Still, contrary to what is proposed by Hammersley & Atkinson (1995) and in line with what Silverman (2001) suggests, it is not merely the particular raft of methods that characterises this research tradition, but also a certain analytic standpoint or perspective. In this thesis the notion of infrastructures for learning and the theoretical foundations on which this is built form such an analytical standpoint (see Chapters 3 and 4).

Ethnography in Hybrid Settings

The sites an ethnographer visits when studying infrastructures for learning are not necessarily tied to the realms of the 'offline' world. The settings explored in order to get to grips with the complexities of infrastructure can be characterised as 'hybrid settings'. Interactions in these settings commonly involves both online and offline interactions. This can be either computer-mediated interactions or human-computer interactions (i.e., interactions or resources found in a 'virtual environment'). They are also hybrid in the sense that they combine interactions that are computer-mediated and at the same time part of institutional practices.

As noted in Chapter 4, infrastructures for learning have a certain reach or scope, it reaches "beyond a single event or a one-site practice" (Star, 1999, p. 381). This means that studying infrastructures for learning may imply following this infrastructure over time and in different research sites[46]. Another research area – that have been investigating communication that is not bound to a specific place – might offer some useful discussions. Several studies have recently been conducted using an ethnographic approach within the field of computer-mediated communication (CMC).

[46] Recent additions to the body of ethnographic research explore such challenges as 'multi-sited ethnographies' or 'virtual ethnography'. Marcus (1995) proposes a mode of ethnographic research that "moves out from the single sites and local situations of conventional ethnographic research designs to examine the circulation of cultural meanings, objects and identities in diffuse time-space" (Marcus, 1995, p. 96) Another example is Burawoy's (2000) "global ethnography" – studying globalisation 'from below' through participating in multiple fields and in the lives of those who experience it.

Perhaps one of the most interesting is rendered in Christine Hine's (2000) book *Virtual Ethnography*, where she calls for an "adaptive ethnography" that is especially suited to studies that are conducted on the Internet. She explores how loosely connected web-pages created by a number of independent people, together with interactions in news-groups and MUDs (multi-user domains), can be part of the 'virtual objects of ethnography'[47]. Such an approach is potentially valuable in the process of deriving methodological precepts for studies of infrastructures for learning. Many of the artefacts, resources and texts that are part of an infrastructure can be such 'virtual objects'.

The online-offline distinction

Researchers involved in studying online communication are also concerned with managing the relationship between online and offline activities. Some argue that online and offline activities cannot be strictly divorced (e.g., Kendall, 1999), and depending on what kind of online phenomena that is being studied, different approaches to data-collection and data-analysis are chosen. Jones (1999) argues that "to study it [the Internet] as if it were somehow apart from the "off-line" world that brought it into being would be a gross mistake…on-line experience is at all times tethered in some fashion to off-line experience. (p. xii)".

Hine (2000) elaborates on the matter: "It appears that emphasis can usefully be placed on the production of meaning in context, where context is understood as both the circumstances where the Internet is used (offline) and the social spaces that emerge through its use (online)" (p. 39). As this citation illustrates, there are some methodological issues that needs to be considered when the context of the ethnography is expanded beyond a physically bounded social space. To honour issues of validity and ethical considerations when studying MUD users, Sherry Turkle (1995) did not report on her findings unless she had "met the Internet user in person rather than simply in persona" (p. 324n). Other researchers approach this differently, and several studies of computer-mediated communication have been conducted

[47] There are several other works containing interesting discussions of methodological issues when doing ethnography of computer-mediated communication and researching Internet-related phenomena (e.g. Turkle, 1995; Jones, 1997; 1999; Paccagnella, 1997; Taylor, 1999; Hakken 1999; Miller & Slater, 2000).

without face-to-face interactions or interventions of any sort (e.g., Taylor, 1999). These kinds of considerations are important, but vary according to the topic and the focus of the ethnographic research.

On an analytical level, a 'pragmatist turn' to this distinction would suggest something similar. Strauss (1993) describes his 'non-dualistic' position this way:

> In the writings of the Pragmatists we can see a constant battle against the separating, dichotomizing, or opposition of what Pragmatists argued should be joined together: knowledge and practice, environment and actor, biology and culture, means and ends, body and mind, object and subject, logic and inquiry, lay thought and scientific thought, necessity and chance, cognitive and noncognitive, art and science, values and action (p. 45).

Adding 'online and offline', and 'real and virtual' to this list offers another approach to this issue. In this way, the researcher does not need to make *a priori* analytical assumptions about the relation between 'online' and 'offline', but rather treat it as a matter of investigation and scrutiny. This can also be related to the different ways of reading infrastructure as discussed in the beginning of this chapter. Using material solely derived from online interactions, the researcher would have to treat this as a veridical representation of the particular social world under investigation.

In line with this discussion, in the case studies presented here, I look at the relations between interactions that are computer-mediated and the contexts in which these interactions are created. In the first case study, even though I rely mostly on empirical data collected from the 'virtual environment' (online interactions), I also look at how this is part of an institutional practice. In the second case study, *accounts* of the use and non-use of an infrastructural tool constitutes the main material, still, the interactions in the discussion forum were also used as a source. The last case study relies on both reading the content of different learning material (in the so-called 'elearning modules'), texts published at the intranet, observations of use and interviews with the users. None of the case studies can be considered 'multi-site ethnographies'. Still, without travelling to all the sites of usage of the infrastructures

under investigations, other techniques were used to get access to relevant empirical material.

Techniques, Sources and Interventions

What are the techniques we need to take into consideration when studying infrastructures for learning? What sources does one rely on when collecting data? What is the epistemological status of these sources? What kind of interventions does the ethnographer need to do in order to get at these sources?

Observation and Participation

In ethnography one of most common techniques is observation. The ethnographer looks and listens, and this is preformed with techniques and competencies also used in every day life. To be able to observe requires some kind of participation in the studied practice. In the most general sense, participant observation is somehow an inevitable feature of all social science since we cannot study the social world without being part of it (Hammersley & Atkinson, 1995). In another sense the "oxymoron *participant observation* implies simultaneous emotional involvement and objective detachment" (Tedlock, 2000, p. 465). Still, it is common to distinguish between participant observation and non-participant observation depending on the degree of involvement and how the ethnographer 'immerses' her/himself in the setting. This ranges from being a full participant – doing the same things as the next participant, to, as un-notably as possible, just 'passively' observe what others are doing (video cameras and other recording equipment is commonly used at this end of the spectrum). Full participation, it is argued, gives the ethnographer a privileged position with regard to the understanding of what is going on. As a stranger or 'outsider' you first see the culturally 'taken-for-granted', then gradually get access to an 'inside knowledge'[48]. I will return to some of these issues, but it is not my intention to attempt resolving this debate, and in my own work I rely on both participant and non-participant observation[49]. Still there are some specific challenges that arise in relation to observing people using or interacting through ICT.

[48] This is in line with the ethnographic model 'naturalism' (see Hammersley & Atkinson, 1995, pp. 3-22, for a description and an overview of common critiques)

[49] For an overview of the different views or models of ethnographic (or qualitative) research see: Lincoln & Guba (2000); Gubrium & Holstein (1997).

Participation and Use

A key element of participation when studying the use of ICT is to what extent the researcher is familiar with the particular tool/system him/herself. In this sense the very use of a particular system, getting to know its particularities, can be considered a way of participating. This can vary from trying out and performing the tasks and operations your informants are supposed to do with a certain system (e.g., if you are studying the use of online tutorials, you participate by going through the tutorials yourself), to being a full time member of an 'online community' (e.g., participating fully in an online course in order to study it). This latter kind of participation has been used frequently in Internet research:

> In highlighting the rich and complex interactions that CMC can provide, researchers have established CMC as a cultural context. (…) A style of ethnography that involves real-time engagement with the field site and multiple ways of interacting with informants has proved key in highlighting the process through which online interaction comes to be socially meaningful to participants (Hine, 2000, p. 27).

Engaging in online activities and immersing oneself in such social worlds has proved to be a fruitful way of doing research on Internet related phenomena (see also Kendall, 1999).

Another relevant issue with regard to participation, is what perspective to take on the use of artefacts. According to Engeström (1990b), when observing the use of artefacts (e.g., ICT) we may take two different views of these artefacts: the *system view* and the *personal view*. Under the system[50] view "the system is composed of the person, the task, and the mediating artifact. The artifact enhances the performance of the entire system. Under the personal view, the mediating artifact changes the nature of the task the person is facing" (p. 171). He goes on to talk about how these different views are related to different roles: "The system view is typically taken by the observer, the designer, and the researcher. The personal view is taken by the user, the subject, the

[50] The concept of system is here used in another sense than in for example 'computer system' or 'information system'.

actor" (Ibid.). He further argues that it is important for the actor to take the system view and for researchers (observers) to take the personal view, and that both should be able to switch between multiple views.

The kind of access privileges you have to a computer-system can also be a key issue. For example in most groupware systems, there are different views or user roles such as administrative users that comes with a set of privileges in relation to how you can use the system. This issue is relevant to what kind of participant observation of a system the researcher can perform. In my field work at Telenor (see Chapter 8), I had access to their computer-network as an end-user with limited access privileges. Through the assigned account I could use the software installed at a workstation (PC), and had access to the intranet, and the LMS and 'e-learning modules'. I did not, however, get access to the administrative view of the LMS. In the DoCTA project, we had unlimited access to all files and logs (with informed consent from the participants). A particular challenge with such logs is how to manage and analyse the data. In this project a specialized application was developed to make the log files from the groupware system TeamWave Workplace intelligible (see Meistad & Wasson, 2000).

Another issue in relation to participation is the challenges that arise when attempting to study action at a distance. If the participants are geographically distributed, 'offline' observations might involve considerable costs in terms of time, energy and money (e.g., Star, 1999). This is among the choices that must be made in relation to the research design. As mentioned, in the studies presented later, the participation was done from one site, but made use of the traces left in the computer systems. In the first case study (see Chapter 6), I also performed email interviews. In the second case study (see Chapter 7), the ethnographer (Geir André Bakke) participated in meetings in the network (and had worked for a period for one of the member organisations). In this case we were also granted access to the portal, the document archives and the parts of the discussion forum that were closed for the public.

Documents, texts and data-logs

The use of different kinds of documents as part of ethnographic research is well established (Hammersley & Atkinson, 1995; Hodder, 2000). In any literate culture texts and documents have a central place. Documents may be 'informal' or 'formal' and in contexts like organisations texts are generated routinely for different purposes. These kinds of documents can be used in an ethnography as "written accounts" of a certain practice (Hammersley & Atkinson, 1995). These texts should, of course, be approached with methodological caution. They are produced in a context for certain purposes, and this should be taken into account when analysing such texts.

In relation to analyses of ICT-mediated activities some special features of texts are especially relevant. "While spoken interaction is ephemeral (unless transcribed by social scientists) and local, texts are mobile, and so available outside the immediate circumstances in which they are produced" (Hine, 2000, p. 50). Electronically created and stored texts are usually also mobile in this sense, comprising another important technique and source of data in ethnographic research of ICT-mediated practices. The electronic 'traces' of interactions in or with computer systems offers new opportunities for researchers (see McLaughlin, Goldberg, Ellison & Lucas, 1999). Transaction logs or email archives can serve as 'ready-made' transcripts - or 'instant field notes'. Nevertheless, this is not unproblematic and ethical, methodological and practical dilemmas easily emerge. The volume of the material can be almost unmanageable. Turkle (1995) argues that even though computer-mediated interactions are captured in an exact form in a log file, " the elusiveness of social discourse (…) is not pinned down by this technological possibility"(p. 312n). The meaning of these interactions still has to be interpreted and understood in relation to their context.

Insider accounts and interviews

Ethnographic studies try to incorporate participants' perspectives on the activity under study. The participants' insights are often a valuable source of information. Gaining access to the participants' interpretations, opinions and views is therefore another challenge with which to wrestle in this kind of ethnographic research. This is most commonly done through in-depth interviews and informal conversations. How to

approach such accounts methodologically has been under considerable debate. Hammersley and Atkinson (1995) elaborate on the matter:

> [T]here are two legitimate and equally important ways in which insider accounts can be used by ethnographers. On the one hand, they can be read for what they tell us about the phenomena to which they refer. We see no reason to deny (or for that matter affirm) the validity of accounts on the grounds that they are subjective, nor do we regard them as simply constitutive of the phenomena they document. (…) [On the other hand] accounts are also important (…) for what they may be able to tell us about those who produced them. (…) What is of interest here is the forms of discourse through which accounts are constituted (Hammersley & Atkinson, 1995, pp. 124-126).

These two ways of using insider accounts are not mutually exclusive. Rather in company of each other they can allow the ethnographer to both interpret the accounts as part of a certain discursive practice and take his/her informants seriously, without resorting to a naïve reading of these accounts (i.e. accepting them at face value).

Hammersley & Atkinson continue with distinguishing between "solicited and unsolicited accounts". The latter are what others have labelled 'naturally occurring' (e.g., Silverman, 2001), while the former are accounts where the ethnographer actively intervenes to produce these accounts, as for example in interviews. This is also referred to as 'researcher provoked data' (Ibid.). Depending on the analytical perspective, the two types of accounts are given different epistemological statuses (for a thorough discussion, see Fontana & Frey, 2000; Kvale, 1996; Silverman 1998).

In both the Case 2 and the Case 3 study this kind of researcher provoked (or solicited) accounts serve a central role in the analysis of the empirical material. The way these are interpreted is, as discussed above, both as a referring to the phenomena under investigation, and as part of a certain discursive practice.

Three Case Studies

Choosing a particular case to study can be done according to many different criteria (see Yin, 1994; Ragin & Becker, 1992). The empirical studies in this thesis consist of three different case studies. In general, all cases have been chosen from my interest in the relation between learning practices and technologies. The three case studies look at quite different contexts and quite different technologies (see Table 1). Still, it is not my intention to conduct a full comparative analysis of the similarities and differences between these cases. Rather, the individual analyses are carried out according to the specificities of each. Nevertheless, a final conceptual comparison is made where examples from each of the cases serve as step-stones for the overall conceptual analysis.

Table 1 – Focus and sampling in the three case studies

	CASE 1 – DoCTA	CASE 2 – IFS	CASE 3 – Telenor
Analytical theme	The organisation of interaction in relation to the infrastructure for learning	The integration of a new infrastructural tool into an existing infrastructure for learning	Concerns and agendas key to the introduction of a new infrastructure for learning
Sample (within each case-study)	The interaction of one group of three students (another group was interviewed for comparison)	One subject-group that was selected as the pilot group in the use of the portal was studied	Actors central in the organisation of the e-learning project (training administrators, project management, and end-users)
Methods and sources in data collection	Collection of email, chat-logs, interviews	Documents, interviews, participant observation and informal conversations	Interviews, online material from the intranet, observation and informal conversations, participation in training activities

The different cases were not studied at the same level of granularity. The first (Case 1) looks mainly at a group of (three) students and how they organised their work in relation to an infrastructure for learning. Their work was of a relatively short duration – one month. In this case, however, I got almost a complete record of their interactions, the interaction between them was analysed in detail.

The second case study (see Chapter 7) places more emphasis on the background and history of a particular inter-organisational arrangement, and is thus more concerned with the particular institutional setting. Still, focus was on a particular group of employees from different companies comprising a particular subject/interest group. In this analysis I mostly rely on the members accounts of the adoption and use of the web-portal.

The third case study (see Chapter 8) is concerned with how a large-scale e-learning project (involving more that 6000 people) is organised and what kind of concerns are prevalent in this process. This led to a different sampling strategy than in the other studies. As the focus was on the introduction and use of the specific LMS and the e-learning modules, it was most salient to look at how the work around this was organised. Still, interviewing end-users of the system was also relevant, and in this case I also to a large extent rely on accounts of this process.

The next three chapters describe the three different case studies and the respective analyses. A part in each of these chapters is devoted to elaborating on the data collection made in relation to each of the case studies.

CHAPTER 6 – CASE 1: THE ORGANISATION OF INTERACTION IN DISTRIBUTED COLLABORATIVE LEARNING

Introducing a set of computerised tools in educational settings can be done with a strong or weak pedagogical anchoring. On the one hand, it is not uncommon to 'dump' technologies into for example a classroom setting, without any clear agenda or purpose for how this is going to be integrated into the relevant learning practices. The trend in schools and universities (at least in Norway) is moving in a direction where the use of educational technology is becoming imperative, as the institutions have invested in, for example, learning management systems. How these systems are going to be integrated into instructional and learning practices, however, is not central to this agenda. As a result such systems are often more focused on administrative needs and routines than learning and teaching practices. Pushed to the extreme this can be seen as "a bureaucratisation of educational technology". On the other hand, there are plenty of cases where computerised tools are introduced with a strong pedagogical anchoring. The most celebrated example is perhaps that of CSILE (Scardemalia & Bereiter, 1996). Where the pedagogical anchoring is not only manifest in the way the educational arrangements are organised, but also reflected and inscribed in the particular software that are being introduced in educational settings.

A specific educational arena in which computerised tools have been integrated is that of distance education. The need for tools to support distance communication among participants has been widely discussed. The way these technologies have been integrated in different settings has also varied according to not only the level of pedagogical anchoring, but also in relation to which pedagogical model that is being applied[51].

Nevertheless, the use of a strong or weak pedagogical anchoring is not the only variable when it comes to the introduction of technologies in educational settings. Rather than being assumed, the complexity of these matters should be put under empirical investigation. In this chapter, what I put under scrutiny is a case where the

[51] Fjuk (1998) explores how a pedagogical model related to that of collaborative learning can be applied in distributed collaborative learning.

introduction of computerised tools in an educational setting was closely linked with a 'strong pedagogical anchoring' and the use of a specific pedagogical model. The focus of the inquiry is particularly on challenges facing students participating in distributed collaborative learning, the interactional processes that constitute a collaborative effort in a networked learning environment, how this interaction is organised to get the work done, and on what social and technical conditions such activities rely.

In light of the theoretical framework for this thesis, this case can be seen as an analysis of an intervention into an existing educational practice, which also involved interventions at an infrastructural level. The following analysis looks at how a group of students organise their activity in relation to these new arrangements and the new set of infrastructural tools introduced in this setting.

As discussed in Chapter 2, the notion of collaborative learning places emphasis on interpersonal interaction with respect to shared knowledge construction. *Distributed collaborative learning*, on the other hand, is used when the collaborative learning takes place in a distributed setting, which in this chapter is understood as a term "used to designate new forms of distance or of computer mediated learning, where the distance is not only in space or time as in traditional distance learning, but the mediation of learning activities served by information and communication technologies" (Wasson, 1998, p. 277).

The distributed nature of the collaboration and the absence of regular face-to-face communication undoubtedly separate distributed collaborative learning from co-located collaborative learning. In a recent paper Fjuk & Ludvigsen (2001) address the complexity of distributed collaborative learning, and state that the introduction of ICT and networked computers have caused profound changes in the area of collaborative learning. Distributed collaborative learning should be viewed "as a new phenomenon relying on its *own specific conditions*" (p. 237, italics in original). They go on to mention some of these conditions:

> [D]istributed collaborative learning is a product of complex interconnections between several aspects, such as: theories of learning and instruction, subject domains, teacher's

> roles, delivery institution's educational praxis and tradition, organisational and administrative arrangements, costs, properties of ICT (information- and communication technology) and available software, geographical distances between co-learners, etc. (p. 237).

The aspects listed here, can be seen as either part of or relating to what I have defined as an infrastructure for learning (see Chapter 4). The "delivery institution's educational praxis and tradition" for example, are related to how an infrastructure *links with conventions of practice*. The geographical distance between co-learners is related to how an infrastructure has a *reach or scope*. The properties of ICT and available software are part of the technical resources contributing to an infrastructure for learning. Organisational and administrative arrangements are commonly part of the social resources in an infrastructure for learning. At large, seeing this as an infrastructure for learning covers the above-mentioned aspects (in more generic terms) that make up the social and technical conditions of distributed collaborative learning.

In this chapter attention is drawn to how students organise their work when participating in a distributed collaborative learning scenario. What challenges do they face? What are the interactional processes that constitute their efforts in relation to the infrastructure for learning? The analysis thus concerns how the *students* deal with the shifting conditions for their interaction and how they establish collaboration patterns in relation to an infrastructure for learning.

In the next section the empirical studies and the setting in which the students worked are described, before turning to an empirical account of the students work in one of the relevant 'learning scenarios'. Then the analysis is presented focusing on the interactional processes constituting the students' work, before finally turning to a discussion of the findings in the last part of this chapter.

Case Study and Empirical Material

The scenarios on which this analysis is based were part of Project DoCTA (Design and use of Collaborative Telelearning Artefacts, see Wasson, Guribye, & Mørch, 2000), that focused on the design and use of artefacts in collaborative telelearning

scenarios aimed at teacher training. Four scenarios were deployed within DoCTA between 1998 and 1999. The scenarios utilised the Internet to engage students in distributed collaborative learning activities.

These scenarios were subject to a number of exploratory studies with the aim of providing insight into processes of collaboration. More specifically, to identify collaboration patterns and further our understanding of how instructors, students, and other learning facilitators organise their learning and work. The findings rendered in this chapter are based on studies of how teams of students organised their work in two of the scenarios; IDEELS and VisArt (Guribye, 1999; Andreassen, 2000; Wasson, Guribye & Mørch, 2000)[52]. In IDEELS, distributed teams of Norwegian students at the University of Bergen and Nord-Trøndelag College collaborated with teams in Germany, Spain, and France to develop a treaty. The goal of VisArt was to design a visual artefact to be used in teaching a subject of choice. This scenario comprised teams of distributed students from three Norwegian educational institutions. In both cases, the level of analysis was the intra-group collaboration of one specific group that was distributed across Norway. The groups were supplied with the groupware TeamWave Workplace™ (TW) and other computer tools to support their distance collaboration. Although similar, the design of IDEELS and VisArt varied with respect to: (1) Preparations for the scenario (e.g., the way the students were trained and prepared for the collaboration process, training in the use of the tools, etc.); (2) aspects of the learning activity (e.g., text based vs. visually based; well-defined learning tasks and goals vs. ill-structured tasks and goals; etc.); (3) the kinds of artefacts they had access to (e.g., the artefacts provided in the various Internet environments); (4) the kinds of artefacts they were to design and produce (e.g., textual or visual).

At the institutional level DoCTA involved an intervention in educational practices, and can methodologically be categorized as a 'design experiment' (e.g. Brown, 1992; Cobb, Confrey, diSessa, Lehrer & Schauble, 2003). It meant changing curriculum practices at several institutions and arranging and organising a set of learning

[52] The initial analysis was based on the IDEELS scenario and this is emphasised in this chapter. This was later compared with the data material and findings in VisArt (especially with the data gathered by Andreassen, 2000). The analysis of the interactional processes (this chapter) was presented in Guribye, Andreassen & Wasson (2003).

activities (Wasson, Guribye & Mørch, 2000). This can be described as a transition from "traditional lectures" and self-studies to collaborative learning with 'advanced technologies'. This was not only a transition from individually based assignments to collaborative assignments based on a new underlying pedagogical philosophy, but also an introduction of a new set of mediating artefacts – a collection of computerised tools. The pedagogical foundation was, in addition to being based on notions of collaborative learning, strongly influenced by Salomon's (1992) concept of "genuine interdependence", and the 'design experiment' was thus tuned to create interdependence between the members of each team. The primary means for achieving this was giving the students a 'collective assignment', where they were all equally accountable for the end product. From the participants' perspective, this educational activity differed in many respects from those in which they traditionally participated. They had to learn how to collaborate at a distance with these tools as the medium for their collaboration, and they had to get acquainted with each other as well as with the subject matter central to their tasks and assignments.

In this chapter the participation of one team in the IDEELS scenario is used as an example to provide a detailed account of the process the students went through. Therefore the next sections are devoted to explaining the rationale behind this particular scenario. Then a narrative-like description of the process the team went through is given. Even though the description of the process focuses on one team participating in one scenario, the efforts of several teams in two of the scenarios are the basis of the final analysis presented in this chapter. The final analysis can thus be considered a 'meta-analysis' or a synthesis of the studies of these scenarios.

Data Collection

The research results presented in this chapter were based on an ethnographic approach, and made use of the raft of related methods and techniques for data collection (see Chapter 5 and Guribye & Wasson, 2002, for a detailed account).

Initially, informal conversations with the students situated in Bergen focused on their first impressions of the scenario and their thoughts on the challenges they were facing. As the distributed students started to work, the focus was set on how to obtain data

from the virtual learning environment. Email was the most frequently used communication tool, and team addresses that included the researchers were created so that the researchers automatically received the email correspondence. How the students made use of the technological artefacts served as a central focus in the observations. The observations were conducted by immersing oneself in the environment following the students' interactions. For example, when the students were using TeamWave Workplace, the researchers could be present in the shared virtual space. This made it possible to observe and come to grips with parts of the sequential flow of discourse and interaction within the medium.

TW was used more frequently in periods of the learning activities that necessitated developing a shared understanding of a problem area or when negotiating at the level of intentions. Such negotiations were mainly conducted in real-time meetings, and although different tools within TW were used, chat-logs collected from these real-time meetings were the most important for analytical purposes. An additional technique that was used was to exploit the electronic traces the different software leaves in the data-logs. The data logs in TW are not just statistics recording "who is logged on when", but include periodic chronological recordings of all artefacts in the environment. This means that we could recreate versions of the environment to study the use of artefacts over time and the creation and development of the artefacts produced in the collaboration process (see Meistad & Wasson, 2000).

Interviews were also made with the participants, providing yet another angle from which to analyse the organisation of their work. The interviews had two functions: to clarify in which activities each student had been engaged, and to gain insight into *their view* on why the different activities had taken place and *their* reflections on why they chose to do them in this particular way.

The IDEELS Scenario[53]

Project IDEELS (Intercultural Dynamics in European Education through on-Line Simulation) brought together a diverse group of educators and researchers from five

[53] A team at the University of Bremen – lead by Janet Sutherland, developed the IDEELS scenario and the accompanying technology. The description here is partly based on their account of the scenario.

tertiary institutions in four European countries who shared a common interest in simulations and games. IDEELS has been an EU Socrates curriculum development project with partners at the University of Bremen, Germany (co-ordinators), the Polytechnic University of Valencia, Spain, the University of Nice, France, and Nord-Trøndelag College (HiNT) and University of Bergen (UiB), Norway. The goals of IDEELS included adding impetus to the curriculum development trend towards content and process-based learning and to enhance European competitiveness by providing students with opportunities to learn essential cross-cultural, linguistic and negotiating skills. A generic simulation game was used to complement existing curricula in a wide range of areas including language learning, negotiation, policy studies, political science, environmental issues, cross-culture communication, law, education, and computer science. In IDEELS simulations, students acted as high-level negotiators, consultants, and journalists in a fictional world, working to resolve real problems of importance to the European Community – problems that can only be solved through co-operation at the international level.

Teams from the various partner institutions took on different roles in a simulation conducted on two levels: deliberations within a team and negotiations between or among teams. Thus, it can be said that the simulation scenarios were designed to require (inter)dependence among both team members and between teams. Teams were given a common mission where the goal was to produce, agree upon and ratify a jointly written document (e.g., come to a consensus and sign either a policy or treaty, or write a set of recommendations). In the November 1998 simulation, teams from the various partner institutions represented a country, a technical consulting company or a newspaper. The overall goal or the common mission these teams had was to produce, agree upon and ratify a jointly written set of recommendations for a design plan for the educational system for "Eutropolis", the "New Eutropian Capital". The first task each team had to do was to prepare two documents: an Internal Briefing Document, intended to guide the team's actions through the negotiation, and; a Position Paper for "public consumption" stating the team's initial negotiation position. Other specific tasks that the teams had to engage in included a number of real-time online teleconferences, where the different parties should discuss a pre-selected topic. The teams were also encouraged to engage in an ongoing dialogue by sending each other questions, inquiries and by requesting clarification of different statements.

To communicate their policies and conduct a dialogue with the other teams, all participants had access to OPUSi through the World Wide Web. OPUSi is a computer-based communication system developed at the Department of Computer Science, University of Bremen for use in IDEELS simulations, which enables participants to send each other written messages (within a team and between teams), and to participate in real-time online teleconferences.

Two teams of students from the University of Bergen participated in the November 1998 scenario as part of a graduate course in pedagogical information science. Six students volunteered to participate in the IDEELS scenario and write a term report (later referred to as the assignment) based on the experience. The students were divided into two teams of three students and each team was assigned a role by the IDEELS facilitator at the University of Bremen. One team played a country, Highland, and the second team was journalists. As the participating Bergen students were geographically distributed over Norway, it was decided that OPUSi did not provide enough support for *intra-team* collaboration, so it was supplemented with both team email addresses and a groupware system called TeamWave Workplace (TW). In addition, the students had access to their own PC environment with whichever word processor and Internet browser they preferred.

The study described in this chapter focus on the team of journalists who were responsible for publishing a newspaper or magazine, so the descriptions from here on focus on their team role and their intra-group collaboration. In addition to producing a periodical edition of their publication (at least twice a week), they had to regularly interview the other teams and provide reports from the different events and developments in the scenario. In the teleconferences they, as journalists, had a more passive role and were only supposed to join these conferences as observers without any active interventions in the actual discourse. The first decision of the team was that they wanted to produce an electronic newspaper, called “NewWave” and publish it on the Internet.

The Collaboration Process and the Organisation of Work in the Scenario

The group's collaboration process can be divided into two main phases (see Figure 1), which have basic differences in terms of the tasks in which they were engaged, the objectives they had, and the collaboration patterns that emerged. The first phase is referring to the period when they were participating in the IDEELS scenario (the first two weeks). The following two weeks are denoted as the second phase, and in this period they were engaged in carrying out tasks related to the assignment. The days between the two phases can be called an 'intermezzo', where there was practically no collaboration at all, and could perhaps be described as "an anticlimactic" reaction after the scenario had ended. Overall, the two phases constitute a useful distinction for analytic purposes.

In the *first phase* is the students were quite confused about both their intended role in the entire scenario, and the lack of a (for them) meaningful objective and significant motivation for their participation. All the same, the students ambitiously began to carry out the tasks and collaborated eagerly in the initial stage.

Their first introduction to the scenario was given very briefly at one of the lectures in the course they were taking. Beyond this, they got the instructions and descriptions available from the web page for the IDEELS scenario. The first intra-group communication in relation to the scenario was in a spontaneous face-to-face meeting where they discussed their role in the scenario and also decided that they wanted to make a web-based newspaper. After going back to their respective hometowns, the students used email to reinitiate the communication.

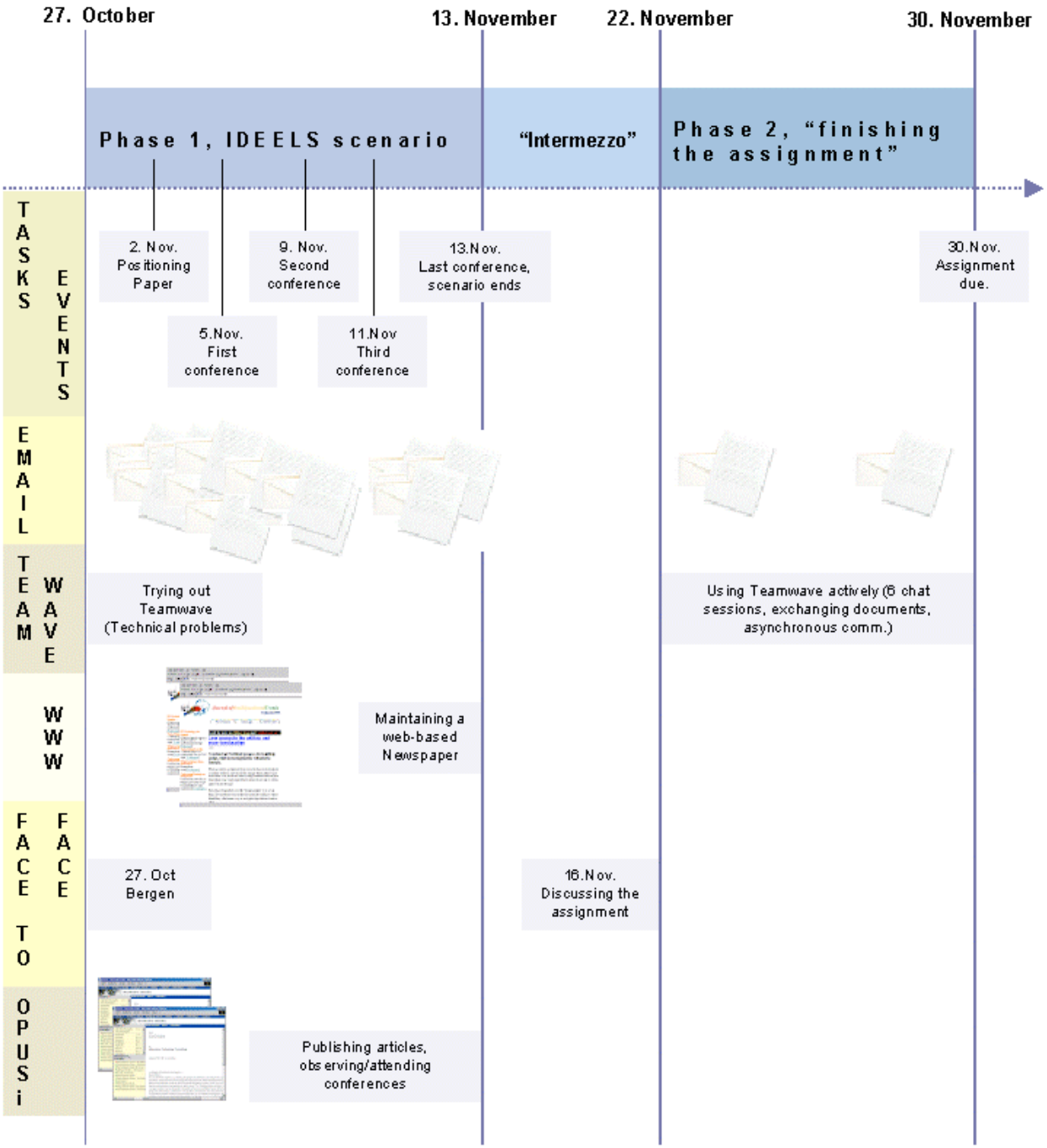

Figure 1 - The two phases in the collaboration process. The horizontal axis denotes time and along the vertical axis the different tools they were using are listed, indicating when they were used and for which purpose it was used. In addition, there is an overview of important deadlines and events.

The first task in the scenario was to publish an "internal briefing document" and a "positioning paper". One of the group members wrote drafts of these, shared them as email attachments for the other two members to read and comment. This became one of the ways they collaborated when producing documents for the scenario. In the "internal briefing document" they explicitly assigned internal roles for each of the group members with respect to their status of producing a newspaper. The roles were labelled as web-editor, journalist, and editor with the responsibilities for designing and updating the web pages, designing questions and "interviewing" the other teams in the first phase, and writing and editing articles for the newspaper, respectively. When they divided the roles between themselves, they partly did this according to their different skills and experiences. For example, one of them knew some web design and volunteered as a web-editor. These initial roles and responsibilities were *not* rigorously applied to guide the division of tasks and collaboration. As the scenario was running, their roles evolved and new ones emerged. It was only the work with the web pages that was handled by one student, but this same student also had other responsibilities.

This negotiation of ways to work, involved decisions concerning who should have the responsibility for which tasks. Each one of them made suggestions on what tasks they were willing to do and what the others could do. Extracts[54] 1 and 2 give an illustration of this process.

> **Extract 1** (2/11, 14.05):
> Then it's ok; John is handling the publishing of the Position Paper, and is thus free to add whatever he wishes.

> **Extract 2** (2/11, 15.26, as an answer to the comment in extract 1):
> Did I get the responsibility to publish the Position Paper? Ok, then I'll do it, even though I really didn't manage to keep up with 'every' move today.

In these two extracts it is apparent that they are negotiating the distribution of their tasks; one of the students (based on a previous discussion) gives one of the others the

[54] My translation – the emails were originally written in Norwegian. The names of the students have been changed for the sake of anonymity.

responsibility of a certain task. The reply is rather interesting because it is quite obvious that the involved student (John) is not aware of this and makes that pretty clear in his answer, but he still accepts the responsibility.

At a later stage in this phase, they continued to publish articles and sending questions to some of the other teams. The collaboration patterns varied as new tasks had to be carried out. When they were writing articles, one of the students took the initiative. This student, however, did not feel quite confident about his English proficiency, so he wrote them in Norwegian and sent them to the others so they could translate them into English, since the two others had more experience with writing this foreign language. At the same time, the student that wrote the Norwegian drafts might be characterised as the one who had the best overview over both the scenario and the topics discussed there. This might suggest that they choose a division of labour where they all got to do what they do best, and in this way pooled their skills and resources.

Another task they were obliged to in the scenario was to follow the conferences. In the initial stage of the first phase they tested out the different features of the conference tool and how they could use this to communicate among themselves and with other teams in the scenario. This is related both to figuring out what their access privileges were within OPUSi, and to what their role in the scenario was to be, in general and in the conferences specifically. An example of this is given in this extract from one of their emails:

> **Extract 3** (2/11, 11.31):
> I also believed that we could initiate a conference, but it doesn't look like we are allowed to do that. Did someone [the facilitators] forget to put in NewWave [the name of their team], or are we not supposed to participate in conferences? We, as journalists, are not supposed to participate in the actual negotiations, but shouldn't we be allowed to start a conference within our group or to interview somebody else?

In this extract the sender is sharing her/his confusion about their intended role in the conferences and how they are supposed to use OPUSi, and asks to the other members of the group (rather implicitly) if they know anything more about this. The conferences were only meant for formal negotiations on important issues where all

teams were present, and only the facilitators could actually start and invite others to participate in these online conferences.

In the next extract, one of the group members has a rather clear comprehension of what they are supposed to do, and (as a response to another email) shares this with the others.

> **Extract 4** (2/11, 11.48, under the title "what are we doing?"):
> What we should have accomplished before ten o'clock this evening is to send our Internal Briefing-document to the Message Centre [a certain view in OPUSi were all teams could see the messages] (not to the other groups). Then we have to produce a Positioning Paper, which we have to send to all the other groups. That's really all we have to do today. After all the groups have written their positioning papers, we should read these, and ask questions to the respective groups if there is confusion concerning the meaning of the content.

Once they figured out that they were only supposed to have a passive role as observers (by virtue of journalists) in the conferences, they divided the tasks between themselves differently. As the group members were quite busy with assignments in other classes, work etc., they did not have time to attend all of the conferences. Instead, one student followed each conference, saved it as a file and sent this log to the others by email. This shows how they, quite opportunistically, used the possibilities of the tool to reduce the time each of them had to spend on this particular task.

One rather significant event early in the first phase occurred when one of the students tried to communicate with the other group members through the Internal Messages (an asynchronous message board for intra-team communication) in OPUSi. He submitted his message, but had to wait for approximately half an hour before it was displayed in the system. Experiencing this kind of delay in the system was a contributing factor for not using the internal communication facilities in OPUSi, and for resorting to email as the main communication medium, at least in this phase.

Their use of email peaked in the very beginning of phase one. The same day as they published their first "articles" in the scenario, they sent more than twenty emails to each other. This resulted in frustration as they had to sit and wait for a quick reply to their questions and inquiries from the other students. At a certain point they used email to emulate synchronous communication, but quickly realised that this was a rather cumbersome way of using the tool. After this, the frequency of email stabilised at around three to four per day. As part of these emails they regularly informed each other of what they had been doing since the last time they had been in contact with each other or what they were working on at the moment. An illustrative example of this is given in extract 5.

> **Extract 5** (3/11, 10.33):
> I have downloaded Position Papers from InfoTech (ITU) and Highland [two of the other teams in the scenario]. They were the only which were submitted this morning. In the mean time I've been trying to make some questions for ITU.

In this extract one of the students explains what he has been doing, and tells the others about the latest events in the scenario. So, part of their communication was dedicated to continuously *updating* each other on both what each actor was working on and on events and happenings in the virtual environment (this will be discussed later).

Another aspect of their collaboration is more directly related to the texts they produced and the actual content of these. As they exchanged documents and parts of the texts on which they were working, they criticised, approved, questioned or explained the content of these. An example is presented in extract 6.

> **Extract 6** (3/11, 16.14):
> I have also read your questions for ITU [one of the other teams], and many of them are good. But there was something I didn't quite understand: [these next two sentences were originally written in English in the email] "We also want to know that of the CSCL applications, the locus of use, how the use will be co-ordinated in time, and the instructional role it is design to serve. This brings us to the distinction between co-operation and collaboration, and some questions:"

> I'm not quite sure what you mean by this. Especially the first sentence is a bit diffuse. Could you write in Norwegian what you mean to say (perhaps it's me that am a bit slow here). And, is there a difference between co-operation and collaboration?

In this final extract from their emails, one of the group members is commenting on a document one of the others has written. He copies a paragraph from the document, and asks the author to explain what he wants to say in this paragraph. In this way they share their understandings of different documents and events, and by commenting, questioning and elaborating on each other's products or explanations, try to reach a shared conception of the topic at hand. This also shows how they share their understandings about the different concepts and topics through their participation in the collaboration process.

When trying to use TeamWave Workplace in the first phase they also met some technical obstacles. During the first days, two of the students tried to use this groupware system, but one of them was frequently "kicked-off" due to technical problems. They also had problems with getting into the "room" created for the their group, and after a couple of days they also gave up on using this tool. The problems were located on the server side where the TW server was running on a rather unstable Microsoft NT™ server. At the same time some of these problems were related to other infrastructural barriers, such as the fact that one of the students was trying to access the server from behind a firewall at her workplace. Actually, the logs from TW indicate that the third student did not log on to TW until the last week of phase two.

After having started with a very high activity level, some confusion and a considerable amount of communication, by the last one and a half weeks of the scenario many of their actions were becoming more or less routine and the communication was less frequent, especially about how to co-ordinate their work.

In the *second phase* distinctively different collaboration patterns emerged − they used the provided tools differently, had a clearer objective, and had more discussions on specific topics and tasks. This phase also began with a face-to-face meeting at the university. At this meeting they tried to get an overview of the task − what had to be done? In one of the interviews this meeting was characterised as very efficient,

because they had ideas and suggestions that they could easily exchange and elaborate upon. They also divided the assignment into subtasks and made a preliminary division of the main responsibility for these subtasks. This was reported to be a fruitful way to start the collaboration with respect to the assignment.

After this they went each to his/hers town, and did some work on their own. They then exchanged the produced documents (drafts) with each other (first using email) and made comments on this work in the email body. The last week, they also used TW extensively, having several long chat-sessions and, in addition, made frequent use of the facilities for asynchronous communication provided in the groupware system.

During this last period the collaboration was intensified, and they realised that they needed a medium for synchronous communication, and had to give the work with the assignment a high priority (as we so often see when students have an assignment due). After they began using TW, the number of emails dropped significantly in relation to some of the peaks we saw in phase one, and they "only" sent a couple of emails a day. Another reason that made it possible for them to collaborate through TW was that the TeamWave server software was moved to a Unix server, thereby providing a more stable, reliable and accessible service. Together with email they used TW to exchange documents. By leaving the documents on the whiteboard they could access each other's files whenever they wanted. They used the highlight and "track changes" tools in their word processor to edit and give comments to each other's work. One of them downloaded a text document one of the others had authored and highlighted or made a strikethrough (which meant it should be deleted) on certain sections and made editorial comments to these. The co-ordination and version control of these files was to a large extent managed through use of the "post-it notes-tool" available in TW.

They arranged synchronous meetings in TW by sending each other emails where the time for the meeting and a preliminary agenda for the upcoming online session was set. Extract 8 is an example from the beginning of one of the chat-sessions. Two of the students are waiting for the last one to show up. In the mean time they update each

other on what they have done and give their opinions on some of the documents they have read or produced.

Extract 7 (chat-log, 27/11):

Paul says:	Hi, Linda!
Linda says:	Hi Paul, have you seen John?
Paul says:	No
Linda says:	Guess he'll be here soon
Paul says:	But we are only three minutes past scheduled time, according to my watch
Paul says:	I'm sitting and reading his 'prosjektkladd2' document
Paul says:	It's better than the last one, as far as I have read
Paul says:	Did you read it?
Linda says:	I was just sitting and reading your new draft, and it looks very good
Paul says:	Yes, I felt I was heading in the right direction this time
Linda says:	I also read John's draft, this also looks good but I'm still not sure whether we should use his last figure
Paul says:	I still haven't read the entire document, so I'll await drawing a conclusion
Paul says:	I was thinking I ought to try reading it before he arrives
Linda says:	Ok, you can read the rest of it while we are waiting for him
Paul says:	Okay
Paul says:	Meanwhile, you can 'twiddle your thumbs'
Linda says:	I'll study [the professor's] description of the assignment one more time
Linda says:	Hi John
John says:	Hi, did you wait long?
Linda says:	No, that's ok.

There are many things going on in this short extract, first of all they are exchanging their viewpoints on several produced documents, which they have read (or partly read) beforehand. In addition, Linda suggests she once again should read the instructor's description of the assignment, and as this indicates, they are still engaged in understanding the formal requirements for their work.

Apart from *updating* each other and *commenting* on each other's work, they also usually started to plan their further work efforts. This is illustrated in this extract from the end of one of their chat-sessions.

Extract 8 (chat-log 27/11):

Paul says:	Should we sum up each one's tasks now?
Paul says:	I will write something more about the research question…
Linda says:	I'll write the section on the scenario and on how we will go about to collect data
John says:	We'll read each other's documents. I'll write about theory and analysis
Linda says:	Ok, that's it then?

This extract shows how the division of tasks and the co-ordination of their work are continuously negotiated and reconstructed by the students in the computer-mediated communication. Notice that this conversation took place in one of the last days of the second phase.

They worked closely together producing the final document, and all of them gave an extra effort and contributed to the work throughout the last part of the second phase. In this way they finished the assignment and the student located in Bergen printed out the final version of the written assignment, and handed it in to their professor in due time.

Interactional Processes

The description above focused on how the students organised their collaboration, and what they were discussing and talking about. From the observed interaction, certain aspects of the collaboration were identified. These aspects are part of the learners' activities, and can be seen as interactional processes that constitute the collaboration between the students. Three different aspects of the students' communication were identified: 1) understanding the conditions for collaboration; 2) coordinating collaborative efforts; and 3) commenting on products and contributions. Each of these is discussed in detail below.

In the communication and interaction these aspects were manifest in a variety of ways, and could be observed as a distinct utterance in the communication, or as a topic of an entire discussion. It should be noted at the outset that these aspects should be understood as analytical categories – closely related, intertwined and overlapping in the actual discourse. The aspects are *the kind of interactional processes* that were part of the students' collaboration. These processes can be seen as particular kinds of interactions required to "get the work done". They are not meant to be exhaustive with regard to understanding the organisation of interaction in distributed collaborative learning, but as analytical generalisations, and can be seen as a step towards conceptualising some of the work that needs to be done when engaged in distributed collaborative learning.

Understanding the conditions for collaboration

The first aspect is related to the process of understanding the circumstances or conditions prevalent for the collaboration process (this is illustrated in extracts 3, 4, and 7). In its widest sense, this aspect is not unique to the organisation of interaction in distributed collaborative learning. All groups working together need to collectively understand the circumstances of their efforts. In collaborative learning, the conditions are partly given by the pedagogical scenario design, i.e. instructions, tasks and assignments, and available artefacts and tools. This might seem obvious, but the point I want to make is that even though these conditions, to a large extent, are given, the process of collaboratively *understanding* these conditions is an interactional process. It is the topic of discourse and subject to negotiations – the learners need to establish a shared understanding and a shared horizon for their work.

Throughout their collaboration, the students continuously engaged in understanding these conditions. These processes were usually most evident in the beginning of a collaborative effort, as it is crucial to establish a minimum of common ground in the initial stages of collaboration. Still, breakdowns, unexpected events, and contingencies in general, such as a server crash or a misunderstanding, can set focus back to these processes. In this way, "contingencies become conditions" (Star, 1996, p. 304; see also Strauss, 1993), conditions that in turn mediate the following interactions. This was evident in some events in the students' collaboration. A

breakdown in the students' communication due to a software problem, changed the students' understanding of the conditions for their collaboration, and they, consequently, found a preliminary way of working around the problem – which again became a preferred way of collaborating for a certain period. Understanding the affordances (Gibson, 1979) of the different tools in use is another important part of understanding these conditions. As Engeström (1990b) points out, a "tool always implies more possible uses than the original operations that gave birth to it" (p. 174). The virtual learning environment was composed of a number of tools that afforded use in a plethora of ways. Figuring out how and when these tools functioned, what their user privileges were, and equally important, how they could facilitate and support the computer-mediated collaboration process, were something that the students did through trial-and-error. It was, however, also a topic of discussion.

The final dimension of understanding the conditions of collaboration is creating a shared horizon. The learners engage in "negotiations of a joint understanding of the problem" and this also involves a "definition and clarification of the aim of the project" (Fjuk & Dirckinck-Holmfeld, 1997, p. 13). In activity theoretical terms this dimension can be seen in relation to the concept of object and object formation. According to Engeström (1990b), "[t]he object is a transitional being. It is both 'anything presented to the mind or senses' and 'an end or aim'… In other words, the object is both something given and something anticipated, projected, transformed, and achieved" (p. 181). In this case, this is illustrated through how the participants in both scenarios collaboratively change the object of their activity. The object is created in a dialog between the formal instructions and how the students understand and perceive their role and the responsibilities of the group throughout the process. It is subject to negotiation and a topic of the students' communication. Creating and maintaining a shared object is in this way a part of understanding the conditions for collaboration.

Coordinating collaborative efforts

The concept of co-ordination is one that is much discussed in the CSCW literature (e.g., Malone & Crowston, 1994; Schmidt & Simone, 1996). Group work always involves some sort of co-ordination, and in CSCW much focus has been on understanding how computer tools can support different kinds of coordination and

articulation work. Distributed collaborative learning is no exception, and an aspect of the collaborative process is thus labelled coordinating collaborative efforts (such interactions are illustrated in the extracts 1,2, 5, and 8). This process involves negotiations about the division of labour and maintaining an awareness of each others work.

These coordination processes were evident at several points in the students' collaborative effort. They engaged in deciding who should do what, through what medium it should be communicated, and when and where (in the virtual environment) to meet the next time. Note that this is also related to the use of the different mediating tools, and that much of the coordination is happening across the different tools they are using. For instance, a real-time meeting is planned and coordinated through email communication. Hence, the actual use of the tools and artefacts also needs to be coordinated. This was managed over many dimensions, such as synchronous and asynchronous communication, or the use of English and Norwegian language.

Coordinating collaborative efforts is also related to the concept of division of labour in activity theory, which can be understood as "the continuously negotiated distribution of tasks, powers and responsibilities among the participants of the activity system" (Cole & Engeström, 1993, p. 7). In activity theory the division of labour is an aspect that mediates the activity. Looking at the organisation of work in our case, indicates how this is part of the interactions, and how the learners in their collaboration engage in the work of negotiating the distribution of tasks and responsibilities. In this way, part of the coordination process can be seen as a set of interactions where the aim is establishing and maintaining a division of labour.

Another important part of coordinating the collaborative efforts is to maintain an awareness of what the other learners are doing and what they have produced. Maintaining such awareness gives a certain amount of work for the learners. These interactions are a constituent part of the collaboration process and compared to other settings (e.g., face-to-face) it involves a certain coordination overhead, or implies extra articulation (Fjuk & Dirckinck-Holmfeld, 1997; Wasson, 1998). In the empirical material, this can be seen in the way part of their interaction is dedicated towards

updating each other on what they have been doing since the last time they were in contact with each other or reporting on what they are working on for the moment. This process of updating also involves reporting on what changes have been made to the products, as well as on events in the scenario or messages from the instructors relevant to their work. In this way, new conditions for further coordination of collaborative efforts are constantly created.

Commenting on products and contributions

Commenting on products and contributions denotes a set of interactions that are content oriented. They are oriented toward the subject matter. In this case, this entailed interactions such as criticising, questioning, approving, or explaining the products and contributions of the learners (examples are found in extracts 6 and 7). By products I refer to concrete texts or visual artefacts (such as a web page) made by the learners. Contributions should be understood as ideas, knowledge, interpretations, meanings, and conceptions the learners bring to collaboration. These processes involve, as Fjuk & Dirckinck-Holmfeld (1997) point out when discussing a similar phenomenon, "negotiations on individual ideas, interpretations and knowledge" and, further, "negotiations on individual contributions to the project" (p. 15). Put simply, it can be seen as the process of giving feedback on each other's writings and work.

In collaborative learning, these "interactional processes are means of critical reflection and confrontation of perspectives. The meaning of collaboration is not primarily aimed at a common product, but rather at an active knowledge construction" (Fjuk & Dirckinck-Holmfeld, 1997, p.10). From a pedagogical perspective, such interactions are both aim and means for the collaborative learning process, and through them the learners negotiate and establish shared knowledge about the topic or issue at hand. This leads our attention to the contingent and situated nature of collaborative learning (see Arnseth & Solheim, 2002). The collaborative negotiation of knowledge is largely evident through the interactional processes that have been identified as *commenting on products and contributions*, and these interactional processes are very much the aim of collaborative learning.

Discussion

In an idealised version of distributed collaborative learning such "rich interactions", (e.g., Dillenbourg, 2000) or "productive interactions" (Littleton & Light, 1999) where students are deeply involved in collaborative knowledge construction, are emphasised and seen as the main part of the collaborative effort. This is, however, painting a pretty benign picture of distributed collaborative learning. As we have observed, a large amount of the collaboration involved other kinds of interactional processes. Collaborative efforts are just as much about understanding the conditions for collaboration and co-ordinating work and use of communication technology, as it is a matter of collaboratively constructing knowledge about the topic at hand. Identifying these three interactional processes, can help get a more nuanced picture of the work students engaged in distributed collaborative learning are doing.

Distributed work has since long been a reality within work organisations, and the field of Computer Supported Cooperative Work (CSCW) has devoted much time and effort in clarifying the conditions for distributed work. The terms of, *inter alia*, awareness (Dourish & Bellotti, 1992; Gutwin, Stark, & Greenberg, 1995) and coordination (e.g., Malone & Crowston, 1994; Schmidt & Simone, 1996), along with guidelines of how to design groupware (Grudin, 1994b), are central within CSCW. Such guidelines have also influenced the development of environments and tools supporting distributed collaborative learning, as many generic tools (such as email and groupware systems) are used in these settings.

The subtlety of the processes of cooperative work have been analysed by many researchers. In a seminal paper Gerson & Star (1986) analyse what they call "due process" in the workplace. Implying how work with technology (especially information systems) requires a *due process* through "assuring that information systems make adequate provision for recognizing, weighing, and evaluating alternatives from conflicting sources" (p. 258). Part of the work that goes into this, is what they call *articulation work*, borrowing a term from Strauss (1985). According to Gerson & Star (1986) "[a]rticulation work consists of all the tasks needed to coordinate a particular task, including scheduling subtasks, recovering from errors, and assembling resources" (p. 258). This is part of the complexity that characterises cooperative work. The interactional processes denoted as 'coordinating collaborative

efforts' have much in common with what Gerson & Star (1986) call articulation work (see also Fjuk & Dirckinck-Holmfeld, 1997). These processes are constituted in relation to a specific computing infrastructure.

Goldman (1992) identifies three different foci of interaction in co-located collaborative learning: social, task and procedural, and conceptual. These different foci serve, according to Goldman, different purposes in the collaborative effort of students. The social focus is denoted simply as "socialising" with the other members, talking about 'extracurricular matters' such as parties, grades and personal health. The task and procedural focus is when they engaged in understanding the task and assignments, and dealing with how they would accomplish these tasks. Finally, the conceptual focus is when students "attended to conceptual aspects of the (…) activities, they suggested ideas or hunches, revised their ideas in light of others' responses or comments, (…) asked questions of one another to get their point across" (p. 6). These three foci are interwoven, interdependent and mutually constituting. Building on this categorisation, Gutwin, Stark & Greenberg (1995) draw up four different types of awareness related to the use of educational groupware. In addition to the corresponding three types of social, task and conceptual awareness, they add the a fourth, which they call workspace awareness.

> Social awareness is the awareness that students have about the social connections within the group. Task awareness is the awareness of how the task will be completed. Concept awareness is the awareness of how a particular activity or piece of knowledge fits into the student's existing knowledge. Finally, workspace awareness is the up-to-the-minute knowledge about other students' interactions with the shared workspace, such as where the students are working, what they are doing, and what they have already done in the workspace (pp. 148-149).

Gutwin, Stark & Greenberg (1995) focus mostly on issues concerning workspace awareness and how this can be supported by implementing certain features in a groupware system (TeamWave Workplace supported several such features, see Baggetun, 2002; Baggetun & Mørch, 2002, for a detailed account of this). These can, of course, be important in supporting the up-to-the-minute aspects of coordinating collaborative efforts, but should, as Gutwin, Stark & Greenberg (1995) themselves

point out, be located in a web of other (perhaps equally important) types of awareness. How to design computer support for these other types of awareness, however is beyond the topic of this analysis. Still, the categorization of different foci in collaborative interactions as defined by Goldman (1992) (and elaborated upon by Gutwin, Stark & Greenberg, 1995) are relevant to the above analysis in that it cuts across the identified interactional processes. A "task focus", for example, is in the processes I have suggested present both in relation to 'understanding the conditions of collaboration' and in 'coordinating collaborative efforts'. The conceptual focus, however, is pretty much in accordance with what I have labelled 'commenting on products and contributions'. Nevertheless, a crucial difference between the 'interactional foci' identified by Goldman (1992) and the interactional processes discussed above is that the latter include and are seen in relation to the infrastructural tools.

In this analysis focus has been on how the students organised their work. The organisation of interaction is an emergent process and is done in relation to an infrastructure for learning. As it has been illustrated in the above description, the students used the infrastructural tools differently in the two phases. This was partly due to the technical problems they experienced, but also due to their familiarity with some of the tools (especially email). Email was already part of a working infrastructure and their use of this infrastructural tool was very much naturalised, and thus transparently supported their communication. Still, as they their efforts intensified, they experienced some of the constraints of using email (to e.g., emulate synchronous communication). The availability of some of the tools also relied on certain infrastructural issues. This is perhaps best illustrated when one of the students could not access one of the tools due to firewall restrictions. The students in the IDEELS scenario were all master students in information science and were knowledgeable in use of different ICT tools. Their flexible use of the different tools and their efforts to incorporate these tools into their collaborative efforts should be seen in light of this. Nevertheless, engaging in such an activity involving a set of advanced infrastructural tools require a certain amount of work from the participants in relation to understanding the technical conditions for the activity.

Another aspect of the particular arrangements analysed in this chapter is the way the tasks were designed to create interdependence within each team. The interactional processes identified in the above analysis, at least partly, reflects this specific pedagogical model. In one way, this contributes to creating opportunities for the learners to collaborate closely and comment on each other's products and contributions, while on the other hand it creates a certain amount of 'coordination overhead' or articulation work for the involved participants.

Yet another aspect of this can be found in relation to certain conventions of practice common in educational settings. It is for example usual that students are individually accountable for the work they do and the products they make in educational activities, and this is closely linked to institutional assessment requirements. Such conventions might be in conflict with particular pedagogical models, for example one emphasising interdependence among participants (as in this case). The students being collectively accountable for a collectively produced outcome is, thus, a central aspect of the use of this particular pedagogical model. In established institutional practices the participants are accountable to a set of socio-historically developed norms and rules for managing tasks given within this institutional setting (Arnseth, 2004). This concerns not only the institutional assessment criteria, but also normative aspects of a pedagogical model. Expectations that arise from the introduction of a specific pedagogical model can constitute a set of norms to which the students are made accountable (the use of a certain tool can even be 'an imperative' in particular educational arrangements deploying a CSCL-influenced pedagogy). Together with the introduction of a set of infrastructural tools, these elements should be taken into consideration when interpreting the findings rendered in this chapter.

In this chapter I have looked at challenges facing students involved in distributed collaborative learning. I introduced three aspects of distributed collaborative learning, and explored properties and dimensions of these aspects, and how these appear in relation to an infrastructure for learning.

CHAPTER 7 – CASE 2: A NEW TOOL IN AN INFRASTRUCTURE FOR LEARNING

The adoption and use of groupware have been studied extensively in CSCW (e.g., Grudin, 1988; Grudin & Palen, 1995; Orlikowski, 1992a; Bradner, Kellogg & Ericson, 1999). The focus is often on why such applications fail or why they are not adopted as they were supposed to. A common conclusion is often that to understand the adoption process it requires a focus on both on technical features, social context and the culture of the workplace in which the groupware is introduced. In this chapter I focus on the introduction and use of a web-based tool that are introduced in order to support the practice of an existing inter-organisational network. While similar to many of the studies of the adoption of groupware, this particular case focuses on the integration of this tool into an existing infrastructure for learning.

Intranets and corporate portals have been proposed as an information infrastructure upon which organisational knowledge and learning can be cultivated (see Choo, Detlor & Turnbull, 2000, pp 82-83; Detlor, 2000; 2003; 2004). They are also seen as technologies that can promote organisational communication and cooperation across distances. It is claimed that by providing the members of an organisation with a shared communication space, portals support the sharing and exchange of information and knowledge.

Within CSCW the sharing of knowledge in organisations has been studied widely (e.g., Finholt & Sproull, 1990; Ackerman, 1994; Ackerman and Halverson, 1998; Robey, Boudreau & Rose, 2000; Virkkunen & Kuutti, 2000; Pipek & Wulf, 2003). Intranets and portals can be considered as a form of groupware (Choo, Deltor & Turnbull, 2000), and thus the studies of the adoption of groupware systems in organisational settings are relevant for this domain (e.g., Orlikowski, 1992a; Grudin, 1994b; Hayes & Walsham, 2001).

In most of the studies of knowledge sharing and ICT, the adoption of groupware has been studied as *intra*-organisational processes (Gallivan & Depledge, 2003). Few, however, have studied these processes in an inter-organisational setting (two notable

exceptions are Star & Ruhleder, 1996; Majchrzak et. al., 2000). Majchrzak et. al. (2000) reports on how a virtual team had to adopt to the technological structure by changing their organisational environment and group structure. Focusing on structural elements of this kind of work, they argue that distributed collaboration or virtual teamwork is an interplay between three structures – organisational environment, group structure and technological structure.

Internet-enabled inter-organisational arrangements have been investigated as virtual working (e.g., Jackson, 1999) and as networks and alliances (e.g., Haugland, 1996; Child & Faulkner, 1998), with most of the focus on production processes or product development (e.g., Harris et. al., 1999) and some on trust and control (e.g., Gallivan & Depledge, 2003; Toiviainen, 2000).

In conjunction to this literature, some authors have also looked at inter-organisational learning (e.g., Kumar & Nti, 1998; Larsson, Bengtsson, Henriksson & Sparks, 1998). A few also focus on how ICT can be a facilitator for inter-organisational learning (see Scott, 2000; Davidson & Olfman, 2004).

In this chapter the introduction and use of a web-based tool for the support of knowledge sharing and learning in an inter-organisational arrangement is analysed. The particular tool was part of a web-portal that was implemented to facilitate the exchange of information in an existing inter-organisational arrangement. This transition involved gathering central resources for supporting the networks' activity into a computer-based system. Such transitions are a complicated process. In addition to getting the system up and running – which can involve considerable technological sophistication – participants are faced with the challenges of integrating this new system into their own activity and the organisational arrangements. A transition to the use of such systems can also lead to a change in how the participants perceive their own activity and what aspects of the activity that are important. Kling (1992) discusses a similar issue in more general terms:

> Computerizing an organizational activity involves much more than mapping information flows, finding equipment to automate work and decisions, installing the equipment, and training users. Many computerization projects lead to new work

> practices and new divisions of labor. They may raise (or at least alter) standards for acceptable goods and services. They may lead people to expect themselves and their coworkers to work differently and often faster (p. 365).

As Kling points out, there is more at stake when trying to integrate a technology into existing practices than questions of formal representation of tasks, flows and the technical implementation of such tools. In this case I try to shed some light on how the introduction (and consumption) of ICT can transform existing organisational arrangements, especially in relation to arrangements meant to support the exchange of knowledge and learning processes. The way this is approached is by thinking of the introduction of the system as an effort of making a web-based tool a part of an infrastructure for learning (as defined in chapter 4). It is seen as a part of a set of resources and arrangements to facilitate and support a learning practice. The following case is also an attempt to illustrate what constitutes an infrastructure for learning. With this backdrop I ask the following guiding questions for the analysis:

- How does the introduction of a web-based tool impact on an existing organisational arrangement, and how is this perceived (accounted for) by the participants?
- How (or when) does such a system become part of an existing infrastructure for learning?

Case and Empirical Studies

Empirical material[56] and focus of the study

This case study is based on an ethnographic inquiry. The material gathered consisted of documents addressing the history of the network, strategy documents, annual reports and minutes from meetings in the subject group. Many of these documents were available through the web-portal. Five of the members of the subject group were also interviewed (in depth, open-ended interviews) in May- June 2000, one of which was the project leader for the work with the new portal. The head-executive of the

[56] The empirical study was done by Geir Andre Bakke, under my supervision, during the year 2000, as part of the work for his Masters thesis at the Department of Information Science, UiB (Bakke, 2002). He also had a part time position at one of the network companies during parts of that period.

network was interviewed in November 2000. In addition, the data collection included fieldwork with participation in meetings and seminars.

One aspect that is scrutinized in the following analysis[57] is how the participants view the introduction of the system and how this can be integrated into the existing organisational arrangements. In this case study, I thus look at some of the participants' accounts of their own activity and the introduction of this new system.

These accounts are, as mentioned above, taken from different sources: interviews, reports, informal conversations, and official statements. These are put together in a "collage" to try to give an impression of the role the system came to play in the organisation of the network's activities. These accounts revolve around what role the system played (and was supposed to play) in their practice, the difficulties of incorporating the tool into the practice and existing group structure, problems of making the participation in the network relevant for their daily work, and difficulties in making their knowledge 'mobile'.

The next sections concern the historical, institutional and organisational context of the introduction of the web-based tool. A description of the content and topic of the work of the chosen subject group is also given. In addition, a brief presentation of the web-based tool is included.

Background and institutional framework

Sunnhordland is a region on the west coast of Norway. The region consists of the mainland on both sides of a fjord and three large islands. Companies operating within marine technology, oil technology and refinement of light metal dominate the industry. Two of these companies can be characterised as corner stone enterprises, and play an important socio-economic role in the region. Several smaller supply companies have been established during the last fifty years, many finding their economic basis in being vendors for the larger companies. Despite the fact that there exists extensive knowledge and long-term experience related to industry in the region, formal collaboration between various organisations has been practically non-existent.

[57] The analysis is a reworking of the analysis presented in Guribye & Bakke (2001).

Due to the geographical conditions in the region, travelling can be both time consuming and cumbersome. Even though bridges and tunnels have been built, travelling between the different areas usually involves transportation by ferry. Presumably this raises the threshold for how often people travel within the region, and has had an impact on collaboration in general.

In 1987 a few companies, acknowledging that they might benefit from each others' knowledge in different areas, reached an understanding, and the "Centre of Technology for Sunnhordland" was established. The centre received funding from the Norwegian government's initiative to strengthen the field of technology in both private and public sectors, and to promote collaboration between the different institutions. Through this initiative they aimed at increasing the rate of employment within industry and to give private companies competitive advantages in national and international markets.

The Centre went public in 1992 with the majority of the stocks owned by the member companies. As the different companies in the region did not have sufficient knowledge about each other, the products they were making or their businesses in general, consulting services and products where often brought in from other regions without knowing such services and products existed in their own region. Thus, one of the first tasks was to make an overview of all the companies in the region and to link them in a formal constellation.

In 1998 the centre was renamed "Industrinettverket for Sunnhordland"(IFS), and in 2001 it comprised 17 industrial companies where members from the different companies worked together to pool their competence development efforts and to arrange courses and seminars. The member organisations in the network differ in size (from 15 employees to approximately 1600), with respect to what they produce, and in the respective production processes.

The first major project orchestrated by the network was Enterprise Development 2000[58] (ED 2000), which started in 1995 and had a five-year time frame[59]. The main

[58] The Norwegian translation is "Bedriftsutvikling 2000" (BU 2000).

goal of this project was to strengthen the companies' position in the market and enhance the quality of their end products through 'total quality management, continuous improvement, internal control and partner collaboration'. Work groups were established consisting of executives, employee representatives and other members of the companies' staff. They met twice a year in conferences as part of a "competence development forum". Some of the companies were already in a vendor-customer relationship, but for many, these were the first formal meetings with the representatives of the other companies. During the project initial relations between the participating companies were established, both at the inter-organisational and inter-personal level. To accommodate the exchange of information and experiences and to facilitate discussions between the members, it was decided that the participants from the different companies should be organised into a number of subject groups. These groups were set up according to professions or subjects (e.g., an information technology group, a marketing group, a quality assurance group).

In this study one of the subject groups were followed closely for a year. This was the quality assurance group, KS/HMS[60], which is occupied with quality assurance and issues related to health, security and the workplace environment in general. Their work was also considered especially important in the early stages, as the general objective of the work with ED 2000 was to improve the quality of work processes and products. During ED 2000 the group met in face-to-face meetings four times a year, but they also had more regular distance communication using the established communication infrastructure such as telephone, fax and e-mail.

Most of the companies in the network are certified according to various international standards[61] regarding the quality of products, health and security precautions and the security of the workplace in general. Described briefly, KS/HMS work is a continuous

[59] ED 2000 was a national program initiated by the Norwegian Research Council with the participation of both the Confederation of Norwegian Business and Industry (NHO) and the largest labour union in Norway, The National Worker Organisation (LO). IFS was only one of several arenas where the program was deployed.

[60] The acronym will be used throughout the chapter referring both to the group and to the subject of the group's work. In Norwegian the letters denote Kvalitetssikring/Helse, Miljø og Sikkerhet [quality assurance/health, environment and security].

[61] The standards are provided by International Organization for Standardization (ISO). The different standards vary with regard to complexity, which means that a company certified in accordance to a given standard, will face stricter and more complex demands when trying to advance to the next level.

process where the goal is to improve all spheres of production in the company. Updating the company's internal regulations, maintaining communication with the authorities and auditing environmental control systems, are some of the tasks that come with KS/HMS work. Being responsible for the implementation of quality assurance systems, thus, involves much routine work. Another important feature of this kind of work is motivating the personnel. This implies talking to people at all levels of the organisation, making them aware of the necessity of following routines set by the ISO-standards, and at the same time, allowing the personnel to have a say in matters that concern their own workplace.

Some of the larger member companies have a permanent staff working with these issues, where three or four employees each are specialized in different areas of quality assurance work (for example dedicated staff working with security and health issues). In the smaller companies, however, this work is commonly carried out by a single employee, which also can have other responsibilities.

Being organised into a subject group was seen as a fruitful way of extending the participants' social network and providing them with a forum in which they could discuss problems and raise issues that they were facing in their work. The group had a flat membership structure and all participants were formally equal in the participation in the group work. They did, however, elect a foreman for the group. With this role came the responsibility of setting up meetings and writing minutes from these meetings. Participation is also considered voluntary, meaning that no member company was obliged to contribute personnel for every group. Still, as the member companies contributed with both financial resources and the time of their personnel in the network, they expected some return on the investments.

In 1998 the network became involved in another project called National Information Networks[62] (NIN). This was a pilot project that was carried out in cooperation with another similar network – TESA, located at Jæren, a region south of Sunnhordland. The project was focused on enhancing the competence in the use of ICT and to have the networks actively use ICT tools in their activities. The first year many of the

[62] This is a translation of the Norwegian name, Nasjonale informasjonsnettverk. The pilot program ended in December 2000.

employees (especially managers and key personnel) participated in courses and seminars to learn about ICT. Another important activity related to this project was to implement a web portal to support the network's activities. The subject group on information technology was chosen as a steering group for this project and a member of this group was hired as project leader. The KS/HMS group was selected as a pilot group to test out the use of the new portal with special emphasis on the discussion forum implemented as part of this solution.

At the time, all member companies had Internet connections and used e-mail systems and some also tele-conferencing systems. With the focus on the use of ICT that followed with participation in the NIN project, IFS started to consider possible ways the use of ICT could support the network's core activities. The other network (TESA) had already implemented a web-based environment, and reported that they had positive experiences with the use of this environment and IFS decided to buy a prototype of this particular system.

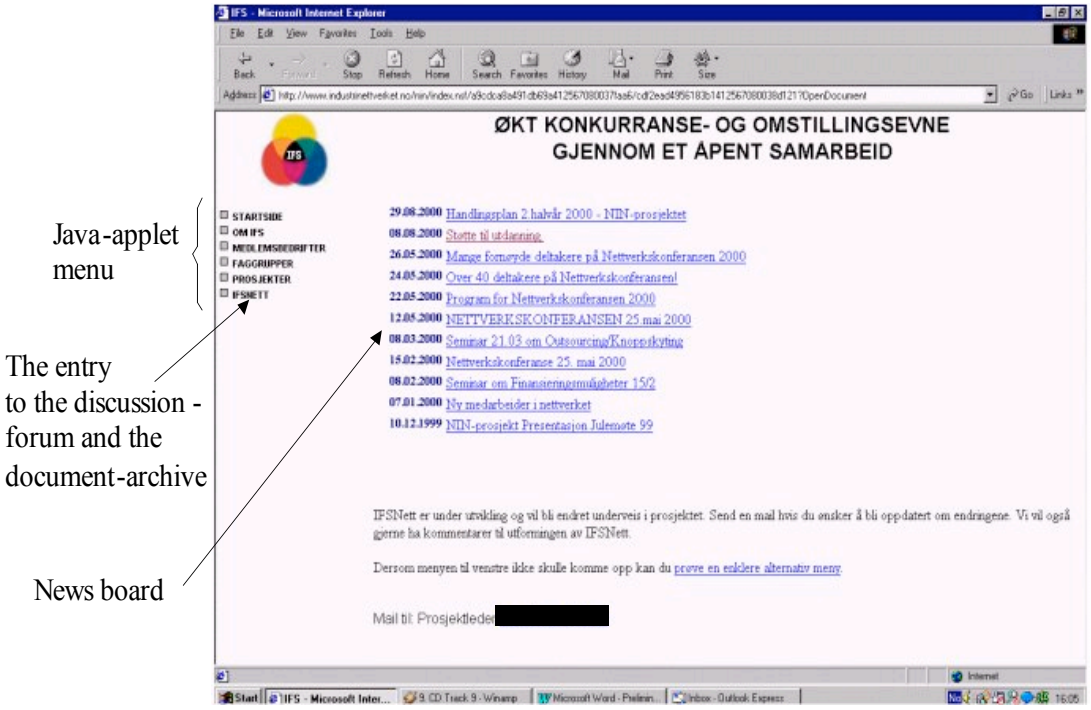

Figure 2 – The first version of IFS Online (from Bakke, 2002)

IFS Online

In January 2000 IFS implemented a first version of IFS Online (see Figure 2) and it was supposed to function as a web portal for the member companies in the network. In addition to support for publishing information about the activities in the network using a news board on the main page, it provided the users with a discussion forum and a document archive. It included a notification service, so when new messages are posted, this automatically triggers a notification through e-mail to the other group members. The portal and the asynchronous textual discussion forum were implemented using Lotus Notes and standard HTML-code as the main development tools. The tree-structured menu on the front page was programmed in Java. Members of different groups in the network were assigned a user-id and a password to access the discussion groups and document archive. All information regarding the users and the discussion groups were stored in the Lotus Notes database. As they adopted the same version as used by their partner network (TESA) they used the same vendor that also held the support service for the portal. In the first version, the portal was hosted, free of charge, at the same (DOMINO) server that was used by TESA, located at one of their cooperating institutions, Rogaland Research. The interface of the discussion board mirrored the way IFS was organised into subject groups, with one forum for each group.

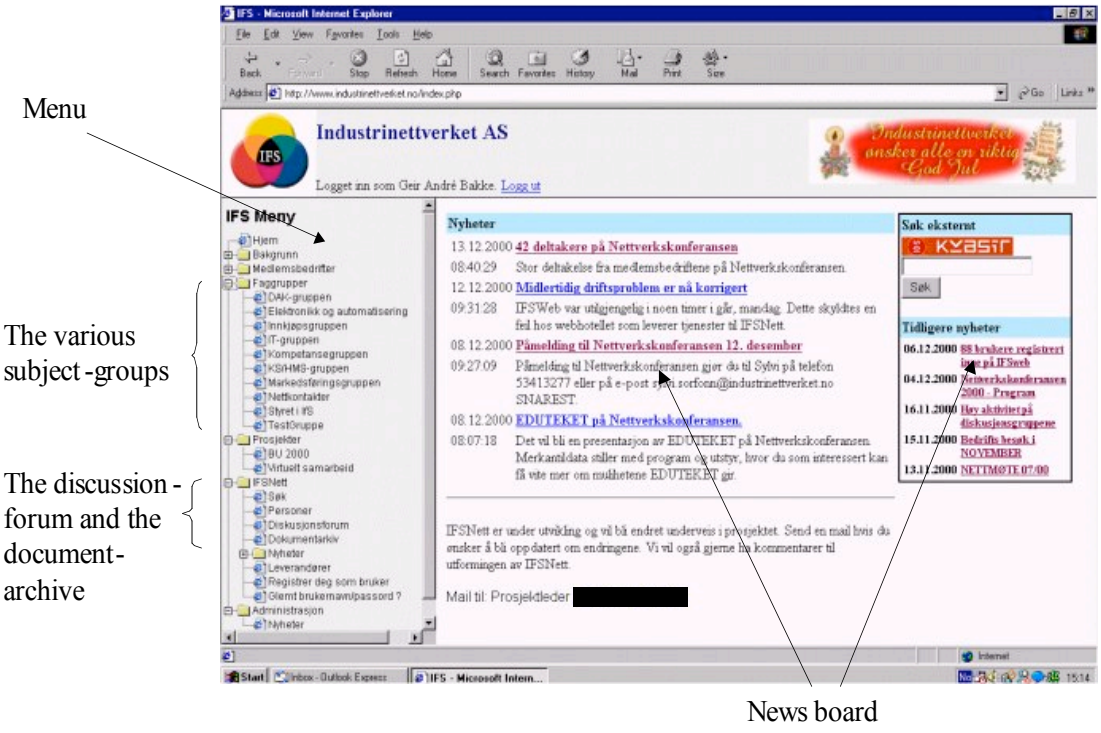

Figure 3 – The second version of IFS Online (from Bakke, 2002)

After five months the development and maintenance of IFS Online was taken over by the software department in one of the IFS member companies and further development was based on the original design of IFS Online. The application was removed from the Domino server at Rogaland Research and placed on an Apache server run by the software department of the member company. The old Lotus Notes database was replaced by a MySQL database solution, and other changes to the portal were made in accordance with a requirement specification based on problems experienced during the use of the prototype. Table 2 sketches the sequence of events in the network's history.

Table 2 – A sketch of events in the network's history

1987-1992	Establishing the network
1995-2000	ED-2000 project - Inter-organisational arrangements Subject groups, regular meetings
1998 – 2000	NIN-project Training staff in ICT (courses and seminars) Starting the preparations for the first version of IFS Online, KSM/HS group selected as the pilot group
January 2000	First version of IFS online delivered by the external vendor
January - May 2000	Testing the use of the new system Experiencing technical problems
May - August 2000	Decided to abandon the current solution Negotiating a new deal with a local vendor
August - November 2000	The local vendor develops a new version of IFS Online Members of the subject group provides input to the design of the new portal
November 2000	The new version of IFS Online launched KS/HMS group starts to use the discussion forum Several discussions about KS/HMS topics

Analysis

This analysis consists of four parts. In the first section a narrative-like description of the process the subject group goes through from the introduction of the first version of IFS Online until they have the second version available and started using this version is given. The focus in this section is also on how the participants account for the

technical problems they were experiencing and the role the tool has in the activities of the group and in the network in general. The next section goes further into the matter and trace different accounts of what role ICT in general and IFS online in particular should and could have in relation to the organisational arrangements. In the third section two other dimensions of the work in the group are explored. First a comparison between how they used to organise their activities, and what the content of their work (or knowledge characteristics) are examined more in detail. This is explored in relation to their 'knowledge interests' and the structure of their participation. The fourth and final part of the analysis looks into how the features of participation and 'non- participation' are salient in relation to the online discussion forum.

The rise and fall of IFS online

As mentioned above, an external vendor delivered the first version of the web-based portal in January 2000. With great enthusiasm the members of the network tried out the new system, but many experienced technical problems. The system simply did not function as it should[63]. The portal had an unacceptable low response-time, and many of the standard browsers[64] used throughout the different companies did not display the java-applet menu properly. This was expressed in the interviews with the participants[65]:

> **Extract** 9:
> "It simply does not work. It is slow, the menus by and large never appear. For all that, lately the menus have appeared, and the response time is down to only forty seconds, and that is fast! Earlier it took from three to four minutes".

> **Extract** 10:
> Interviewer: Problems related to IFS Online, how does that impact on the group's work?

[63] While the neighbouring network TESA, had not experienced the same problems.
[64] In particular this was problematic for those running earlier versions of MS explorer and Netscape Navigator.
[65] All extracts are translated from Norwegian.

> Informant: It stops. People hit the wall in that they can't get in to each of the routines because there has been an update and that creates frustration and problems. It does. The menu has been a continuously recurring problem

An assessment of this technological breakdown was made by some of the members in the network and they agreed that this was the responsibility of the vendor. Subsequently the project manager presented the vendor with these problems, but they showed little interest in resolving these issues. The vendor did, however, suggest a "work-around" for getting the different kinds of browsers to display the java-applet menu. This consisted of deleting the cache of the browser before accessing the web-based portal. Such a cumbersome solution to this, rather fundamental design issue, was seen as unacceptable. Still, as the vendor of IFS Online did not experience the same type of problem when testing the system in their environment, the problem was not perceived as important, and was given low priority. This situation eventually led the IFS administration to consider other potential vendors.

At this point the members of the network also claimed they were ready to start using the system, and that the obvious technological limitations were the most important hindrance to establishing the portal as a sufficient support for distributed collaboration. As illustrated in the extract below, some even reported that this was key to the existence of the entire collaboration in the subject group.

> **Extract** 11:
> I think that if we do not get this web up and running, this network will collapse! I think so because I feel that we have had this many meetings now and we know each other and we know what each other are doing in their jobs, what systems we have established, working method etc. So I think we are simply dependent on this web if we are to maintain this group.

After a few months the contract with the vendor of the first version was terminated, and a new contract was signed with another supplier. The new vendor was the IT department of one of IFS member companies. Representatives from the network companies gave their support to this decision. The IT department would do the job at a lower cost than the company responsible for the first version. According to the

head-executive in IFS, however, the most important argument was that this company was a part of the network and had self-interest in developing a functional web-solution. This department should also be responsible for the running and maintenance of the portal, and the end-user support. The IT department started the work of improving the portal in August 2000.

In November 2000 the new version was implemented and made available for all participants in the network. This new version relied on different technological solutions, and although it was based on the earlier version it was changed according to the requirement specifications that were outlined from the encountered problems with the use of the first version. One of the most important changes was related to making the portal platform-independent. The Lotus database was replaced by a MySQL database. PHP (a server-side scripting language for creating dynamic web pages), standard HTML and Java scripts were used to enhance the dynamics of the web-portal. The problems related to the main menu at the home page were fixed in order to make IFS Online compatible with all types of browsers running HTML version 4. In the development of this new version, the users played an important role in laying out the premises for the design process - in line with the Scandinavian tradition of user oriented design with active participation from the end-users in the development process.

Meanwhile the members in the KS/HMS group, as they were selected to test out the new system, were rather impatient waiting for the system to get up and running. They believed this would make a big difference, and were quite eager to get started using it. Now that the system would work properly, they would use it extensively and this would make their collaboration much easier. In the meetings they discussed various ways they would use IFS Online and agreed that in order to maintain contact in the group they had to actively engage in discussions in the forum. One of the informants expressed this enthusiasm in a conversation with the researcher present at the meeting:

> **Extract** 12:
> Informant: Well, today you should have interviewed me, not at the time you did.
> Interviewer: How come?

Informant: Because now everything is much better. I have a much more positive impression of the network now.

Interviewer: Why is that?

Informant: Well, now we are about to get a web that works! We are actually able to use it for communication purposes.

As soon as the new version of IFS Online was up and running the members of the KS/HMS group keenly started to use it. For a period of 20 days the system was used frequently, culminating in a discussion about an interpretation of the law regulating the working environment, where five of the members participated actively. Several discussions took place simultaneously, forming an emerging communication pattern (see Figure 4).

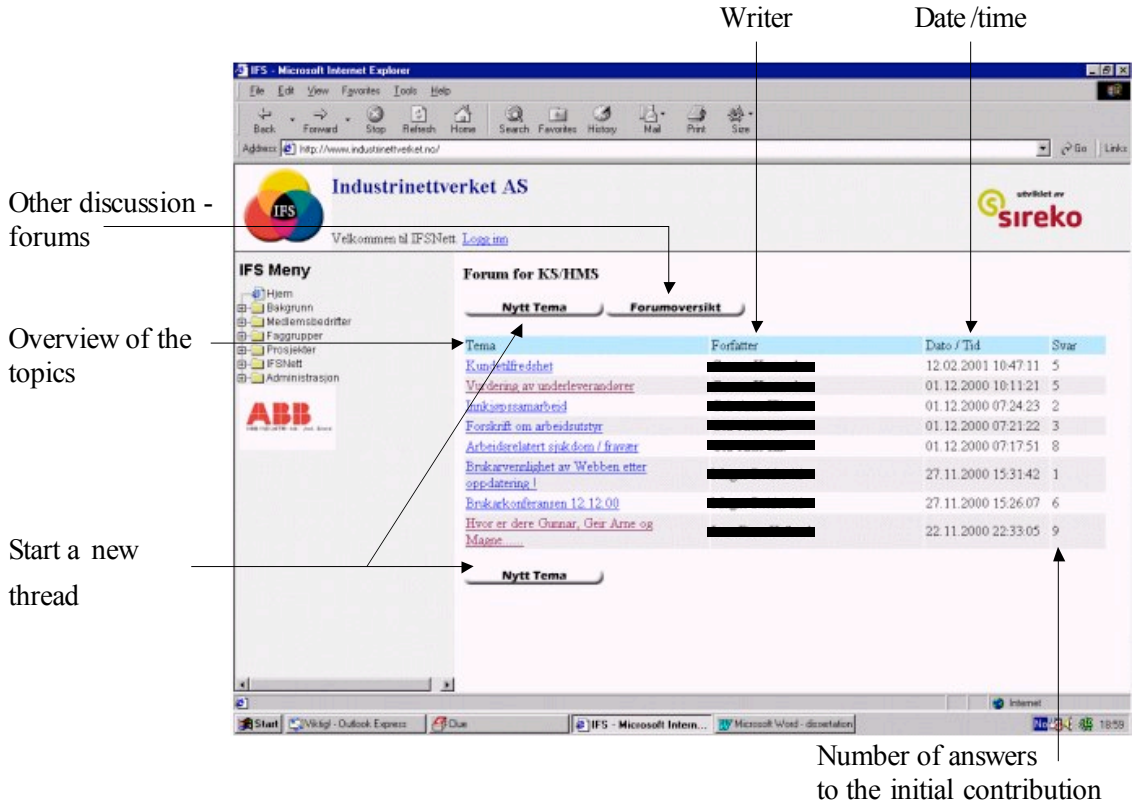

Figure 4 – An annotated screenshot of the discussion forum of the KS/HMS subject group, February 2001(from Bakke, 2002)

After a few weeks of using IFS Online, however, the KS/HMS group virtually stopped using the discussion forum[66]. The only postings were a few meeting notices and minutes from meetings that were saved in the document archive.

Accounts of the role of ICT in the network

The web portal and the discussion forum had a central strategic position in the network's plans and activities. In line with the goals of the NIN project, they incorporated this into the network's strategy. This is apparent in this quote from the business strategy statement:

> **Extract** 13**:**
>
> Strategy 1: Network/Relations
>
> IFS shall ensure that the network companies cooperate on the main goals and the strategies/sub-goals that at any given time appear in their approved plans, inter alia by communicating electronically and learning to utilise today's information technology.

This strategy statement relates directly to the technology supposed to support the activities in the network. This shows how the goals were not only directed towards the members and that they established contact and cooperation, but also that having and using the "state-of-the-art" technology was an important objective in itself. An interpretation of this would suggest that having the members communicate through an electronic medium is perceived as beneficial for the network in that the members learn how to use ICT and keep "up to date" with the technological development. In relation to this, the head-executive of the network was asked about how she conceived of the role of ICT in the network:

> **Extract** 14:
>
> Interviewer: Information technology – is it a goal in itself to use the technology?
>
> Informant: No it's not. The goal is to get the companies to communicate better, to have tighter contact, to get it even more energetic [drivande], to see opportunities, to work differently. That is the goal. And in this work we see that the issue of communication technology is very important

[66] After December 2000 there was one discussion in February 2001 with five answers to the original submission. Subsequent to this (and until September 2004) there have been four postings by the same author in the discussion forum with one or zero answers, all of which were posted in 2002.

As it is construed in this extract, the transformative role of ICT is emphasised. It is not the technology itself, but how ICT can support the activities in the network that is the rationale for introducing and using ICT. The discourse accompanying the implementation of the portal revolved around such an 'imagery' of how the discussion forum could support cooperation and collaboration. According to this 'imagery', implementing this system would help them collaborate on a more regular basis and they would have an archive in which they could go back to look at different issues that had been discussed.

This vision of how the tool should work, was adopted by key actors in the network. It can also be seen as quite a robust vision, having survived the struggles they had with the first version of IFS Online. This is further illustrated in this extract:

> **Extract** 15:
> Interviewer: IFS Online – how do you think it functions in this work [in the KS/HMS group]?
> Informant: The web – it has been a tough way to go… it has. I feel that before I started I should have had some good advice on how this would end, so I think that we will end up with what the goal originally was and that was to get these subject groups engaged and give them a tool to make them work more efficiently. I think we will manage that.

In this extract the project leader at first points to the challenges they have met with the implementation of the first version, but then goes on to talk about how such a tool, once the problems are overcome, still has the same potential for making the work in the subject group more efficient. He elaborates on this after a follow-up question:

> **Extract** 16:
> Interviewer: As of today and until now?
> Informant: What we have accomplished so far of functionality - these things have been requested and they are positive to that. The problem has been and the challenge is to speed it up [lower the response time] and improve the interface. I think that with [the new local vendor] this will be much better. Again this that we have to buy enthusiasm from [the first external vendor] with everything we do … I feel that now with [the new local vendor], as they have a self interest in establishing themselves in this area and have a self interest in showing within the network how good they are – and it is

> precisely this we have missed from [the previous vendor], so I think this next half-year will be much better.

The focus is in this extract shifted from that of the technical problems (which he recounts as a slow response time and a poor interface) to one of having sufficient enthusiasm (apart from merely economic motives) from the vendor. Even though this shift indicates how the process of getting a 'working technology' is a process involving other issues than merely the technical – for example a negotiation of responsibilities and interests – the promise of the technology still lingers.

The subject group, early on, through their efforts, acknowledged that the challenges they were facing also revolved around how they would organise their work. At the end of January 2000 the KS/HMS group arranged a meeting where they discussed the use of IFS Online. They agreed that they would use the system when the members encountered problems in their daily work. Ideally, they would then post a message in the discussion forum and get help from other members if any of them had any experience with the issue. This was the way the network activities would be integrated into the daily work of the members. In addition to being a persistent medium that could serve as an archive of their discussions, it was supposed to reduce the distance between the members in the subject group. It was, at this stage, framed as a question of getting the tool implemented and they would start using it.

In this phase IFS Online took the role of being the topic of the subject group's work. It was to be implemented as a tool to support their collaboration, and for some time it, not surprisingly, became the topic of their interaction. The discourse revolved around the possibilities of the web environment and its potential. Even though most of the group members had experience with using the Internet, few were familiar with this particular form of computer-mediated communication.

In the first weeks after the implementation of the first version of IFS Online, they were not sure how they would organise their collaboration. They were waiting for some of the other members to submit contributions to the forum. After another face-to-face meeting they recognised that they would have to agree on when and how they should use the system. They agreed that IFS Online should be used instead of sending

emails to each other when they were addressing matters that concerned the entire group. It was also suggested that one of the members should be responsible for initiating a discussion, and that a new discussion should be initiated every Friday. A message was posted subsequent to this, but it took nine days before anyone replied. After this only a couple of submissions were entered and this was the only activity in the group for three months. This was partly due to the technical problems they had with the first version.

As using IFS Online was strongly encouraged by the network's administration, and as the group had the responsibility for testing out the system, using IFS Online can be considered as the object of the group's work. In addition, the use of the system was imperative - it was seen as the way they were supposed to interact, and this constituted a norm for their interaction. Overall, the introduction of IFS Online shifted the focus of the group's work. From being preoccupied with issues related to KS/HMS work, they were now oriented towards the use of this particular tool and the challenges they were facing in the wake of its introduction.

Asymmetric participation structures and different knowledge interests

This orientation towards the tool's use stood in sharp contrast to the way they had been working the previous years. During the ED 2000 project they had met regularly and in the meetings they had specific issues to discuss. Different members presented some challenges they were facing in their workplace related to quality assurance work. These issues were taken up for discussion in the meetings. In addition, they reported on changes implemented in their respective organisations.

The collaboration in the KS/HMS group was originally organised around four seminars a year, where the members met face-to-face and presented topics of interest and had discussion concerning problems and developments in their respective companies. The diverging interest in the particular topics did not seem to be of major importance. The work with implementing ISO-standards in the large and the small companies faced quite different demands and were not necessarily similar except at a surface level. The participation in the group and the face-to-face meetings, to some extent, reflected this early on. Participants from the larger companies had most

contributions and long discussions and more or less set the agenda for these seminars in the subject group. This asymmetry in the participation structure was not of major concern and the members from the smaller companies still reported that they benefited from listening to these discussions and being present in the meetings without taking a particularly active role. Digging deeper into how the different members benefited from the participation revealed that the picture was not as clear as it initially was reported as it is illustrated in the below extract.

> **Extract** 17:
> Maybe it is their understanding of my problem – they live in their world and I live in mine, and my experiences after having been in contact with them is that I do not gain very much from it [...] We operate in different industries and it is not always easy to learn from the experiences others have made.

This extract illustrates how the participants sometimes found others' contributions and discussions in the network having low relevance to their own work situation and that others experiences were not easily transferable to their own practices.

> **Extract** 18:
> There are companies at different levels, and if we [the group members representing his company] talk much about process-organisation and that kind of questions, then I am not sure the other companies really know what we are talking about. If they are not preoccupied with these questions I do not think they are willing to take part. And it is obvious that these smaller companies have plenty of work carrying out their daily tasks.

In the above extract the informant points to an important aspect of the difference in their knowledge interests. The member companies are organised in different ways[67]. Members from the larger companies often did not see the value in taking part in the group's work only for the reason of helping the other members. In the larger companies they were mostly concerned with total quality management systems, often based on a process-oriented view on production. The smaller companies, on the other hand were commonly occupied with solving smaller more concrete problems related

[67] E.g., depending on what they are producing - some of the companies mainly engage in large projects, such as building an oil platform yard, and others in mass production of a single product. The latter is what the informant refers to by the term 'process-organisation'

to their production based on procedures that prescribed in detail how to carry out specific parts of production. As it is suggested in the extract above, these differences also translate into differences in the participation in the subject group's work. Interestingly, these differences had not been emphasised in the early phases (before introducing IFS Online).

Another issue that is touched upon in the extract above is the relation between the participants' daily work and the network activities. The network was supposed to provide an arrangement for participants in the member organisations in which different competencies could meet and to provide a supplement to the internal learning processes in the companies. IFS Online was also supposed to help integrate these processes into the workday of each of the members. This was addressed in one of their reports dealing specifically with the role IFS Online should have:

> **Extract** 19:
> Development and implementation of an information network (mainly Internet based through IFS Online) will provide the tool for the member companies to use. At the same time it is important that the content of the information network is directly related to topics that are of interest to the member companies, and that it as much as possible is integrated as a part of the daily work (IFS-report, 1/1999).

It was difficult, however, to maintain a balance between the daily work in a company and the activities in the network. Some viewed activities in the network and activities in the member organisations in conflict with one another. The manager of the project gave this reply when asked about how he looked at the difference between working for the network (managing the project) and working for the company where he was employed.

> **Extract** 20:
> There is a substantial difference [between working for IFS and for the particular member organisation], because in [our company] you can order people to do certain things … if we are upgrading something within IT, then we do it. Nobody can deny us that. In the network [IFS], however, you are dependent on some sort of voluntariness. I can't force anyone to do anything in the network.

In this answer it is suggested that there exists a "clash of loyalties" between the activities related to IFS and the work the employees have to do for their own member organisation. This might be seen as an inherent contradiction or tension in the organisation of the activities. The work in the network is some sort of secondary and voluntary activity for the employees in the member organisations, and competes for the same time as the work they are doing on a more regular basis. Another member of the KS/HMS group, spoke in even more explicit terms when he gave an account of the relationship between the activities in the network and the work in his "own" company:

> **Extract** 21:
> You have to prioritise between different things, and it might be that you give a lower priority to this [the work in the KS/HMS group]. It is just the way it is - the most important task you do is where you get your salary! You have to do the job there first. In addition comes this network.

This illustrates how members accounted for the relationship between the daily work and the work in the network. This was, reportedly, mainly due to the rather heavy workload that characterised the work they had to do for their own company. Collaboration in the network was regarded important to increase skills in the area of KS/HMS. For the most part, however, the members said they did not have enough time to take part in these activities as they prioritised their daily work.

Participation and non-participation in online discussions

Online discussions constituted a different mode of participation in the group's activities. First, the need to articulate issues in terms of posting a message on IFS online, presents challenges for the participants in that their contributions need to be written out in statements that are persistent and visible to the other members. Computer-mediated discussions can be seen as a specific form of interaction subject to certain informal rules and norms, or "netiquette" (e.g., Jones, 1999). In one of the discussions one of the participants posted a contribution containing only upper-case letters. Another member replied that using upper-case letters on the Internet means

that you are shouting. This illustrates how participating in the online discussions presented the members in the group with at new set of challenges.

IFS Online allowed the users to follow the interaction in the discussion forum without actively engaging in the discussions. This phenomenon is often referred to as lurking (e.g., Hine, 2000). One of the participants that did not post any messages in the discussion forum, said that he occasionally browsed the forum to keep himself updated on the ongoing discussions. Some of the members also reported that the reason they had not posted questions in the discussion forum was because they did not want to ask "foolish" questions.[68] One of the members said that because the discussion forum was open and everyone could read his submissions he did not want to post questions[69]. For these members, 'lurking' was a way to participate in the activities, without having to express their views or risk asking the 'wrong' questions.

Still, reading or browsing the discussions in the forum was not visible to the other members in the group. In the face-to-face meetings some of the members were quite passive as well, attending these meetings without contributing to the discussions, mostly listening to what was being said and, in this way, keeping up to date on the various topics. As attending the face-to-face meetings was emphasised, the passive role taken by some of the members was not considered a problematic issue. In a discussion forum, however, the lack of postings can easily be interpreted as not participating.

Discussion

In this case, the arrangements made to support the practices of the network and the communication between the members in the subject group can be considered an established infrastructure for learning. It consisted of the communications infrastructure including the tools in use such as telephones, email, fax, and the communication network. Even buildings and other materials such as notebooks and projectors are part of the infrastructure that underlies and transparently supports the

[68] Star & Ruhleder (1996) made a similar observation (see pp. 123-124). In his study of the Answer Garden, Ackerman (1994) reported that the possibility to ask questions anonymously was seen as a way to lower the threshold for posting contributions.
[69] Only members of the network have access to read the content of the messages.

practice of the subject group's work. The infrastructure also includes the personnel that work with keeping these arrangements "up and running".

Trying to introduce the web-based tool, IFS Online, as part of this working infrastructure implied making changes at different levels. Both at the technical level (such as implementing the required software on the server) and at a human resource level (such as having a staff to run the necessary services) changes were made to facilitate the incorporation of this new mediating tool. Still, as it has been illustrated in this analysis, the introduction of this computerised tool into the established practice, had unforeseen consequences for the way the group members perceived their work. There was a clear shift of focus from subject matter (KS/HMS work) to the specificities of the introduced technological tool. In other words, the set of resources that were introduced remained *focal* resources rather than *supporting* resources in the group's work. In projects that try to implement and integrate a new set of tools or technologies into an existing practice, such a focus can be expected. Having such a phase in projects, where the technological tools are in focus can be seen as a common phase in any adaptation process. It is a process of naturalization of artefacts (see Bowker & Star, 1999, pp. 298 - 300).

The introduction of the new tool seemed to reinforce existing differences in the participation structure. Although the members already had to cope with participating in the network activities along with doing their regular job, they usually found the time to participate in the face-to-face meetings. Introducing the discussion forum was intended as a way to have the members participate in the activities of the network on a more regular basis. This, however, also involved spending more time on these 'secondary' activities, and thus got a lower priority. In addition, differences in their knowledge interests and difficulties in seeing how the discussions translated into topics relevant for the practice in their own companies, it seems, contributed to this reinforcement.

It seemed more salient to have a sound framework for participation and a clear agenda for their interaction (as they had in the face-to-face meetings) than having the flexibility to ask questions "anytime and anywhere". The view of ubiquitous computing to support learning practices has been a central idea in much research -

recently in relation to the use of mobile technology (e.g., Gay, Rieger & Bennington, 2001). This is also an idea that has been central in concepts such as "just-in-time learning" and life-long learning (e.g., Harasim, Hiltz, Teles & Turoff, 1995; Beller & Or, 1998; Wessner, Haake & Tietze, 2002). In relation to just-in-time learning, the flexibility of having (computer-mediated) access to learning resources when and where you need it has been a key idea. As it is apparent in this case, however, this kind of flexibility might as well represent extra workload for participants. It means finding the time to get involved in what might be seen as 'secondary' activities that compete for the same time as you have available for 'getting the work done'. The same goes for Life-long learning, where the idea of integrating learning activities into the every-day work of the employees has been a central aspect of how to offer workers opportunities to enhance their competence.

Another question addressed in the above analysis, is one of how the issues discussed in the subject group are relevant for the local work practices in which the knowledge is supposed to be used. The participants' accounts of this matter indicated that it might be a tension or contradiction embedded in these relations. It was difficult for them to have the discussions and topics discussed in the subject group come to bear upon their own work, partly due to the differences in organisation of their work, the characteristics of the knowledge, and the local divisions of labour in the respective companies. This is a commonly discussed issue in educational research. Debates about how knowledge appropriated in formal schooling transfer into settings of work have been central in much research (e.g., Tuomi- Gröhn & Engeström, 2003; Rystedt, 2002). Rather than seeing this as "transfer" the issue is in sociocultural theories formulated as 'boundary crossing' or 'bridging practices'. Similarly, Kanfer et al. (2000) note that there might be a fundamental conflict in that "authentic and efficient knowledge creation and sharing is deeply embedded in an interpersonal face to face context, but that technologies to support distributed knowledge processes rely on the assumption that knowledge can be made mobile outside these specific contexts" (p. 317). The question of sharing knowledge is also a basic issue concerning how this same knowledge can be made mobile, and somehow uprooted from the context in which it is created. While the empirical material presented in this case, indicate such a conflict, the inter-organisational network studied in this case, still might be a kind of arrangement that facilitates the sharing and reproduction of knowledge. The question

of how to make this knowledge mobile, or how to make the knowledge produced in this setting relevant in other settings, still remains. This is a question of the heterogeneity of the information and how it can be applied in another context. As Bowker and Star (1999) note:

> At its most abstract, the design and use of information systems involves linking experience gained in one time and place with that gained in another, via representations of some sort. Even seemingly simple replication and transmission of information from one place to another involves encoding and decoding as time and place shift. Thus the context of information shifts in spite of its continuities; and this shift in context imparts heterogeneity to the information itself (p. 290).

The adoption of IFS online involved an alignment of the tool to the existing communication and computing infrastructure, the installed base. Technologically this consisted of making it compatible with existing technological structures such as installed browsers and PC's. This task required negotiations with various actors (the vendors, a neighbouring network, the members, the network administration). The process of aligning the technology with the existing infrastructure is as much a process of negotiation of responsibilities, resources and tasks as it is a question of technological feasibility.

Moreover, the tool had to be incorporated into the practice of the KS/HMS group. As the analysis above indicates, the lack of technological alignment of the first version of IFS online was, by the members, seen as the major obstacle for using the system. As they experienced problems with the system at a usability level, this was seen as the major hindrance of use. When this obstacle was finally overcome, and the system worked as they expected, and despite their eagerness and motivation to use it, the web-based tool never became a part of a working infrastructure for learning.

In research on Human Computer Interaction, the development of new software is studied at a specific level of detail. The system's usability features are central together with the design of the specific user interface. These studies focus on key aspects of a system's design. Nevertheless, these aspects only form a basis for the use of such a system. As we can see in this case, the technological difficulties are also related to

deeper infrastructural issues of compatibility and interoperability with the local technical solutions (such as what versions of web-browsers were installed at the various workplaces).

In the first phase (after the implementation of the first version of IFS Online), the users experienced how the system did not function satisfactorily at a usability level. This had certain consequences for how the participants conceived of not only the introduction of this web-based tool, but of the activity as a whole.

Another argument often presented, is that this might be a question of having "the best equipment". We could for example address issues related to the lack of "awareness functionality" (see Gutwin & Greenberg, 2002) implemented as part of this particular groupware system, and propose that implementing such features could make the use of the system "better", and give the necessary support for their collaboration. This could for example have been done by implementing a feature making it possible for users to see who is using the system at a given time. It could in this way be addressed as a question of technological sophistication, which is not an unusual line of argument. "Many analysts assume that the "technologically best equipment" will result in the most significant improvements, even though professionals may differ over which features of work and organizations should be viewed as worst and best" (Kling, 1992, p. 365). Still, as it can be suggested based on the above analysis, the question is not necessarily one of having "the state-of-the-art" technology; a technology that doesn't work is not necessarily used significantly less than one that works perfectly well. It is a question that moves beyond the technical.

Building on Granovetter's (1973) conception of weak and strong ties in organisational relations, Pickering and King (1995) explore a number of issues with regard to how computing infrastructure may support inter-organisational computer-mediated communication. This is seen as key mechanism for promoting the existence of these weak social ties among different organisational communities. It is argued that these weak ties are important when it comes to, for example, access to information resources. As the title of the article indicates, this is seen as a process of "hardwiring weak ties". This is in some respects analogous to the case discussed in this chapter. The very existence of the network is built around the notion that it is important to

have access to other people doing similar things, and that these 'weak ties' can be supported by implementing an Internet-based technology. The idea is ostensibly a fruitful one. The question however, seems to rest on other issues than just "hardwiring" these ties.

In the above analysis various accounts of what role the system plays and is supposed to play have been juxtaposed. The gulf between what the role the system is supposed to do, what the participants express that they *ought to* or *would have* done, is easily comparable to the 'actual use' or, in this case, the lack of use. This is not necessarily a question of the participants having unrealistic conceptions of their own capabilities or efforts, but rather a question of what it would require to integrate this tool into the established practices, and how the tool can contribute to changing the way the activities are perceived. Star & Ruhleder (1996) encountered a similar phenomenon in their study of a distributed community trying to incorporate a tool for distance collaboration into their activities. They tried to track users of the system, but it appeared that "no one was really using the system, though they all "meant to", and figured that it would be available "any day now" (p. 122). Thus they describe what they see as 'near compatibility' and 'any day now' users. This can also be seen as a methodological issue. "This is not difficult to observe ethnographically, but presents a real difficulty in administering surveys about use and needs" (ibid.).

This issue also hinges on debates on how computerization transforms parts of the social order, as it was discussed in the introduction of this chapter. Rather than saying that it has certain effects one way or the other, this case illustrates how computerization can contribute to a change in the actors' focus, or how the focus of the activity is construed. This is in line with how Kling (1992) says that computerization may make workers expect themselves to work differently. It can in this way be seen as contributing in changing their expectations of what the activities in the network were supposed to be.

A question waiting to be answered in this case is "why didn't the technology work?" In this respect the case is in "good company", as several researchers have struggled with questions of such 'non-use' of technological systems or technological systems that "fail" (e.g., Grudin, 1988; Engeström & Escalante, 1996; Latour, 1996a; Star &

Ruhleder, 1996). This question, however, is a question that, in this case, cannot be answered without resorting to overly speculative explanations. There are probably several reasons why it did not work. What is interesting, however, is how the participants talk about this issue in the interviews. What is their reasoning around this problematic? In one way, the accounts they give in the interviews are concerned with how they fail to integrate this technology, and fail to create a lively forum for debate in the virtual environment.

In this chapter the second case study has been introduced and analysed. The analysis revolved around how the actors in this inter-organisational network struggled to incorporate a web-based tool into their practice. The analysis was conducted mainly on the basis of the participants' accounts of how they perceived this effort and the challenges they faced in this process. The issues that have been raised were structured around a discussion of how the new tool was introduced into the existing infrastructure for learning and how this failed to become part of this infrastructure and an important tool to support the collaboration and a forum for the exchange of knowledge between the members.

CHAPTER 8 – CASE 3: ORGANISATIONAL RATIONALITIES AND INFRASTRUCTURES FOR LEARNING

The introduction of e-learning technology is an increasingly popular measure to support and facilitate learning, training or competence development efforts in work organisations. The rhetoric accompanying such initiatives, however, can be quite misleading. Business companies want to be innovative, competitive and adaptive to the demands they are facing in markets and in the new 'knowledge economy'. This imagery is often central in much management literature. Employees are conceived of as 'knowledge workers' – empowered, knowledgeable, flexible and adaptive. The workers need to find ways of keeping up with the shifting demands on their knowledge, to swiftly and effortlessly acquire new 'knowledge'. In all of this, information and communication technology is seen as playing an important role. ICT can provide easy access to relevant information, support communication and co-ordinate work.

Notwithstanding this general rhetoric, whether networked learning environments take on such a role in work organisations is an issue that can be placed under empirical investigation. In this chapter I thus ask what considerations and concerns are key to the introduction and use of a networked learning environment in a work organisation. How is it conceived of in the organisation, and what are the 'rationalities' of the introduction and use of the system?

Through the development of any infrastructure ethical, political, organisational and social choices are folded into the technological structure. These choices may have become invisible for its various groups of users, as the infrastructure assumes its transparency (Star & Ruhleder, 1996). Decisions and behaviour are inscribed in the infrastructure (Hanseth & Monteiro, 1997). Identifying these elements of an infrastructure requires looking into the "technologies and arrangements which, by design or habit, tend to fade into the woodwork (sometimes literally!)" (Star & Bowker, 2002, p. 153). This is also the case when investigating infrastructures for learning.

The introduction of an infrastructural tool such as a learning management system incorporates overt or covert assumptions about pedagogical issues. What the consequences of such choices are, however, is dependent on the complex relations between subject matter, mediating technologies and the organisation of training activities.

In the following, I focus on the introduction of a specific infrastructure for learning, and identify how this infrastructure embeds and is subject to different organisational rationalities. The concept (organisational) rationalities is used to denote considerations and concerns related to and inscribed in the particular infrastructure for learning. Three different kinds of rationalities have been identified and will be discussed in the analysis: a pedagogical rationality; a logistic rationality; and a rationality of managerial control.

In the case presented, the infrastructure for learning appears as a combination of tools and organisational arrangements. Central in these arrangements is the introduction of a Learning Management System (LMS) and a set of online tutorials to deliver training in specific issues related to the new technology and the new workplace. To look into the complex relations between the content of the training, the technologies that mediate the training activities and the way these activities are organised, an ethnographic study of ICT-mediated training in Telenor, a large Norwegian telecommunications company, has been conducted.

Several challenges come with the introduction of new technology. One such challenge is how to offer sufficient and suitable end-user training and technical support services. Another is to find out how to integrate the technologies into routines, work practices and existing organisational arrangements. In this case the object for the training is how to use a new workplace and a set of new technological tools. Additional challenges arose when they needed to offer training to such a diverse audience with different work tasks, work practices, and different needs for training in specific issues and in the use of the various infrastructural tools.

From November 2001 to August 2002 around 6000 employees of Telenor (the largest telecommunication company in Norway) moved from 35-40 different offices within the Oslo region to their new headquarters at Fornebu just outside Oslo. The relocation is part of the enterprise's vision of creating the most advanced work environment in the Nordic region. Parts of this vision are reflected in the design of the new office spaces. Traditional cell offices are replaced by an open floor plan with around thirty people sharing a section of the building. Within each section there is an open solution emphasising mobility - no one has their own desk (see Figure 5). The building also includes numerous informal meeting places such as cafés and art exhibitions, and various types of more formal meeting rooms.

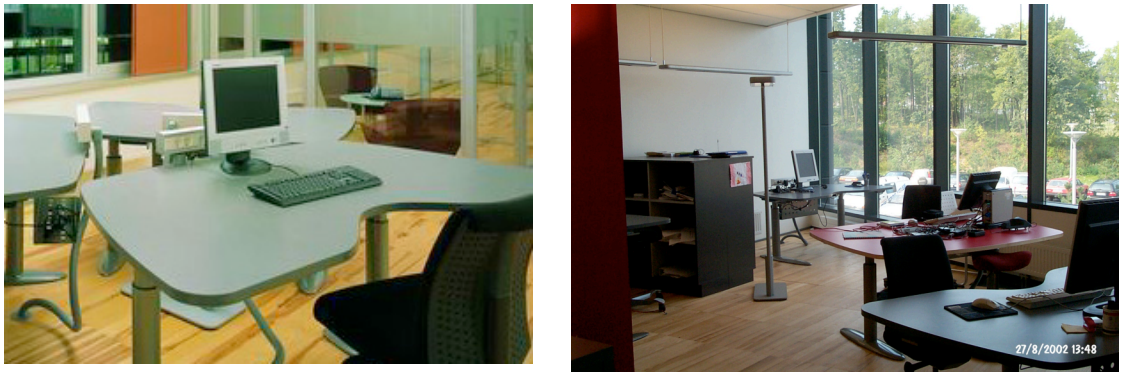

Figure 5 – Pictures from the new workplace

Notwithstanding the general grandeur of the architectural layout[70], the designer furniture, and the art works on display in the building, there are economical motives for moving the entire company to one location and offer the same, standardised solutions to everyone. This standardisation comes with the prospect of cost-reductions and scale advantages (for example bulk buying of technology and other office supplies).

Central to the company's vision is the use of advanced information and communication technology (ICT). The new workplace incorporates a new common corporate infrastructure, including servers, computer networks, plugs, databases,

[70] For an exploration of how the corporate architecture can be a symbolic resource see (Berg & Kreiner, 1990)

electronic document archives, multifunction machines (fax, printer and scanner in one) and so forth. It also encompasses a site-wide WLAN and an emphasis on portable and mobile devices such as laptops, Personal Data Assistants (PDAs), mobile phones, and a common integrated messaging system.

Another important part of this vision of creating the leading innovative workplace in the Nordic region is related to new ways of working. The workplace design, the new ICT solutions, and the organisational changes are supposed to support close collaboration between employees, informal meetings across organisational units, knowledge flow and knowledge sharing in the company. The architectural layout of the office floors (open solutions and 'hot desking') are carefully designed according to such principles (see Becker & Steele, 1995; Duffy, Crisp, & Laing, 1993; Duffy & Powell, 1997; Hatch, 1990). The new work forms are in general referred to as 'flexible work'.

E-learning[71] at the new workplace

Such a large scale organisational change, affecting so many people, introduces challenges in relation to how to give the employees appropriate and sufficient training in the use of the new workplace and the accompanying ICT-equipment. To meet these challenges, the company decided to develop a set of e-learning programs (modules), delivered through a learning management system (Saba LMS™, an off-the-shelf software). The work with the e-learning project was originally organised as two separate projects, both 'owned' by the company's top management. One project dealt with the LMS implementation, the other with the implementation of content material. Since the communication between the projects and the various business areas and departments within the company was of great importance, a role of Training Administrator (TA) was established as a connecting link. The TAs, recruited primarily from the Human Resource staff in the particular business area, were given a broad responsibility: the coordination of learning activities and support within their own units, and in particular to keep their managers informed about relevant

[71] The concept 'e-learning' is used to refer to the particular technological systems and training initiatives in the organisation. E-learning is the concept used to describe these arrangements within the organisation and by the actors themselves.

completion rates (completion of e-learning modules). The main responsibility for the e-learning activities, however, was given to the manager of the business areas in combination with the project group (see also Netteland, 2003). In addition, each unit established a role of Floor Manager, targeted towards the daily support of end users. From January 2002 the two projects merged, with one common project leader and a common project staff.

The particular LMS was implemented as an enterprise wide platform (see Figure 6). The general idea was to make all types of training and competence development efforts, such as e-learning modules, online tutorials, courses, seminars, and traditional lectures, available for all employees through a web interface. The LMS also offers tools for administration, control and support of the training process. User and completion rate data for the different learning modules can be accessed through predefined reports on individual, group or course level, either by the Training Administrators or a manager. Tailor made reports can be generated by the technical staff on request, for instance statistical information on courses begun versus courses completed.

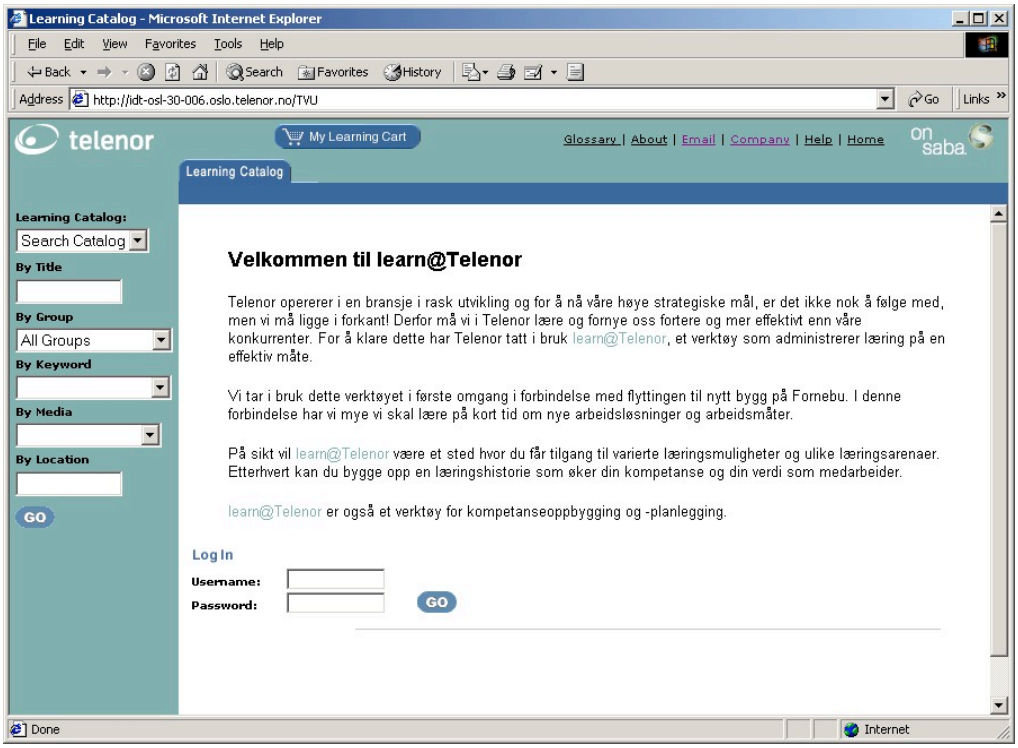

Figure 6 – A screenshot from the welcome page of the LMS

The SABA LMS server communicates (through the JDBC API[72]) with an Oracle™ database that contains all the system data that the LMS is using. This includes data about the users (migrated from the human resource application, SAP™) and logs generated from the use of the content material. The content material is stored in a separate database and the communication between the content server and the LMS happens according to the API-standard, AICC[73].

The LMS interface is organised according to a marketplace metaphor. In 'the learning catalogue', where all the available courses are listed, the user can 'shop' courses and training exercises. This is symbolised with a shopping basket (see Figure 7). For each course there is also a column indicating the price of the course. This is in line with the company policy of making all costs visible to the employees. The initial online training courses delivered in relation to moving to the new workplace, however, was free. When a course is ordered in the learning catalogue, it is moved over to the 'in progress' view (see Figure 8), and once a course is completed and approved it is moved into the 'Learning history' view.

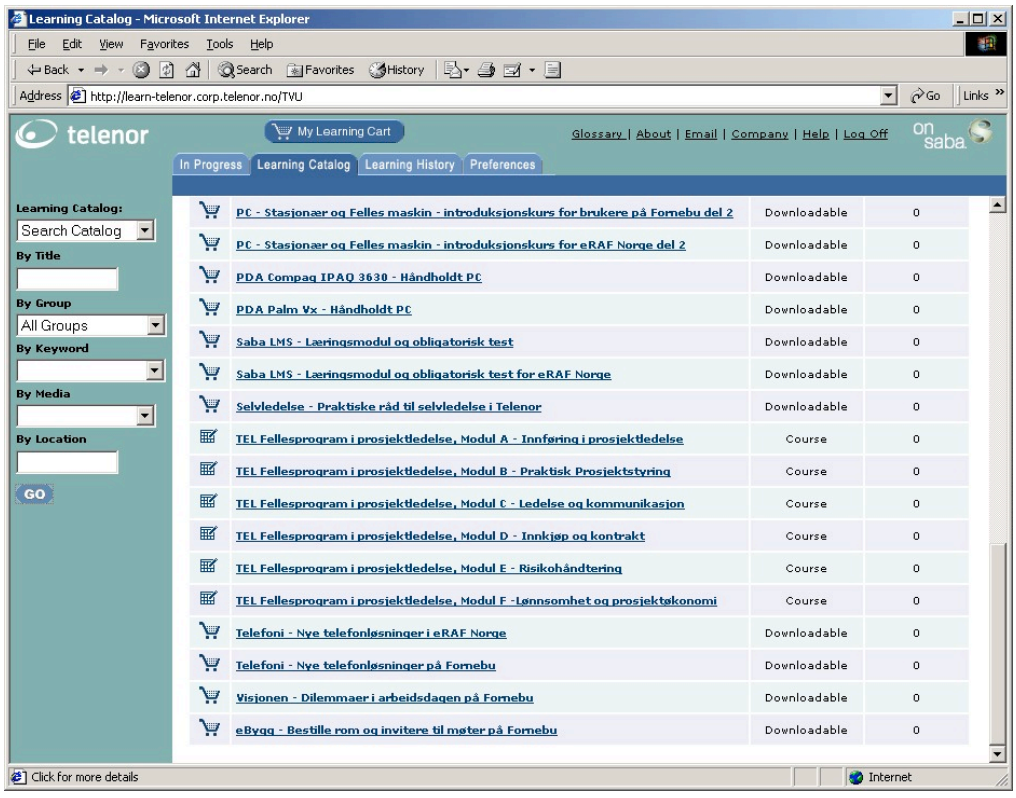

Figure 7 – Screenshots from the "Learning cataloge" view

[72] JDBC API stands for Java Database Connectivity Application Program Interface, and is a standard SQL database access interface.
[73] Aviation Industry CBT (Computer-Based Training) Committee, see http://www.aicc.org/

As part of the relocation process a set of e-learning modules were developed to meet the training needs of the employees. More than seventeen modules were available and more were being added, including five ready-made tutorials for standard Microsoft™ tools such as MS Outlook™ and MS Office™.

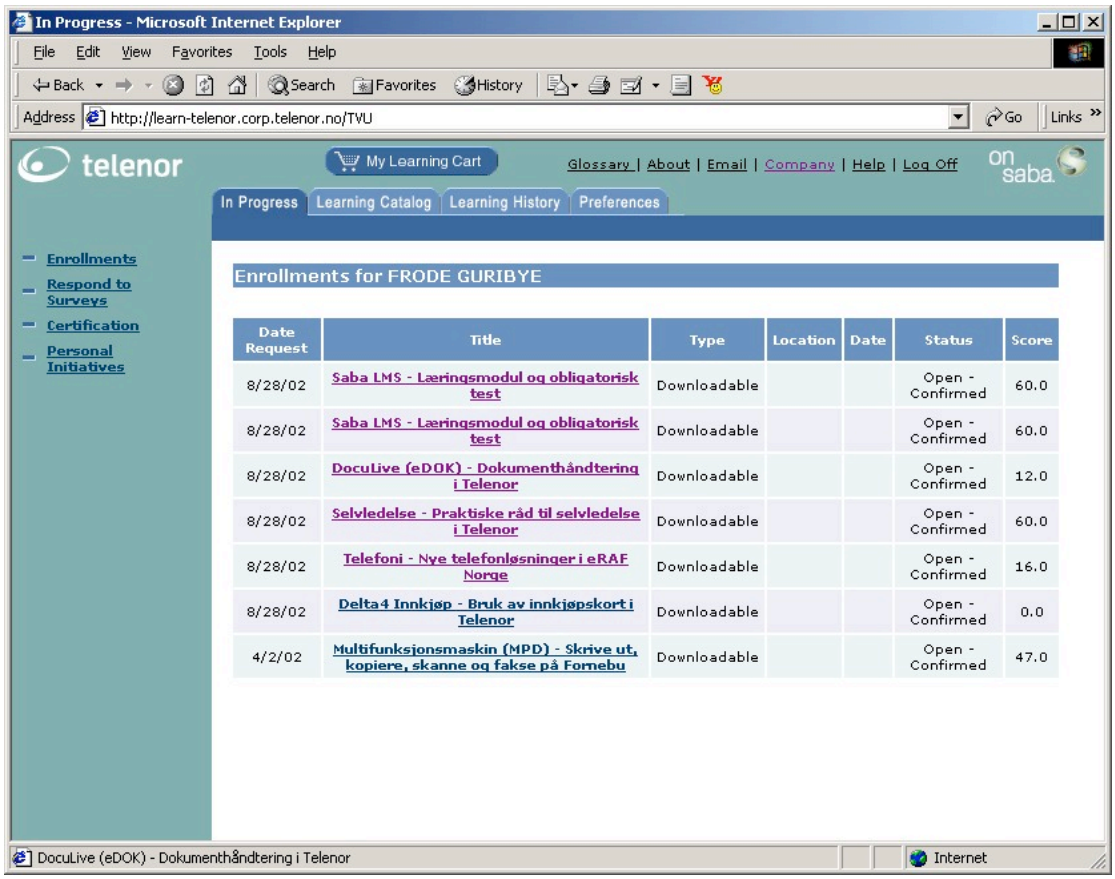

Figure 8 – Screenshot from "In progress" view

Each of the e-learning modules developed particularly to deliver training in the specific infrastructural arrangements at the new workplace can be described as individual, tutorial-like multimedia applications with a menu-based interactivity. The modules can be grouped according to their content in three different categories; the new workplace; the ICT-solutions; and, new ways of working.

The set of actions for completing the modules typically consisted of the following: The user-at-the-terminal accessing an e-learning module through the LMS, then being led through the module step by step as it is prescribed in the program. For each individual user this largely consists of listening to the recorded voice and looking at

the text and the flash animations, but requires the user to click ‘continue’ or ‘next’ after each sequence; in some cases they may need to make choices and answer questions, or perform tasks of varying difficulty before proceeding in the module. The modules are all indexed and the user can, for example, access a particular sequence of the module directly or return to this sequence at a later time (see Figure 9).

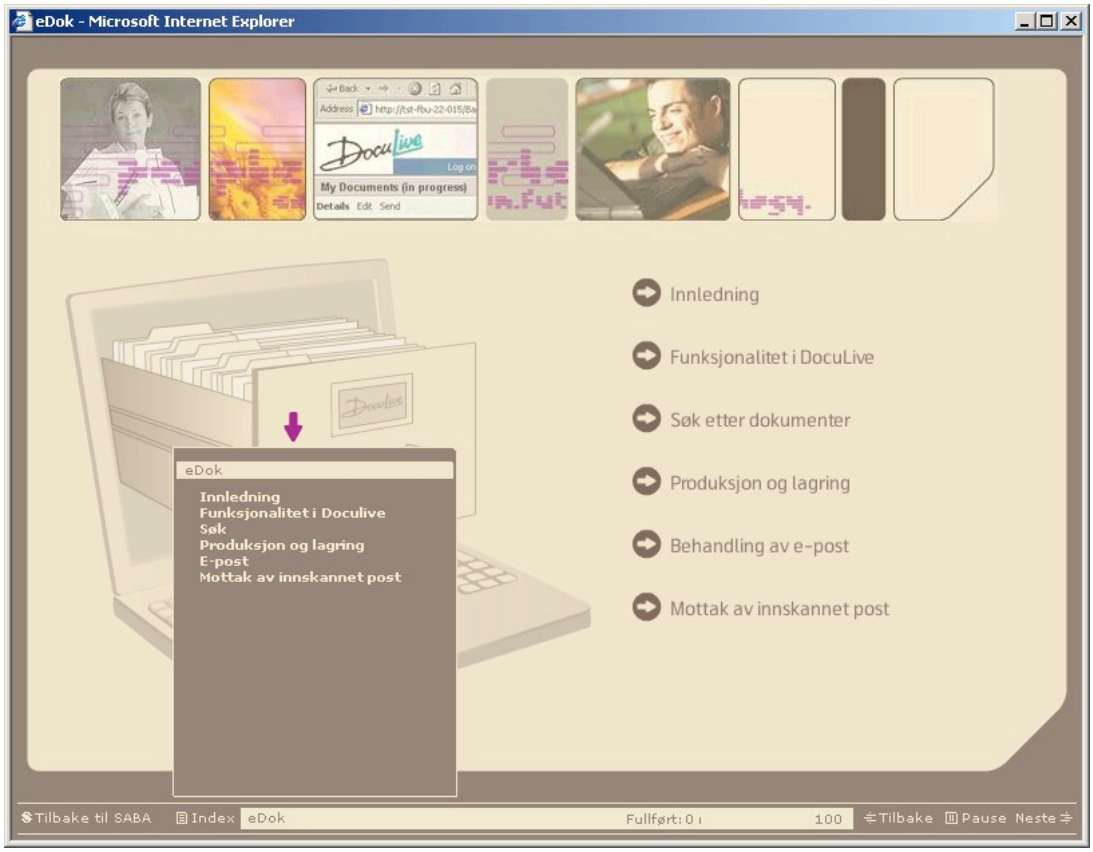

Figure 9 – The index-menu

Expected completion time for each module varied from 20 to 45 minutes. In sum this meant that each employee were required at least four hours compulsory training before relocation and three to seven hours after relocation. Between 80 and 100 percent of each program (module) had to be finished in order to be regarded as completed. The users are free to pause the program, log off and log in later without loosing credits. Some of the modules were compulsory, some optional. The different business areas, or in some cases also the underlying units within those business areas, decided whether a module should be compulsory or optional. That was also the situation regarding whether each module should be completed before or after relocation to Fornebu (see also Netteland, 2003).

Empirical material

The empirical studies were conducted over a period from November 2001 to September 2002, and consisted of video recordings, interviews, informal conversations, observations and participation in the online training activities.

The initial access to the field was given as participants in a project within the company to evaluate the use of e-learning during the first phase of the relocation to the new workplace in November 2001[74].

Later I got the opportunity to conduct further long-term fieldwork at the workplace (February-April and August-September 2002). During these later periods I had access not only to the Intranet, the Learning Management System, and the set of e-learning programmes, but also to key actors in the e-learning project at different levels. Interviews[75] with members of the project organisation, the project owner, and key actors at all levels in the different organisational units were made. Furthermore, internal meetings with participants both from line organisation and project organisation were attended. The topic of these meetings was user feedback and completion rates. The overall focus of the inquiries was how the training activities were organised at the new workplace and what role the e-learning systems played in these activities. An important part of the fieldwork consisted of learning to use the infrastructural arrangements and the new workplace and participation in online training activities.

Different discourses about the e-learning in the organisation were traced - interviewing users, administrators, and other central actors in connection with the e-learning projects. In addition, documents and publications from the Intranet and other sources were gathered and studied systematically. Even the content of the e-learning modules are seen as important objects in this analysis.

[74] During this first week the data gathering was done in collaboration with actors from the company and researchers from InterMedia at the University of Oslo.
[75] The data collection was done in collaboration with Grete Netteland. In total, over 35 interviews were made with various informants. In a few instances follow up interviews were made with some informants.

In the next section, focus is set on how the new infrastructure (i.e., the new workplace and the new set of infrastructural tools) is the topic of the employees' training activities. These arrangements are in this way both topic and medium for the training activities. Thus, an analytical distinction is made between the infrastructure in general (as the topic of their training) and the infrastructure for learning (primarily as the technical and organisational arrangements assigned to support and mediate the training activities).

The analysis starts with a general description of what strategies were applied when learning about the new infrastructural arrangements and the new workplace. Then, attention is turned to how the learning management system generates logs, and how the log data are used in the organisation of the training activities.

Learning About Infrastructure

As Star & Ruhleder (1996) point out, infrastructure is learned through participation in social activities. "The taken-for-grantedness of artifacts and organizational arrangements are the *sine qua non* of membership in a community of practice" (p. 113). An important part of becoming a member is thus to learn and cope with the infrastructural arrangements of the setting in which they are legitimate peripheral participants (Lave & Wenger, 1991). Encounters with infrastructure and the gradual naturalisation of these encounters and the use of technology are thus topic for any newcomer and outsider.

But how are we to understand this when a whole organisation with all its employees is moving into a novel workplace with a new set of technological tools? Is this an abrupt shift of infrastructure? The arrangements on which the communities have relied are, through a decision by the top management, replaced. In one sense, everybody is a newcomer in relation to the new infrastructure and the new workplace. The taken-for-granted becomes topic for all. And this is related not only to where you should work, what technology to use etc., but also considers such mundane aspects as how to get to work, where to park your car, where to get of the bus and so forth. The infrastructure has not yet assumed its usual transparency. It is, as in end-user training, the topic with which to become familiar.

Infrastructure is "changed in modular increments, not all at once or globally" (Star, 1999, p. 382). This was evident in this case as well. Even though the actual wires, plugs and hardware were replaced, data structures, files, folders, documents, and other parts of the information infrastructure were migrated from other systems. The conventions of practice with which these structures link, are also in a way carried over into the new workplace. These aspects, thus, contribute to reducing the unfamiliarity and strangeness of the new infrastructure.

This was apparent when asking some of the informants how they stored and exchanged documents at the new workplace. As part of the ICT tools a common archive system was introduced to facilitate document exchange and knowledge management. All users were supposed to use this to store their electronic documents, which then would be available for others (of course, some documents are more sensitive than others and the documents were graded and access limited according to the degree of sensitivity of the content). The use of this system (although strongly encouraged by the top management) was in several instances, however, very limited. Previously, the users had developed strategies and procedures to exchange documents and this included sharing them via email, or making them available in a shared folder in one of the servers they were using. The use of the archive system interfered with existing conventions of practice, and the system had not yet occurred or "submerged" as an integrated part of the infrastructure.

Training and work practice

This issue, however, touches upon another relation in the ecology of knowledge, work and technology (Star, 1995), namely that between work practice and training activities (see Star & Ruhleder, 1996, pp. 130-131). The courses that are offered as part of the training are somehow taken out of context: removed from the work practices for which the content and the subject matter is relevant. Rather, the e-learning modules try to simulate the post-training environment (see Bjork, 1994). Interestingly, central actors in the e-learning project expressed a specific satisfaction with the way the modules were "contextualised"; scenarios from the new working environment were included and simulated in the e-learning modules. The modules taken after the

relocation were done in the actual work environment, but to go through these modules required an immersion in the virtual world of the multimedia applications (which usually included using ear phones). These circumstances are complex and many strategies were applied in order to learn to use the new technology and workplace. Consider this extract[76] from one of the interviews:

> **Extract** 22:
> Interviewer: so this eBygg [a particular module about the building, e.g. how to book meeting rooms], the one that is about … have you done that?
> Informant: yes I have done that
> Int: have you booked any meeting rooms?
> Inf: yes, I did book some meeting rooms before I did the course … (laughs).. I just had to start using it [the system for booking meeting rooms] so I don't think I learned that many new things there then, when I did it later on. And to use eBygg [the application for booking meeting rooms] is pretty self-explanatory. I have received some advice from others that was not mentioned in the module, about how to easier book, register hours and things like that, so that is something I maybe missed in that e-learning module.

In this extract we see that the informant had already used the booking system and learned this through trial and error and by asking others before taking the e-learning module. It also points out how specific skills and routines that might be relevant are not treated in the particular module, but to expect the modules to be exhaustive is perhaps optimistic. Many of the e-learning modules also revolve around specific skills related to a specific application. One informant characterised the competence acquired through the e-learning in the following way:

> **Extract** 23:
> ... but you don't apply for a job saying: 'I've completed the eBygg module', it's not enhancing your competence like that. It's only like survival skills, rather than competence development

The concept of 'survival skills' for using the new workplace and technology is perhaps suiting, but finding time to do several hours of online training can be hard in

[76] All extracts are translated from Norwegian.

an already pressed workday. The short-term aim of the training related to relocation was to do "business as usual" two days after they moved into the new workspace.

A diverse target audience and standardised training

In general, the e-learning modules were developed for a very large target audience and this audience comprised very heterogeneous groups and actors. Still, a decision was made quite early in the project that they would not differentiate between levels in organisation nor for individual differences in knowledge of the subject matter. They had to agree on a "least common multiple" concerning what the target audience should learn. This standardisation of the training material made the relevance of the training minimal for many. Concerning the question of whether to differentiate and tailor training material to the various groups and actors, which central members in the project recognised as the pedagogically most sound alternative, other concerns such as cost and that e-learning was considered an efficient way of 'delivering the learning' to the employees, were prioritised. The alternative was to have 'classroom courses' for all employees to offer the necessary training. This was seen as too costly and an 'inefficient' way of organising the training. They did, however, offer classroom training as an alternative to the e-learning, but this was, according to the project management, not used to any notable extent.

Even though the e-learning modules related to the relocation were standardised, having an e-learning solution like this was by the training administrators seen as being a flexible solution in the long run. Some of the organisational units were already after a few months developing customised modules to offer training in some of the tailored applications they were using to support their specific work tasks.

Infrastructural imagery

From the perspective of the top management, an important aspect of such a large-scale organisational change is to gain acceptance from the employees for the decisions – to establish a minimum of approval for the changes, and to motivate the employees to use the new workplace and the new infrastructural tools. The introduced technologies need to go through a process of legitimisation (Mantovani & Spagnolli,

2001). In this regard the e-learning also played a certain role. The content of the different e-learning modules are not neutral bearers of objective knowledge about how to use the certain technologies, the new workplace, or the new work forms, but normative artefacts (Mantovani, 1996) and these embed representations of how employees are expected to behave and work – an abstract and ideal 'model worker'. The e-learning modules convey what I have labelled an *infrastructural imagery*. This imagery is an idealised version of how the infrastructural tools and the new workplace can be used. In one way it presents a stylised image of what it means to work at the new workplace, in another it presents some of the possibilities that the infrastructure has to offer in the support of the daily work tasks and routines. It is also a way to give an overarching perspective to the daily activities and work practices.

The infrastructural imagery was, in this case, part of a well-oiled information campaign. The amount of information poured over the employees during the relocation period was enormous. The information was given out in different media including intranet postings, emails, leaflets and in the e-learning modules. The learning material is in this way a conduit to market, promote and sell the decisions to the target audience – the employees. Two different agendas can be extracted from this infrastructural imagery. An agenda, where the objective is to help the employees in learning use the new tools and the new workplace, and an agenda, where the objective is to affect the employees' conceptions of the decisions and changes. This relates to how the infrastructure for learning played a role in the overall organisational change. In the next paragraphs an example of how a system can serve a role in relation to the implementation of a new organisational procedure is offered.

E-learning and organisational procedures

In 2002 Telenor launched a new program labelled Delta4. The overall goal of this campaign was to cut costs with four billion NOK[77] within 2004. In addition to discharging several hundred employees, certain changes in routines and procedures had to be made. An example of this was when they were introducing a new procedure for purchase of goods and services. This procedure consisted of obtaining tenders from at least three different vendors when making purchases for more than a certain

[77] Approximately half a billion euros

amount. To implement the procedure, information had to be sent out to the relevant parties. This was done, inter alia, by posting a message on the Intranet and creating two new e-learning modules about how to act in compliance with the new procedure. In the first module, available through the LMS, each user was walked through the different parts of the new procedure. At the end of the module there was a multiple-choice test where you had to get at least 80% of the questions right to get the module registered as completed. One of the very last pages in the module also recounted the consequences of any failures to comply with the procedures (warning, removal of purchase rights or discharge). There was also another module concerning the use of a new 'purchase card' related to this new procedure. Completing and passing these e-learning modules implies that it will be registered in the user's name and this information is available for managers and others with the authorization to view the logs in the LMS. In one way these e-learning modules were supposed to function as 'certificates', and to be issued a purchase card, the module had to be passed.

This is an example of a way of disseminating information to the employees and at the same time having the opportunity to control who has received the information[78]. As each users' comprehension is assessed through a multiple-choice test, this is both a way of assuring that the information first of all has been given to the ones that are suppose to get it, and an assurance that nobody can claim they did not understand the information if they have completed the module. The information and new requirements related to this procedure by being an 'e-learning module', is framed as an issue of learning and training. It can be argued, however, that it is also an instrument for controlling the flow of information and a rhetorical device for ensuring adherence to the policy.

I now turn from this more broad description of the role of the infrastructure for learning to explore a more specific and background element of the infrastructure. Specifically, focus is set on the role of the logs generated by the learning management system and the use of these in different levels in the organisation.

[78] This was not (at the time the data collection was finished) followed up by the training administrators or managers. An interesting issue for further investigation would be to look at how this is played out in practice. It would be plausible to assume that the users would come up with 'counter strategies' and find different ways to avoid these kind of measures (such as e.g. share information about the different answers to the multiple choice tests).

Logs of Learning

A much discussed feature of information systems is that they encode and represent elements of the activities to which it relates:

> Information systems encode the work processes, directly or indirectly (payroll systems, time sheets, activity reports, and flow charts are among the infrastructural tools that perform this function in the workplace). Such tools, like language itself, are always incomplete to the complexity and the indexicality of the processes represented (Star, 2002, pp. 119-120; see also Suchman, 1995).

Similarly, we can say that an infrastructure for learning embeds representations of the learning process and is never able to capture the complexity of what it represents. Nevertheless, these representations serve an important role in relation to the training initiative in this case.

In the following focus is set on how training activities are represented and presented through the LMS. The LMS contains traces and logs of activities, a record of who has done what kind of training activity. This could be seen as a representation of the knowledge or skills the actors are supposed to have acquired through the process of e-learning. Scrutinised at more detailed level, it is apparent that these are representations and traces of something else: a set of human-computer interactions – a set of actions preformed in a system. A log of these actions is generated and specific traces of the activity are represented as an overview of what an actor has been through and thus, implicitly, of what he or she has learned. The learning management system logs each user's activity, and subsequently a translation occurs. The log, which originally is a silent witness to certain manipulations and sequences of human-computer interactions, is turned into a measure of what a number of people have done – a way of representing their training activities.

Logs and representations as tools

These representations mediate the activities at different levels. They are also used for different purposes. First, there are representations of progress in each and every e-learning program (see Figure 10). An important aspect of these representations is how

quantitative information is displayed visually[79]. In this way the representation accentuates the quantitative dimension of what has been completed and the activities are translated into numbers and visual indicators of the quantity of progress.

Figure 10 – The progress bar in the e-learning programs

Second, there is a log of the overall progress and the completed modules. This is showed in the Learning History view in the LMS (see Figure 11), where you have a full overview of the online training activities of the specific user.

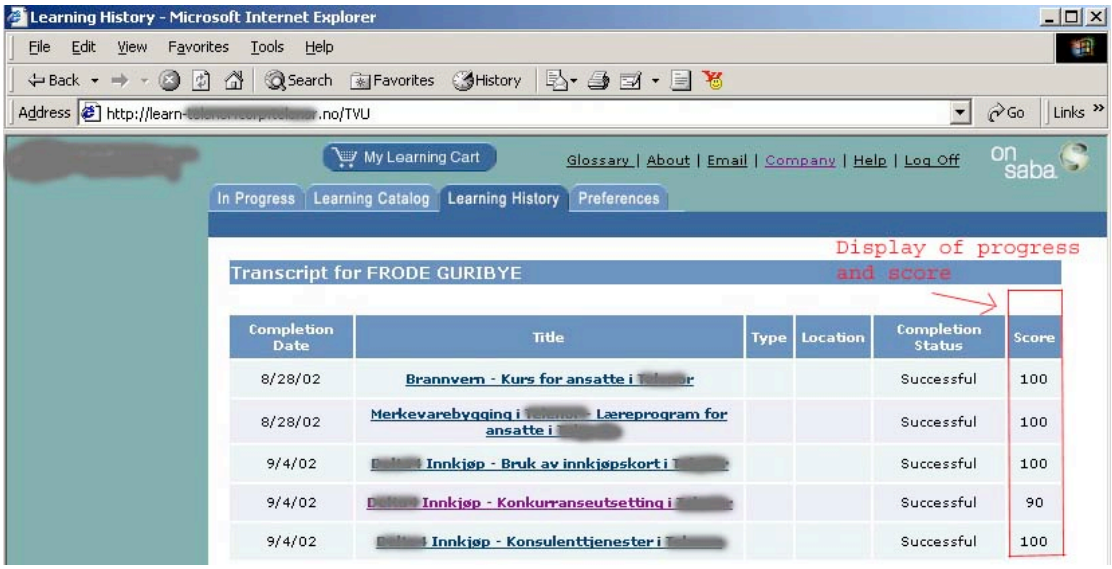

Figure 11 – The Learning history view illustrating how your score and progress is visualised (marked in red).

Third, at yet another level, the logs of the progress are used for a different purpose. The training administrators and the responsible manager have access to the aggregated figures of progress, and these can be (and were) used to measure how much training has been completed within a given business area in the company. These

[79] see (Tufte, 1983) for an exploration of how quantitative data can be displayed visually as a rhetorical device.

figures were then used to assess whether additional motivational initiatives needed to be effectuated. The training administrators expressed reluctance to impose sanctions on those who did not complete the e-learning modules that were considered mandatory. Rather, they wanted to offer rewards for those who had completed the required modules. An example of this can be seen in one of the business units where the employees having finished a set of four specific e-learning modules automatically entered a lottery for three digital cameras. According to the training administrator for the unit, this had an effect and she noticed an increase in the number of completed modules.

These features are, of course, meant to be used to manage and administrate the training activities. They are in this sense tools for managers to acquire an overview of what different employees have completed on one hand, and for each employee to know what he or she has done, on the other. The logs are thus a tool at two levels. To support each individual employee in managing and keeping track of their own training activities, and for the managers and training administrators to keep track of the aggregated training activity of the employees in a particular department or business unit. The statistics generated from the logs can be accessed through running certain reports and inquiries on the LMS database.

Uncertainties and circumstances in the creation of the logs

Another use of the logs was as an indicator of the success of the e-learning project. The following extract from a publication at the Intranet pages illustrate this quite clearly. The extract is taken from an interview made by the public relations department (responsible for the publications on the intranet) in August 2002 where a project leader being is asked about the success of the e-learning initiative:

> **Extract** 24:
>
> E-learning a success at Fornebu!
>
> The reports from the learning portal Learn@telenor shows that 22.554 e-learning programs are completed. This is fairly high numbers for one of the largest e-learning project in Scandinavia. Networks [one of the business units], just relocated to Fornebu,

> … impresses us by the fact that 86% of all their employees has done e-learning with an average of 5 e-learning programs pro each.

This is of course a front stage version, and there were strong motives behind giving the impression that the e-learning initiative at Fornebu was a success. The e-learning solutions and the open office solutions were considered a product they wanted to sell to other companies, and Telenor's own use of these solutions was supposed to be the "showcase".

Still, something happens to the log data between the actual registration of the set of human-computer interactions and the way the statistics are presented in this official statement. It has already been explained how the human-computer interactions are translated into representations of the learning process. In the following I want to look at what circumstances and uncertainties that are tied to the data from which the logs are generated.

The personnel data was, as mentioned earlier, migrated from another system (the human resource application, SAP™) to the LMS. These original data was created and stored according to financial considerations and as a consequence people are grouped according to 'responsibility centres' (the major cost objects in the company). This grouping did not make much sense in the LMS where the organisational units (not the financial units) were important. This meant when generating reports for an organisational unit or subunit, it was (initially – this was fixed at a later stage) not possible to get the data automatically sorted in the proper way. As one of the TAs noted, they practically had to know everyone's affiliation in the list and group them according to their respective groups to get an overview of the completion of e-learning modules according to the relevant units or subunits.

In addition, the data migration frequency also constituted a problem, especially in the first phase of the project. This frequency was reduced from every seven to every ten days, which resulted in a delay in the enrolment of new employees in the LMS and there was also an insufficient removal of people that had quit the company. These were still registered in the personnel records used by the LMS and had an impact on the creation of reliable reports.

Owing to the automatic and uncritical migration of data, most of the training administrators struggled to generate adequate reports. These conditions, according to the training administrators, led to problems in generating reliable and accurate completion rates and statistics of the overall progress with the e-learning activities. Some of these issues were gradually removed during the project, increasing the validity of the generated figures. The solution was finally given through offering five kinds of reports based on the data from the LMS. Nevertheless, subsequent to the introduction of these reports the TAs still experienced problems with the quality of the figures generated by the reports.

Moreover, the way the logs are created contains several limitations with regard to what the users are doing. In order to have a course registered as completed a certain sequence of operations needs to be carried out. It is, for example, important that after completing a certain module (given that everything is carried out in one sequence) that the module is shut down in the right way (i.e., pressing the "return to SABA" button). Another limitation is illustrated by this extract from a group interview with the training administrators:

> **Extract** 25:
> … if you log on to SABA, and then it says that you can take a break, you know, so you press the pause button, and you don't bother to log out completely, then you go and have lunch for 20 minutes or so, and then you return, and if more than 45 minutes have passed, then you're thrown out and nothing of what you have done is saved, and you have to start all over again…

These kinds of technical limitations in the actual logging process could be frustrating for the users. Overall, many of the employees saw the registration of a completed mandatory e-learning module as an important aspect of the training process. Nevertheless, other, more pragmatically orientated users see this registration as less important:

Extract 26:

What I'm thinking is, if I have completed a course, and then it's not registered as completed, I would not bother to do it again as long as I know I have completed it.

This, together with other reasons for not getting the registration completed, results in incomplete logs and statistical figures of the use of the e-learning modules. At some occasions we encountered people who had gone through some of the modules in collaboration – two or three people sitting together at the computer, discussing the material. This was also mentioned as a very suitable and fruitful way to learn about the topics. With this solution, however, only the person who was logged in got the module registered as completed. This also resulted in missing registrations of completion rates, and although the managers of each subunit eventually were allowed to register the completion rate manually in the LMS this option was not used frequently.

Unsuccessful completion registrations because of inactivity, quick navigation, breaks, double program orders and incorrect log outs have all been sources for incomplete logs of progress. These issues were the topic of discussions and negotiations, and caused frustrations for both training administrators and for users.

The process the logs go through from their creation to their use, like in the official statement above, as an indicator of success, is complex. In the official statement, uncertainties and attending circumstances prevailing in the creation of the logs are not taken into consideration. Despite of these uncertainties, the logs are used as a tool in the organisation of the training activity and as a benchmark when measuring the status of the project.

Multiple Rationalities

According to Star (1999), one of the strategies we can use "for 'reading' infrastructure and unfreezing some of its features" (p. 384) is to identify the *master narrative* of the infrastructure:

> Many information systems employ what literary theorist would call a master narrative, or a single voice that does not problematize diversity. This voice speaks unconsciously from the presumed center of things. […] Listening for the master narrative and identifying it as such means identifying first with that which has been made other, or unnamed (p. 384).

This "quasi-generic voice" (Star, 2002) of the infrastructure is conceptualised as a narrative. The concept master narrative (or grand narrative) is commonly used to denote a representation of a history or a process in which the structuring of events are in accordance with a certain ideology or to justify some version of the world (see Lyotard, 1984). Similarly, an infrastructure can embed a narrative that conceals some version of the world and gives emphasis to another. The uncritical acceptance of "powerful infrastructural tools on a wide scale … may obscure the ambiguous nature of tools and technologies for different groups, leading to the de facto standardization of a single, powerful group's agenda" (Star & Ruhleder, 1996, p. 114). Through the design of an infrastructure particular choices and agendas may be inscribed in the technological arrangements.

Even though this analysis aims at scrutinizing a similar phenomenon, I will not use the concept narrative. Rather than talking about one single master narrative, I look at how multiple rationalities govern the introduction and use of the infrastructure for learning.

The concept of rationalities[80] is here used to capture the norms and elements of an organisational or social order appearing in relation to action and practice. The rationalities can be inscribed in an infrastructure (and is in this sense similar to what Star terms the narrative of infrastructure), but it can also be part of organisational arrangements, norms or objectives. As an analytical concept 'rationalities' is used for addressing this middle ground between structure and action, more specifically between organisational arrangements and the activities of its members. The different rationalities can also be seen in relation to different organisational goals. Official

[80] This is not referring to the concept of rationality as it has been used by cognitive scientists and in artificial intelligence, a rationality closely tied to formal logic. It should be understood in a pragmatic sense: something that is subject to a certain logic, still not always fully purposeful, planned or clearly conceived. It is also key to note that this is not assuming that action is always rational. Action is rather seen as emergent and contingent and seldom fully rational (cf. Strauss, 1993, pp. 30-31).

statements and formal decisions are resources that contribute to structuring these rationalities. In this way 'rationalities' are used to describe various and multiple agendas that can either be inscribed in the infrastructural arrangements or impinge on the infrastructure in a plethora of ways.

This brings us to another facet of the different rationalities. The relational nature of infrastructure for learning suggests that it means different things to different people. A LMS can be target object for the system developers, a tool for measuring the training activities of the employees for the training administrators, and virtual space from which to download e-learning modules for the employees. As such the infrastructure for learning is dependent on different vantage points and roles in the organisation. It looks different depending on what view or position you have in the organisation. In the same way, the concerns and considerations relevant to the introduction and use of the infrastructure for learning will vary according to the different view or role an actor has in relation to these arrangements. Rationalities as it is applied here, should thus be seen as a fundamentally relational concept.

In this discussion I will make an analytical distinction between three different rationalities bearing on the introduction and use of an infrastructure for learning: a pedagogical rationality; a logistic rationality; and a rationality of managerial control.

Networked learning environments are often seen as being a means for supporting the training and learning of the workforce in a business. They serve pedagogical purposes. These purposes are related to facilitating, helping and supporting the employees in their work and giving them the required training in the topic at hand. A networked learning environment are then introduced and used according to a pedagogical rationality.

In addition, the use of these networked environments is a way of administering and delivering training exercises, resources and learning material to the employees. A networked learning environment can thus be said to be playing a role in *the logistics of learning*. From a managerial perspective this involves decisions about who needs what learning material and what kind of training should be offered to whom? It also includes planning how to distribute and administer the relevant resources or learning

content. In more general terms this is also related to the communication apparatus in an organisation. A networked learning environment can be used (along side other channels of distribution) as a way of getting information distributed and disseminated in the organisation. As such, it can be an effective organisational medium of mass communication. This can be understood as a logistic rationality.

Another role such systems can play is related to managerial control of workers. Through logs and measures of accessed and completed courses the system can be an instrument for controlling the training activities of each employee. This can also be used, for example, in relation to the implementation of new routines and procedures. In the latter case, the system is a means to control the flow and dissemination of information in the organisation. We can thus speak of a rationality of managerial control. Joanne Yates (1989) offers a definition of managerial control in her book 'Control through Communication': "Managerial control – over employees (both workers and other managers), processes and flows of materials – is the mechanism through which the operations of an organization are coordinated to achieve desired results. Managerial control is essentially management as we now think of it" (p. xvi). This definition is not in line with definitions of control offered from a Critical theory or neo-Marxist perspective, where the exercise of control often is seen as involving some kind of coercive force, but it can also operate in more subtle ways through the disciplining of workers. At least this perspective does not assume goal consensus, but rather assumes systematic conflicts of interest (see Thomson, 2001). Sewell (1998), for example, looks into how electronic surveillance of work performance and the use of new ways of working (especially team work) are increasing the managerial control of the workforce. Yates' definition, rather, stands somehow in the middle of such a definition and a definition from a purely managerial point of view where the goal would be how to most efficiently exercise such control. The concept of managerial control is understood here in a similar way as it is defined by Yates.

Making a distinction between the different rationalities identified in this study is, of course, an analytical generalisation. In some respects the different issues related to this might be intertwined and overlapping. For example, considerations belonging to issues of control can be a central part of pedagogical processes (see Ford, 2003). In classroom teaching the control of for example classroom interaction and learning

material can be part of the pedagogical strategy. As will logistical matters usually be a part of any pedagogy, assuring the distribution of learning material and other resources. The rationalities come to bear upon practice in different ways, and in the analysis above focus was set on the considerations that govern the introduction and use of the specific networked learning environment. The different rationalities can operate simultaneously, converging in some instances and be competing in others.

Discussion

The choice of a given technology to support training has pedagogical implications in that the specific system has certain possibilities and limitations in what kind of training schemes it can support. The LMS that was chosen in this case, for example, had little support for interpersonal computer-mediated communication and this rules out the use of online collaborative training activities. When the system was picked out, however, this was a topic that was discussed. Nevertheless, the LMS and the accompanying e-learning modules gave rise to a limited set of pedagogical choices. The LMS and the individual, multimedia modules afford the use of a tutorial-like training methodology. As discussed in the analysis, the training activities are in this way removed from the work practice (as it also would in classroom courses).

Wenger (1998) use the concept *exctractive* about training schemes that "extract requirements, descriptions, artifacts and other elements out of practice, transforms them into institutional artifacts (courses, manuals, procedures, and the like), and then redeploy them in a reified form, as if they could be uprooted from the specificities and meaningfulness of practice" (p. 249). He contrasts this to what he labels an *integrative* training scheme "that focuses on practice and seeks "points of leverage" at which design[81] can support learning" (ibid). Put simply, the norm (or pedagogical principle) Wenger applies is that training schemes closely related to and integrated in the actual work practice are somehow better than training schemes that are removed from the relevant work practice. Pedagogically speaking, this is an important point, and it is an issue related both to debates about transfer (see Tuomi-Gröhn & Engeström 2003) and

[81] Wenger uses the word 'design' to denote the design of learning activities or to design "social infrastructures that foster learning" (1998, p. 225).

debates about the formal representation of knowledge (see Rumelhart & Norman, 1985).

The introduction and use of a networked learning environment, however, is not only oriented towards pedagogical issues. Other considerations can be prominent in this process. An example of this was given above when discussing the standardisation of the learning material to be delivered to the diverse group of users. In this case the pedagogical considerations compete with the rationality concerned with the logistics of learning. Thus, questions such as "how can we most efficiently spread and distribute this information in the organisation?" are at some points considered more important than pedagogically oriented concerns.

In information systems *audit trails* are records that show who has accessed a computer system and what kind of operations the user has performed over a given period of time. This is frequently used in accounting systems and e-business solutions, and most database management systems include an audit trail component. In educational technology, audit trails have been introduced as an advantageous feature of computer systems that offer specific pedagogical benefits in that it makes it possible for each learner to keep track of their learning history, and allows for a certain kind of reflection of their own learning process[82] (Brown, 1985; Collins & Brown, 1987). This has also been explored with regard to the use of other technologies. Lankshear & Knobel (2003), for example, discuss of how weblogs can function as audit trails in the learning process, and can, as such, be a useful pedagogical device.

Besides being a pedagogical device, the logs or audit trails can be seen as a means for electronic surveillance of the employees (see Zuboff, 1988; Sewell, 1998; Bryant, 1995). Through keeping track of the operations the users perform in the system, it becomes possible to monitor the employees training efforts.

Another implication of the figures and the representations generated from the logs of the training activities is that they may take the focus away from the pedagogical

[82] The audit trails are here seen as representations or reifications of cognitive processes. See Wenger (1987, pp. 317-320) for a review.

objective of offering training to the employees, namely that they learn to use the new technology and the new workplace. This can be characterised as a double bind (Bateson, 1972) – a double communication in the infrastructure. At one level what is communicated (the message) is that the important aspect of these training activities is that you learn to use the new workplace and the technology. What the logging and the visualisations of these traces of progress communicates (the meta-message), however, is that what is important is only what you have accomplished, how many modules you have completed.

The logs of the training activities are, as explored above, used for different purposes in the organisation of the training at the new workplace, and mediate these activities at different levels. This process might be understood as a *delegation* (Latour, 1992). The LMS has been given the responsibility to keep the overview of the training activities. Each human computer interaction is automatically kept track of and logged. The representations are inscribed in the system and rendered visually in the systems interface. According to Latour (1999a), when an actor is enlisted (human or nonhuman) a translation occurs. The presence of this new actor (in Latour's terms the LMS would count as an actor in the collective of humans and nonhumans) adds something to the practice. Goals and meanings are translated (changed, shifted, replaced). Used to understand the infrastructure for learning this would mean that through using the system a new goal or aim emerges. This goal is closely related to the rationality of managerial control. Introducing the LMS gives new opportunities when it comes to the transparency of the logistics of the training process. The managers and leaders are able to superintend the training process in new ways.

The process can also be understood in other terms. These inscriptions and visualisations of progress have a certain logic attached to them. In exploring *the language of new media,* Lev Manovich (2001), distinguish between a computer layer and a cultural layer in new media objects:

> Because new media is created on computers, distributed via computers, and stored an archived on computers, the logic of a computer can be expected to significantly influence the traditional cultural logic of media; that is, we may expect that the computer layer will affect the cultural layer (p. 46).

According to Manovich, these layers influence each other mutually. The translation between these layers is called *transcoding* – "the projection of the ontology of a computer onto culture itself" (p. 223). This concept of transcoding can also be used to understand the relation between practice on one hand, and the logic and affordances of a computer system on the other. As I have illustrated the very logic of the computer system, making it easy to log activities and human-computer interactions are 'transcoded' into the training activities. An aspect of the training activities related to the logic of the system is now accentuated: to count and measure training. Still, to measure and represent the activities of employees is an activity that has long traditions in management. The use of charts and tables as representations of productivity and efficiency has been a central component of managerial control for several decades (see Yates, 1989). Of course the information processing capabilities of computers and information systems have accelerated the possibilities for such measures, but to attribute this aspect of a socio-historical practice (management) solely to the introduction of computers as a tool in management, would be to oversimplify matters.

This measuring of the training activities is not unproblematic when it comes to the question of what is actually being measured. As it was explored above, infrastructural issues, such as the migration of data from one system to another, can create discrepancies in the figures. In addition, the logging process was contingent on the users performing the right sequence of operations when logging out. Pedagogically these features are insignificant for the training process. Still, in the organisation of the training activities, these serve an important role. The completion rates are central in the administration of these activities. In this process they are used according to a control rationality. The process of exercising control of the workforce can be a quite subtle process:

> Social controls affect individual behavior, in the first stance, through the use of power, the application of sanctions. Valued behavior is rewarded and negatively valued behavior is punished. Control would be difficult to maintain if enforcement were always needed, so that more subtle mechanisms performing the same function arise. Among these is the control of behaviour achieved by affecting the conceptions persons

> have of the to-be-controlled activity, and of the possibility or feasibility of engaging in it (Becker, 1963, p. 60).

In this case, enforcement of control was not a central aspect. Rather, there are examples of rewarding valued behaviour, as when they had a lottery and gave away digital cameras to those who had finished some of the e-learning modules. In addition, through the infrastructural imagery, they try to affect the conceptions the employees have of what it means to work at the new workplace, and to gain acceptance for the decisions. The infrastructural imagery is also an example of how the pedagogical and control rationality works simultaneously. Apart from being a way to affect the conceptions of the workers, the imagery is also a way to help them learn how the technological solutions and the new workplace can be used.

To communicate decisions and intended changes in the organisation, the use of a learning management system can, as mentioned, take on a specific role. As the system allows for a view into the operations that are done with a document (and who are doing them) and for access to this information, the system also allows for a specific form of control – it embeds a control rationality.

Similarly to the way Yates (1989) shows how the flow of documents and internal communication primarily were mechanisms of managerial control, the point made here is that a LMS, especially through the logging of the interactions with the system, is an instrument for managerial control, not only a pedagogical device to facilitate learning. The LMS works as an instrument for control at two levels. It can be used to control the flow of information in relation to implementation of organisational changes, and as a means for controlling and monitoring the training process in itself.

The LMS used at Telenor is an example of how such systems can take the role as a medium of mass communication within a large organisation. Together with mass distribution of email and the use of an intranet, it becomes part of the communications apparatus used to distribute information in the organisation.

> Much of the internal communications apparatus of modern organizations is designed to "get the word to the troops," to ensure that employees have current information on

> policies, procedures, and other relevant topics. Devises ranging from televised messages from the company president to routine policy manual updates are intended to reduce the information distance between peripheral employees and the center (Sproull & Kiesler, 1991b, p. 456)

Although Sproull & Kiesler discuss how communication technology can increase the *personal* connections within an organisation, the point they make in the citation above is relevant to the considerations made about both a control rationality and a logistic rationality as it is treated in this chapter. Still, the kind of connections that are promoted here, can be said to be of a more impersonal character. The LMS is in some sense a medium to, impersonally, distribute information (learning content). At the same time, it gives certain possibilities of controlling the dissemination of information in the organisation in that there are logs of what process this information has been through. This can be traced back to a single employee, and thus become a personal connection. The LMS is part of the communications apparatus which shall ensure that employees have updated information and at the same time allows for control of this communication process. This can go down to the level of ensuring that the content of messages is understood, for example by using multiple-choice tests.

In this chapter I have discussed how an infrastructure for learning can embed or be subject to different rationalities. An analytical distinction was made between three different rationalities: a pedagogical, a logistic and a control rationality. A key aim has been to demonstrate how these rationalities are played out on how they compete for the same territory in some cases and can converge in other instances. These are all important in the process of introducing and using infrastructure for learning, and can be used to understand the role such systems play in the organisation of training activities.

CHAPTER 9 – INFRASTRUCTURE, PEDAGOGY AND DESIGN

As emphasised in Chapter 1, the overall focus in this dissertation is on how ICT are introduced and used in learning practices. Another central theme is how the introduction and use of ICT change the social and technical conditions of such learning practices. In Chapter 1 three questions were asked which have guided the research discussed in the previous chapters. The first question – how is the introduction and use of ICT is realised through the interaction of the participants? – was discussed in Chapter 6 where I focused on how the infrastructural tools played a role in constituting the conditions with regard to how a group of students organised their work. The second question – how are tools incorporated into existing institutional arrangements? – was answered through the analyses in Chapter 7. The last of the three questions – what organisational concerns and agendas are related to the introduction and use of ICT in learning practices? – was addressed in Chapter 8 and discussed mainly with a focus on the multiple rationalities that are key to this introduction. In this chapter, I will further elaborate on these issues, and discuss the findings from the three case studies in relation to the notion of infrastructures for learning. In addition I will elaborate on the relation between pedagogy and infrastructure and issues concerning what it means to design infrastructures for learning.

In this chapter I also argue that an infrastructure for learning can be inscribed with pedagogical choices through its design. These choices may lie in a particular pedagogical model being employed or be inscribed in infrastructural tools that are part of the infrastructure. This is also relevant to how learning theory and instructional theory are applied when it comes to educational technology. In the next paragraphs, however, I will discuss these aspects in relation to the three case studies.

In the first case study (Chapter 6), I discussed how an intervention in an educational setting gave rise to a set of social and technological conditions – in relation to which the group of students organised their intra-group collaboration. The students were presented with a set of resources and certain pedagogical arrangements. They were participating as a team in a scenario simulating a negotiation process, they had a

collaborative assignment to accomplish, and a set of new technological tools they were supposed to use (OPUSi and TeamWave Workplace). In addition, they were mostly working from different geographic locations. These resources and arrangements (the different tools, the pedagogical model, the scenario, and the computing facilities as related to the practice of the participants) make up what I have labelled an infrastructure for learning.

The students' work was, as discussed, organised in relation to these infrastructural arrangements. An issue that appears to be key in this case is how the educational conventions – the pedagogical model (collaborative learning) and how the students are made accountable for their actions (collective assignment) – were changed together with the introduction of the new tools. The introduction of the set of tools was in this case done with what I described as a strong pedagogical anchoring. A specific pedagogical model was closely linked with the introduction of the computerised tools. This tight link separates the studied scenario from the other cases where technological tools were introduced without a specific and theoretically informed idea about how these technological tools could be integrated with a pedagogical model.

In the second case study (Chapter 7), the introduction of the particular tool (IFS Online) was not accompanied by such a strong pedagogical agenda. The idea that the web-based tool could support some kind of collaborative knowledge sharing between the members of the subject group was only loosely articulated. Still, there are pedagogical aspects to this case as well. The agenda of using the tool to create a forum for sharing experiences and transferring knowledge between the member companies touches upon pedagogical issues, at least implicitly.

Moreover, the introduction of the tool into the existing infrastructure for learning did, in this case, prove to be quite problematic in terms of getting the members to actively use the tool. This illustrates how the integration of a specific tool in an existing infrastructure for learning can be challenging, and how the tool itself can take much of the focus. As it was pointed out the introduced tool remained a *focal* resource rather than becoming a *supporting* resource in the relation to the group's work and the participation in the activities in the network. The infrastructure for learning in this

case was constituted as a set of resources and arrangements for the workers to meet and discuss their work. The organisational arrangements – having an inter-organisational network – imply that the participants come together from different work environments, working with similar, but not necessarily common problems and challenges in their everyday activities. Seen in relation to the ongoing practice and established arrangements in the network, the introduction of the web-based tool seemed to reveal some inherent tensions in the infrastructure for learning, in particular with regard to the asymmetric participation structure and the differences in knowledge interests. There are, as I discussed, two major challenges to this kind of arrangement: to address issues relevant for the various members and to have the supporting resources to make knowledge about such issues available and mobile (via some sort of representation) between the organisations. Making a web-based tool available for the members is, as this case illustrates, not necessarily a sufficient way of meeting these challenges.

Analytically, these issues are not understood with a narrow focus on the particular features of the web-based tool. Rather a wider focus on the various aspects of the infrastructure for learning: the existing arrangements for supporting the activity of the members; the resources available; the institutional framework; and how this is related to the particularities of the participation structure and the differences in the knowledge interests, were key dimensions identified in the analysis.

In the third case study (Chapter 8) focus was set on how a large telecommunication corporation organised their training efforts when relocating the different departments and branches into a new common workplace. In this case the infrastructure for learning comprised a learning management system, a set of e-learning modules and the accompanying organisational arrangements (such as assigning super-users and training administrators). This infrastructure for learning hinges on other infrastructural arrangements and the general computing infrastructure at the new workplace is, as such, part of this infrastructure for learning. In addition, the topic of the training activities was the particular technological tools and working arrangements at the new workplace. Hence the infrastructure was both topic and medium for the training activities.

In this case the analytical focus was set on how the infrastructural tools played a role in the organisation of the training activities. Even though there was not an overall pedagogical model being deployed in this large-scale e-learning project, there are pedagogical choices embedded in the infrastructure for learning. For example, the particular learning management system was designed and used in accordance to what Wenger (1998) characterise as an *extractive training scheme* (see Chapter 8). Another example is the way the e-learning modules were designed as multimedia tutorials for individual use. The learning management system was also deployed in a way that can be seen in relation to pedagogical issues. Some of the actual choices made, such as emphasising the delivery of a standardised content and a uniform set of e-learning modules to every employee are illustrative examples. In pedagogical terms this is a design that focus on delivery and acquisition.

A central theme in the analysis of this case was how multiple rationalities were at work when introducing and using the infrastructure for learning. Pedagogical issues are, quite obviously, not the only element to consider in such a process, and I discussed how the different rationalities (control, logistic and pedagogical) converged in some instances and were competing in other instances. An illustrative example of this is the use of the logs created in the LMS. These can have a pedagogical function in that it provides audit trails of the training activities of each user, and can at the same time be a device for controlling employees and making them accountable for their interactions with the system.

Pedagogy and Infrastructures for learning

There has been considerable research and debates on the relation between technology and pedagogy (e.g., Cuban, 1986; 2001; Koschmann, 1996; Steeples & Jones, 2002). A focus on investing in and building computing infrastructure through providing computers, internet access and sufficient resources are commonly seen in opposition to having a pedagogical focus where the need for technology is driven by certain pedagogical needs or pedagogical advantages (often substantiated by theories of learning) of using technology to enhance or support instruction or learning activities. Quite crudely this can be seen as a focus that is technologically driven on the one hand, and a focus that is pedagogically driven on the other.

What is more, the idea that technological tools can be designed and implemented as a clear response to a learning theory is also quite common. Conole & Olivier (2002), for example, state as an explicit goal to embed theoretical knowledge into the application of learning technologies. Conole, Dyke, Oliver & Seale (2004) propose a model, distilled from different learning theories, which can be used to map pedagogical approaches onto the application of learning technologies (e-learning). They summarise different learning theories and map out some potential applications of technology (e-learning) in response to these theories[83]. Koschmann, Kelson, Feltovich & Barrows (1996), however, claim that to establish what counts as a theory-based approach can be difficult

> because there are a variety of different types of theories that come into play – theories of how people learn, theories of how an instructional systems should best be designed to accomplish these ends, theories of social interaction, theories of how people and technologies can best function together, and so forth (p. 83).

Rather than discussing how different learning theories (such as behaviourism or constructivism) have been implemented in tools (in particular computerised tools) or what the implications of certain learning theories are with regard to the application of educational technology, I will address the intricate relation between pedagogy and technology in other terms.

Sfard (1998) distinguish between two different metaphors[84] that underlie both everyday conceptions and scientific understandings of learning: the *acquisition metaphor* and the *participation metaphor*. The acquisition metaphor denotes that "learning means the acquisition or accumulation of some goods (…) [or] gaining ownership of some kind of self-sustained entity" (p. 5). The participation metaphor emphasises that learning is a "process of becoming a member of a certain community. This entails, above all, the ability to communicate in the language of this community

[83] For a discussion of instructional planning and contemporary theories of learning see Wasson (1996).
[84] Sfard uses metaphor in the same vein as Reddy (1978) and Lakoff & Johnson (1980). These metaphors cut across common distinctions in learning theory such as individual and collective, and different pedagogical models such as transmission and construction of knowledge (these both belong to the acquisition metaphor).

and act according to its particular norms" (p. 6). Analogously, I will make an analytical distinction between how different infrastructural tools or an infrastructure for learning can be inscribed with the properties for supporting delivery, conveying information and distribution of content on the one hand (analogue to the acquisition metaphor), and supporting interaction and communication between people on the other (analogue to the participation metaphor). For simplicity these can be called *tools for acquisition* and *tools for participation* respectively. The use of this distinction can help to understand how different tools are not neutral in pedagogical terms, but that certain pedagogical choices are embedded in the tools. As Koschmann, Kelson, Feltovich & Barrows (1996) claim,

> most instructional innovations have at least some rudimentary underlying theory of learning and instruction, and most applications of technology in education operate from some theoretical notion of efficacy – even though it may not be made explicit by, or even be explicit for, the system designer (p. 83).

As it is emphasised in this citation, the pedagogical choices do not need to be derived from an explicit theory of learning, but can also be informed by more rudimentary or commonsense ideas about learning and pedagogy. This will be explored further below. First I will relate the distinction between tools for acquisition and tools for participation to some traditional applications of educational technology.

The former (tools for acquisition) is commonly focused on how to deliver and distribute information and content and this has been prominent in new models of using ICT for learning. In distance education, for example, the opportunity to readily distribute content to geographically distributed learners has been seen as one of the promises of ICT.

The efficient deliverance of learning material to learners has been seen as key in for example Computer Aided Instruction. The programs developed in CAI were traditionally "statically organised receptacles structured to embody both the domain and the pedagogical knowledge of expert teachers" (Wenger, 1987, p. 4). In this way decisions based on the instructor's experience can be implicitly reflected in the design of a given program. According to Koschmann (1996) CAI applications "utilize a

strategy of identifying a specific set of learning goals, decomposing these goals into a set of simpler component tasks, and, finally, developing a sequence of activities designed to eventually lead to the achievement of the original learning objectives"(pp. 5-6). The result is typical drill-and-practice programs that based on the experience of the teacher and the domain knowledge are supposed to support transmission or delivery of a given content. This strategy corresponds to the acquisition metaphor.

In Intelligent Tutoring Systems the representation and presentation of content have taken on another dimension. The idea is not to capture and represent the decisions of the experts[85] (pedagogical or domain) in programs, but to create new ways of representing the knowledge. Wenger (1987) calls these systems "knowledge communication systems", and "knowledge communication is defined as *the ability to cause and/or support the acquisition of one's knowledge by someone else, via a restricted set of communication operations*" (p. 7, italics in original). The main goal in ITS is to support this process of knowledge communication by means of computational models of the domain, the student and the communication process, and the application of Artificial Intelligence in manipulating such systems and processes. In this way the programs would give the learners dynamic access to the content and could modify the presentation of the content according to the learners interaction with the program (Ibid.). Still, for the purposes discussed here, the general trend can be seen in clear reference to tools for acquisition.

Examples of technology to support acquisition are also found in debates about how to use features of computer technology to present content to learners. The use of multi-modal representation (using multimedia systems) is one such example. Another is the use of hypermedia where features such as hypertext can provide links between the information presented and thus another mode of delivery. A third such feature is interactivity, where the presentation of content depends on the input of the user/learner.

[85] Wenger (1987) sees this difference as one between implicit versus explicit encoding of knowledge.

A major trend within e-learning is the standardisation of ways to structure and deliver content according to certain criteria[86]. The main idea is that if content is structured and encapsulated in a standardised fashion into learning objects, this content can be reused and reassembled in new ways and is compatible with all systems (in particular learning management systems) that follow a given standard. This trend is also in coherence with making tools for acquisition. This is also an issue that can be seen in relation to the dimensions of infrastructures for learning discussed in chapter 4. How an infrastructure incorporates standards, is not only related to the technological standards, such as protocols for data transfer etc., but also standards for structuring learning material which may have implicit or explicit pedagogical implications.

Tools for participation (analogue to the participation metaphor) are commonly more generic communication tools. Virtual learning environments that are centred on creating virtual meeting places, provide access to the resources of a community, creating occasions for interaction between learners or between learners and instructors, are prominent in this second category (support for participation). The use of groupware or discussion forums are typical examples. Lipponen & Lallimo (2004) call such tools collaborative technology and refer to "all those applications that can be involved in collaboration among learners and workers" (p. 112). They further note that it can be difficult to make a distinction between collaborative technology and communications technology.

In addition to the more generic communications technology, tools for participation have been developed through which it is attempted to influence the participation (interaction) in a certain direction. In Chapter 2 I discussed how CSILE and FLE3 uses such a strategy. There are also other ways of doing this, and two such strategies are structuring and regulating collaboration (Dillenbourg, 2002; see also Jermann, Soller & Lesgold, 2004). Structuring is done in the design phase (before the interaction) through scripting the situation. Regulating happens during the interaction and the interaction of the participants is dynamically assessed in reference to a normative model of interaction and an intervention is done when there is a discrepancy in the actual collaboration and the desired collaboration (Jermann, Soller

[86] See for example http://www.aicc.org

& Lesgold, 2004). This process can be supported by pedagogical agents (see Mørch, Jondahl & Dolonen, 2005). This illustrates some of the variety of strategies that pertain to the use of tools for participation.

This is not to say that tools *in themselves* either support participation or acquisition in a strict sense. Neither should the two categories be seen as mutually exclusive[87]. This has to be seen in relation to the actual use and integration of the particular tools in particular practices. Nor is it meant to be a normative categorization, e.g., implying that tools for participation are pedagogically more sound than tools for acquisition[88]. Still, as Sfard & McClain (2002) point out, the perspectives that are based on the idea of learning-as-participation (e.g., Lave & Wenger, 1991) give artefacts a different role in the explanation of cognition and learning than perspectives that use learning-as-acquisition.

The idea that certain learning theories have clear pedagogical implications, which again has particular implications for how to design, use and integrate technology in learning activities is not uncommon. An example is that behaviouristic learning theory implies drill-and-practice exercises that can be supported by for example CAI programs. This idea, however, provides a quite idealised picture of the relation between learning theory, technology and pedagogical practice. Using Sfard's (1998) metaphors of learning to categorize educational technology can offer another take on this problematic. These metaphors cut across formal learning theories and common sense understandings of learning. With regard to pedagogical practice and technological responses to pedagogical issues these dimensions will often be mixed. In a similar vein, Petraglia (1998) offers an understanding of constructivism[89] as a metatheoretical idea – "individuals actively construct meaning based on their prior experience" (p. 165) – that inflates the differences between sociocognitivist and

[87] Similarly, Sfard (1998) makes no claims about exclusivity when it comes to the acquisition or participation metaphor, but rather argues that we need both for a comprehensive understanding of learning.
[88] If a tool for acquisition (for example an online tutorial) is used as the basis of discussion for a group of learners, it would be hard to derive how this tool, in itself, is more pedagogically sound than a tool for participation.
[89] Interestingly, Sfard (1998) argues that the idea of constructivism (both in it's moderate and radical form) is conceptualised according to the acquisition metaphor. To the contrary, Petraglia (1998) contrasts the CAI tradition to the metatheory of constructivism.

sociocultural[90] theories. He further argues that educational technologists and teachers commonly subscribe to this metatheory rather than a specific theoretical strain (such as socioculturalism). To describe the relation between constructivism and it's pedagogical application he introduces the term "mediating theories"[91]. These mediating theories (he mentions, among others, apprenticeship, collaborative learning and cognitive flexibility as examples) suggest elements of both learning theory and practice, "yet are flexible enough to accommodate variations in both theories and practices" (p. 75). In this way collaborative learning, for example, can be substantiated in different theoretical approaches *and,* at the same time, draw on more mundane and everyday conceptions, such as "people should work in groups". Petraglia also emphasises that there can be various technological responses to such mediating theories[92].

The relation between theoretical perspectives on learning and pedagogical applications of such perspectives is, thus, quite complex and there is not necessarily one clear way of applying technology as a response to a particular perspective on learning[93]. It is possible, however, to tackle this issue in a somewhat different way, by looking at what kind of metaphor of learning a technology is designed or used in accordance with. The idea of mediating theories provides a way to approach the relation between these matters with an intermediate link that also embrace pedagogical ideas that are not explicitly grounded in formal learning theory.

A recapitulation of the cases I have studied with regard to these concepts is now in its place (see Table 3). In the first case study, the tools are clearly in support of participation. In one way the tools were enabling the students to carry out their work and participate in the scenario. This case is also a prime example of how the tools are used as a response to the mediating theory collaborative learning. In the second case,

[90] Petraglia uses the term sociohistorical rather than sociocultural.
[91] I have to this point used the term *pedagogical model* to describe collaborative learning, but this can be understood in the same way as a mediating theory.
[92] These mediating theories can also inspire new theoretical ideas. The concept of apprenticeship has, in this way, been theoretically furthered by the idea of *legitimate peripheral participation* (Lave & Wenger, 1991).
[93] It is not my intention to claim that different perspectives on learning do not have any implications for pedagogical matters. What these implications are, however, I see as a matter of specification, translation and realisation. See Koschmann, Kelson, Feltovich & Barrows (1996) for an example of how such implications can be specified.

the pedagogical issues are not so elaborated and clear-cut. The tool introduced (the web-based discussion forum) is clearly in line with a participation metaphor. Still the dominant way of talking about the role the tool is supposed to have (its pedagogical function) is more in line with the acquisition metaphor, for example the idea that the forum should enable the exchange of knowledge and experience. In the last case study, the tools are undoubtedly in line with an acquisition metaphor. The LMS is organised according to a shopping metaphor (according to which the acquisition happens through economical transactions). The encapsulation of the knowledge to be acquired in e-learning modules also supports this argument. In addition, the deployment of technology can in this case be seen in relation to a version of the idea of constructivism. By offering a set of e-learning modules (the learning material), they provide the framework and the learning material, but the users (employees) are themselves responsible for acquiring and actively constructing the knowledge. The mandate of the e-learning project was to find a way to make learning resources available and ready at hand.

Table 3 – Pedagogy and tools in the three case studies

	CASE 1	CASE 2	CASE 3
Tools	Tools for participation, generic communication tools	Tools for participation, asynchronous web-based forum	Tools for acquisition, shopping metaphor for learning
Pedagogical model	Explicit focus on collaborative learning	Exchange of knowledge / experience	Constructivism / delivery and acquisition

To sum up, pedagogical issues, like the ones discussed above, can be seen as a dimension in infrastructures for learning. Infrastructures for learning are inscribed with pedagogical decisions (for example they can include tools for acquisition or tools for participation) and these are brought to bear on the learning activities. The systems/tools meant to support learning are not neutral tools in pedagogical terms. Rather we can say that infrastructures for learning embed pedagogical decisions

through overtly or covertly incorporating choices about pedagogical issues through its design. In addition, an infrastructure for learning can include certain pedagogical arrangements (based on explicit pedagogical models or a mediating theory).

In the discussion in the beginning of Chapter 6, a distinction was made between a weak and strong pedagogical anchoring when it comes to the introduction of computerised tools to support activities aimed at learning. This distinction addresses the link between the specific tools that are introduced and the pedagogical arrangements. Pedagogical anchoring thus says something about how strong the tie between a pedagogical model (or more loosely formulated pedagogical ideas) and the introduction of a tool (or a set of tools) is. In addition, the introduction and use of tools can be subject to concerns other than the pedagogical. This is what I addressed in Chapter 8 when discussing the different rationalities. A weak pedagogical anchoring based in the prevalence of other concerns (for example logistic concerns). The logistic rationality concerns issues very close those discussed in relation to the acquisition metaphor. What I discussed as different rationalities, however, move beyond the purview of the metaphors of learning. A focus on logistics and delivery may be rooted in other agendas and concerns than what I have called the pedagogical rationality. Nevertheless, concerns about logistics might have implications for pedagogical matters. Still, the logistics of learning says more about the management and administration of learning or training activities rather than instructional issues. The different organisational rationalities are thus most relevant when looking at the organisation of such activities. Still, management and administration can be seen as important aspects of a pedagogical model.

Using the idea of mediating theories, as discussed above, to look at these cases opens for an understanding of how different tools can be introduced and used in response to commonsense ideas about learning, and not necessarily be derived from theories of learning. In the Telenor case, the project team had members who were experts in pedagogical issues, but their concerns about the pedagogical implications were not always given way in the myriad of other prevailing issues. Even in the design experiment DoCTA (Chapter 6), where the pedagogical design was in focus, the theoretical understanding of learning is represented through the mediating theory of collaborative learning. This application of technology is also guided by practical and

commonsense concerns. The relation between pedagogy and infrastructures for learning, however, is also caught in a tension between intentions and consequences. In order to further highlight the discussion of the realisations of the different infrastructures for learning, I will now turn to the relation between design and use of such infrastructures.

Design and Infrastructures for Learning

In Chapter 2 I argued that there is an inherent tension between a normative agenda and a descriptive agenda when it comes to research on CSCL. This tension is constituted as one between designing technological tools to support collaborative learning, learning material and pedagogical arrangements (together often referred to as a learning environment), and to better understand how the introduction of collaborative technology influences processes of learning. That is, a tension between design and empirical (analytical) studies. In the borderland of these agendas we find research designs such as design experiments. Similarly, in CSCW issues of design and implications of empirical studies for the design of computer support for cooperative work is a major theme and established as one of the ultimate goals of CSCW research.

A relevant question to ask in this regard is: what is the object of design? The development of information systems has been widely discussed and design is then commonly seen as a phase in the systems development cycle. The object of design in systems development is the system itself. A major trend in CSCW (and Participatory Design) is how ethnography can help bridge the gap between formal descriptions of systems and the actual uses of these systems (e.g., Raeithel, 1996; Crabtree, O'Brien, Nichols, Rouncefield & Twidale, 2000; Suchmann, Blomberg, Orr & Trigg, 1999) Ethnographically informed design of information systems is seen as one way of making systems fit actual work practices and local variations of use. Another (Scandinavian) tradition in information systems development is to look at how not only the technological systems might be designed or redesigned, but how organisational arrangements can be changed in parallel with such systems (Andersen, 1989; Dahlbom & Mathiassen, 1993). In such cases the object of design is not only the information system but also the organisational arrangements and work practices.

Focus on processes and workflow in systems development (e.g., Iden, 1995), can be seen as analogue to a focus on instructional and pedagogical processes.

Similarly, designing an infrastructure for learning is different from designing a technological tool. It is not only a question of designing single-standing artefacts, but also a question of designing pedagogical and organisational arrangements. Following Wenger (1998) design can be understood as "the systematic, planned, and reflexive colonization of time and space in the service of an undertaking. This perspective includes not only the production of artifacts, but also the design of social processes such as organizations or instruction" (p. 228). This view on design can also be taken into account when looking at infrastructures for learning. As Wenger is looking at communities of practice as the arena for learning, he further asserts that "*learning cannot be designed* but that it can only be designed *for* – that is, frustrated or facilitated" (p. 229, italics in original). The notion infrastructures for learning implies such a relation between design and learning.

Discussing the relation between action, institutional properties and technology Orlikowski (1992b) claims it is common to have a strict demarcation between a design phase (where technologies are produced and designed) and a use phase (where a technology is consumed). She suggests a slightly different approach[94]:

> Rather than positing design and use as disconnected moments or stages in a technology's lifecycle, the structurational model of technology posits artifacts as potentially modifiable throughout their existence. In attempting to understand technology as continually socially and physically constructed, it is useful to discriminate analytically between human action which affects technology and that which is affected by technology. I suggest that we recognize human interaction with technology as having two iterative modes: the *design mode* and the *use mode* (p. 408, italics in original).

As Orlikowski emphasises, even though the design of a technology can be analytically discerned as a certain phase, it does not mean that the technology is a

[94] Orlikowski draws on Giddens' theory of structuration, but this is not central to the argument made here.

fixed entity with absolute effects on human action when it is used. To explain this process she borrows a concept from Pinch & Bijker (1984), interpretive flexibility of technology, which focus our attention to how a technology is always interpreted and reinterpreted in both design and use.

> The interpretive flexibility of technology operates in two modes of interaction. In the *design mode*, human agents build into technology certain interpretive schemes (rules reflecting knowledge of the work being automated), certain facilities (resources to accomplish that work), and certain norms (rules that define the organizationally sanctioned way of executing that work). In the *use mode*, human agents appropriate technology by assigning shared meanings into it, which influence their appropriation of the interpretive schemes, facilities and norms designed into the technology, thus allowing those elements to influence their task execution (Orlikowski, 1992b, p. 410, italics in original).

Rather than thinking of these two phases in a technology' s life-cycle as discontinuous, Orlikowski suggests that we talk about two modes of interaction with technology. One in which certain features are built into the technology – the *design mode*, and one in which technology influence action through its adoption and use – the *use mode*. Similarly, I will distinguish between a design mode and a use mode of infrastructures for learning. In the empirical studies I have focused on the *introduction and use* of technology (the use mode) in practices aimed at learning, and thus not on the design mode of infrastructures for learning. Still, there are some design issues that can be discussed in relation to the notion of infrastructures for learning using the actual case studies as examples.

Fjuk & Sorensen (1997) argue that when designing distributed collaborative learning there is a need for a holistic approach that integrates organisational, pedagogical and technological aspects of a learning practice. Similarly, Goodyear (2002) claims that "educational design for networked learning involves three connected sets of design considerations – design of tasks, design of organisational forms/structures and design of supportive tools/physical environments" (p. 66). The three aspects are seen in relation to activities, communities and places respectively. It is the former (tasks, structures and spaces) that are the object of design and these indirectly influence

learning. This is in line with Wenger's argument presented above. Bearing this in mind, I argue that the notion of infrastructure for learning can offer a perspective that focuses on the relations between such aspects and how this is constituted in practice.

In the design mode of an infrastructure for learning there can be many actors involved (see also Foster, Bowskill, Lally & McConnell, 2002). Wasson (1997) argues that the design and use of a learning environment[95] (LE) includes not only the designer of the learning material but

> the author of information on the WWW is a hidden designer, the developer of a tool such as a spreadsheet is a designer, the researcher who wants to test new learning material in a classroom is a designer who has to work within the constraints set by the other LE actors (p. 568).

In the same way, different actors are commonly involved in the design of an infrastructure for learning and the various components of which it consists. In the second case study, for example, the designers of different elements in the infrastructure for learning consisted of the people involved in designing the OPUSi conferencing system and the IDEELS (in Bremen, Germany), the designers of TeamWave Workplace (designed by a research group in Canada), the team of researchers in Bergen that designed the assignments, tasks and pedagogical arrangements. In addition, the infrastructure for learning was built on an installed base and the telecommunication networks, email systems and so on should also be considered part of the designed arrangements. Furthermore, this infrastructure for learning was designed in relation to the institutional arrangements such as the course structure and administrative routines at the university. This list is potentially endless, but how different elements fit together and how these elements are integrated are an important aspect to consider in the design mode of an infrastructure for learning.

[95] Wasson expands on Schneider & Peraya's (1995) model of the learning environment, and Wasson's final model of a technology rich learning environment includes different actors: teacher, monitor, learner, fellow learners, and LE designers. "The entities include the school, university, workplace or self-study environment, tools, information sources, learning material, and the sociocultural niche" (Wasson 1997, p. 574)

Similarly, in the third case study, there were a number of actors involved in the design of the infrastructure for learning: The designers of the LMS, the designers of the e-learning module (an external company that worked with, among others, pedagogical experts from Telenor), the designers of the computing infrastructure, the training administrators (following up the training activities by, for example designing initiatives to raise motivation), and so on. This list makes the question of design quite complex. This points to another important issue, established as one of the premises of this understanding of the notion infrastructures for learning, is that an infrastructure for learning can only be partly designed as it emerges in relation to practice. It is possible to design certain components or parts of an infrastructure, but the infrastructure only appears, as such, when it is used.

This example also illustrates the impossibility of having full control over an infrastructure for learning (from an administrative or managerial point of view). This point is emphasised by Ciborra & Hanseth (2000) when they discuss how information infrastructures are "open-ended and in part out of control" (p. 4). They "capture these features by saying that infrastructures tend to 'drift', i.e. they deviate from their planned purpose for a variety of reasons often outside anyone's influence" (p. 4).

The lack of full control over an infrastructure for learning should also be seen in relation to what Hanseth (2000) calls the *inertia of infrastructure*. Changing or modifying an infrastructure for learning can be difficult due to the inertia of the arrangements that are already in place – the installed base. The interdependency between different elements of an infrastructure is a key issue. This refers not only to the interconnectedness of technical components, but the interrelations between heterogeneous elements, such as administrative routines, technical design, institutional arrangements and pedagogical arrangements. This is not to underestimate the importance of compatibility and interoperability between technical elements of an infrastructure. There are several examples of the importance of this in the cases I have studied. In the second case study (Chapter 7), many of the problems the users experienced with the first version of IFS Online was due to such interoperability issues. The implemented solution did not take some of the aspects of the existing computing infrastructure into account, such as making the tool compatible with the various kinds of browsers the members were using at their respective workplaces. In

the third case study, the migration of user data to the LMS caused problems in creating reliable reports based on the logs of the training activities, and had an impact on the organisation of the training activities. In the first case study (Chapter 6), one of the students had trouble logging onto the TeamWave server from her workplace due to firewall restrictions set by the organisation. This illustrates how a policy decision regarding a general information security issue – quite certainly with other intentions than to limit the access to this virtual learning environment – can influence practice and interaction, and how ostensibly technical issues are interlinked with institutional aspects. This inertia gives infrastructures for learning a conservative character. It is built on an installed base (Star & Ruhleder, 1996) and this installed base (including existing institutional arrangements and conventions) makes an infrastructure for learning hard to change[96]. Resolving issues concerning the installed base also depends on taking the many local variations of an infrastructure into account (see Rolland, 2003). Many of these issues should be understood in relation to the tension between the design mode and the use mode of infrastructures for learning.

What Orlikowski (1992b) refer to as the use mode of technology, Bruce & Peyton (1990) talk about as *realisations* of innovations. They propose a model of implementation

> where the active agents are not only the innovations themselves, but also the participants in the setting in which the innovation is placed. These participants first develop a perception of what the innovation is and then recreate it as they adapt it to fit with institutional and physical constraints, and with their own goals and practices (Bruce & Peyton, 1990, p. 172)

The use mode can thus be characterised as a realisation of an infrastructure for learning, where the technology (or innovation) is seen in relation to different actors' interests, institutional constraints and existing arrangements. Yet another approach to this problematic is discussed by Wenger (1998) as the tension between the *designed and the emergent*: "The relation of design to practice is … always indirect. It takes place through the ongoing definition of an enterprise by the community pursuing it. In

[96] Hanseth & Lundberg (2001) describe this inertia as an infrastructure's "momentum and irreversibility" (p. 360)

other words, practice cannot be the result of design, but constitutes a response to design" (p. 233). In line with Wenger's argument, an infrastructure for learning should be seen as emergent – as a response to design.

In the first case study (Chapter 6) such a response to a specific design was studied at the level of intra-group interaction. It was precisely how the infrastructure for learning was *realised* through a number of interactional processes that was the topic of investigation. I identified three different interactional processes and these should all be seen as responses to the particular arrangements that were made in the design experiment. The students continuously engaged in *understanding the conditions of collaboration* illustrates how this is a process through which the participants (the students) make sense of the prevailing conditions and how this is done in response to the tasks, assignments, instructions and available tools. It is through the realisation of these arrangements that they emerge as an infrastructure for learning.

In the second case study (Chapter 7) focus was, as mentioned, on an attempt to integrate a web-based tool into the existing infrastructure for learning. This serves as an example of how the focus on the design and implementation of a tool (these are, of course, technical challenges that should be taken seriously) is different than a focus on making a tool fit into arrangements or how these arrangements must be changed to facilitate the use of a certain tool.

In addition, the case is a prime example of how certain visions of change and how the rhetoric accompanying a technology can be misleading with regard to the challenges this implies when it comes to integrating such tools in an existing practice. Bruce and Peyton (1990) portray this process of integration as a resolution between old practices and new practices:

> New technologies … arrive wrapped in ideologies for change that represent challenges to established beliefs, values, and practices. These challenges create tensions between old and new ways of doing things that can be resolved in various ways. For some people, the resolution is to abandon old practices. But more generally, people create new practices that reflect complex and situation-specific compromises between the old and the new (Bruce & Peyton, 1990, p. 171).

The challenges the introduction of a tool represent to established practices was discussed in detail in the second case study (Chapter 7). In this case the resolution was not to abandon the old practices, but to abandon the use of the new technology. As the expectations concerning the use of the web-based tool revolved around the problems with the tool when it was first implemented, this was seen as mainly a technical issue. Still, there were no immediate gains from using the tool, nor a clear agenda for how to use the tool. The demands the use of the tool put on the time that needed to be spent on this activity and the, for some, lack of relevance of the topics discussed overshadowed the potential benefits of using the tool. This also stands in contrast to how the accounts of the promises accompanying the introduction of this tool.

In the third case (Chapter 8), a more integrated, but top-down, approach was applied when introducing the new technologies and arrangements for training. The infrastructure for learning was introduced as part of a large project of organisational change. The e-learning modules also played a role in conveying some of the ideology of this transformation in focusing on the potential challenges met at the new workplace and providing an idealised picture of the potential challenges met at the new workplace and with using the new technological tools. Moreover, this case can be seen as an illustrative example of how infrastructural tools can serve different agendas in the process of transforming work practices.

Evaluation of the Research

Any study has limitations with regard to validity and reliability. To establish what criteria according to which research should be evaluated, however, is not a straightforward question. In qualitative case studies, such as the ones presented in this thesis, there are some inherent limitations. A problem often encountered is, according to Silverman (2001), the use of selective and anecdotal evidence, and that the findings are grounded in the specific interpretations of the researcher. These are important concerns to bring to the analysis of empirical data gathered with the use of ethnographic methods (see also Hammersley & Atkinson, 1995). Still, the argument about anecdotal evidence can be in conflict with giving an account of the research with a given focus. Choosing a particular focus in a given study can be seen as resorting to anecdotal evidence and not treating all data as equally important. In

addition, the reliance on the researcher's interpretations is also a challenge that is inevitable. In ethnographic research the researcher's interpretations can be seen as a resource rather than a limitation. Using the repertoire of competencies and analytical rigour to an empirical material is the only way to produce a particular account of a study. These concerns are all general methodological issues that have already been widely discussed. Rather than reciting ongoing methodological debates, I will look at some specific limitations and challenges in the particular case studies that have been done as part of this dissertation work.

A challenge met in the first case study (Chapter 6) was the tension between studying a design experiment and studying a 'natural' setting. At one level, studying interventions in an educational setting means that the results are dependent on the particular interventions that have been made. At another level the design experiment provides a number of conditions and a framework for the students' activities, and, as such, their interactions can be seen as naturally occurring. At least for the students, this is a very realistic setting. Thus I analysed the student's intra group interactions, and looked at how these interactions were related to the broader arrangements. Nevertheless, the findings are, strictly speaking, tied to the particular arrangements and the particular design experiment. It is in this way important to construe the analysis as one of naturally occurring interactions *in* a design experiment. As such an analysis one of the strengths of this is that I managed to get an almost complete picture of the occurring interactions. Another strength is that I was able to capture these interactions first hand, not having to rely on secondary accounts (through interviews) of how they organised their work in relation to the infrastructure for learning.

In the second case study, the reliance on secondary accounts is one of the potential weaknesses of the study. As we could not get access to all interactions between the members in the subject group, we had to rely on secondary accounts of the use of other means of communication than the meetings and the use of the web-based portal (the use and lack of use of this portal, however, is well documented). Another potential weakness is the timing of the different interviews in relation to the particular phase of the project of introducing the portal and the discussion forum. Some of the informants were interviewed in quite an early phase (before they had implemented the

more reliable second version of the portal). This might have contributed to the kind of answers that were given in the interviews. Especially with regard to how they explained and gave accounts of why the portal was not used (which was by some of the informants construed as mainly a technical issue). This, however, was taken into consideration when analysing the material, and the material was in itself sufficient to serve as the basis of the analysis. It was not done any follow up interviews, which might have given us a more complete picture of the process. Still, the opportunity to access the discussion forum gave an overview of the lack of use and was a good indicator of the failure to adopt the forum into the practice of the subject group.

In the third case study (Chapter 8), an inherent limitation of the study is related to the size and scope of the e-learning project. As it involved as many as 6000 users, it was, with the chosen methods, impossible to get a complete picture of the use of the LMS and the e-learning modules. Still, focusing on the organisation of the e-learning project, lead to a sampling strategy aiming at producing variation (rather than a representative sample) in the kind of actors that were interviewed. This was pursued through interviewing actors that had different roles in the e-learning project, ranging from end-users, "super-users", floor managers, to training administrators and project management. Another limitation was the lack of access to the log data created in the LMS. In this way we had to rely on secondary accounts of the use of the system, rather than observing them first hand. As the e-learning project was divided into different phases, certain changes were made in the phases subsequent to my fieldwork. The analysis presented is mainly based on the phases which I observed, and did not, to any large extent, take into consideration that things were organised slightly different in subsequent phases. This issue, however, has been addressed through my cooperation with Grete Netteland, who is focusing on changes in the different phases in her dissertation work and has gathered data from these phases (Netteland, forthcoming).

In addition to these particular issues, which have been addressed throughout the research and analyses, there is an issue related to the overall research design. The two first case studies were not originally designed as studies of infrastructure in the way it has been rendered in the respective analyses in this thesis. Still, the issues addressed in these studies have been refocused and through the framing of these issues as

relevant to the notion of infrastructures for learning, each analyses give important insights into different aspects of the notion infrastructures for learning. Another general issue is the difference in the level of granularity in the three case studies. Where the first case study focus on data at the level of interaction, the second and the third look at accounts of an introduction process. This is simultaneously a limitation and a strength of the research presented in this thesis. It is a weakness in the sense that it prevents a full comparative analysis of the different case studies, and it is a strength in the sense that it provides a rich and varied material to the understanding of the notion infrastructures for learning. At the same time, it was possible to present findings from the individual case studies, which, I would argue, are valuable in themselves.

Summary

In this dissertation I have used the notion infrastructures for learning as an analytical backdrop, and as a way of understanding the fundamental social and technical conditions of learning practices. I have not, however, tried to map each of the different properties and dimensions of infrastructure as outlined by Star & Ruhleder (1996) (presented in Chapter 4) onto each of the cases (the same could have been done using Hanseth's (2000) description of infrastructure). The reason for not doing this is that it would seem like mainly a conceptual exercise and that it easily could have resulted in forcing concepts onto the empirical material (Glaser & Strauss, 1967, discuss the methodological implications of such a strategy). Neither have I taken each of these dimensions and discussed them specifically with regard to infrastructures for learning. This because I consider these dimensions as important, in themselves, for understanding infrastructures for learning, and any potential elaborations should be done in relation to actual practices.

In this chapter I have discussed, in mainly analytical terms, the relation between pedagogy, infrastructure and design. The three case studies have been further elaborated on and used as examples in the discussion. Building on Sfard's (1998) two different metaphors for learning, I offered a way to approach the implications of using different kinds of tools with regard to pedagogical issues. I have also discussed how the notion of infrastructures for learning can be used to capture the inherent tension between design and realisation with regard to technologies for learning. Finally I

addressed some limitations and potential weaknesses in the empirical research and the overall research design in an evaluation of the research. In the next and final chapter, I will give some specific implications that can be derived from the different case studies.

CHAPTER 10 – IMPLICATIONS AND FINAL REMARKS

In this final chapter I will discuss some implications from the case studies presented in this dissertation, and discuss further how the notion infrastructures for learning can be useful when approaching actual practices and what it would mean to design an infrastructure for learning.

Implications for Design and Practice

The implications from the case studies are, in one sense, already given through the descriptions of the settings and particularities of these cases. The findings and descriptions are already interpreted and focused on particular aspects in order to make an intelligible and manageable account of what it is possible to learn from the analysis of these case studies. Further implications must thus be seen in relation to the actual institutional settings that have been put under scrutiny. The first case study looked at a design experiment within higher education. The integration of pedagogical and technological aspects was key in the design of these arrangements. In the second case study, I looked at a network of companies that had made arrangements that were rather informal. The participation and efforts of the members were based on voluntariness, and potential gains from participation were not seen in relation to the efforts that needed to be made. In such a setting the lack of a framework for how to use tools and the lack of pedagogical expertise, can be important elements. The last case study was of the organisation of corporate training. A focus on efficiency and control is not unusual in such settings. In addition, all three cases focus on the introduction of new arrangements and tools. This implies that choosing cases where tools and arrangements were already in place and had a more stable and established use would yield different results. Still, the introduction phase is critical in any project where ICT is used for supporting learning.

Extracting these kinds of implications from a case study means walking the tightrope between saying things that are, for many, obvious or self-evident and making claims that you don't have support for in your empirical material. Still, based mainly on my own reflections from the field and my working with the material I will try to identify

some themes that can be extracted and articulated as possible implications or challenges for designers and practitioners for each of the case studies.

In the analysis of the first case (Chapter 6) I discussed how the students' work comprised different *interactional processes*. A key element of the analysis is that in distributed collaborative learning the participants will be faced with different challenges. Accordingly, a key aspect when designing learning scenarios is to recognise the extra (articulation) work the students have to do when engaged in such processes.

As it was discussed in Chapter 6, a limited focus on the pedagogical benefits of collaborative learning can contribute to an idealised understanding of what it means to participate in such learning scenarios. Building on the three interactional processes can help getting a more nuanced picture of distributed collaborative learning. In this way, taking into consideration that the students will have to constantly engage in understanding the conditions for collaboration and coordinate their collaborative efforts, besides doing what they are supposed to do (commenting on each others' products and contributions) can be a fruitful exercise when designing distributed collaborative learning scenarios. In addition, thinking through how these processes can be simplified and supported by different computer tools can be useful in the design phase. If it is presumed that the participants actually have a limited amount of time and energy to spend on the activities with regard to a given scenario, spending much of this time and energy on seemingly "extracurricular" tasks (such as coordinating) might have negative motivational effects and reduce the time spent on the task at hand.

Another aspect to consider is the importance of offering a variety of tools that can support different modes of interaction (synchronous and asynchronous) and provide a stable and flexible environment for their interaction. Having several tools and options can provide the participants with flexibility and something to fall back on if (when) there is a technical problem with any of the tools. Providing training in both the use of tools and training in how to collaborate can also be important aspects. I would also recommend incorporating some tools that are familiar to the participants (in most

cases email). This can be a step towards achieving a desirable level of *transparency* for, at least, parts of an infrastructure for learning.

The introduction of web forums for discussions and asynchronous interaction can be a fruitful way of giving a medium for reflection and debate over important issues in a community. While there are numerous examples of successful use of such forums, the number of empty, unused forums is probably at least as high.

As it was emphasised in the analysis of the second case study (Chapter 7), I have pointed to some possible reasons for why the network failed to integrate the tool into the existing infrastructure for learning. Nevertheless, there are some aspects that should be put forward and highlighted which can shed some light on the challenges of incorporating a new tool to support this kind of activity.

This case is an illustrative example of how it can be quite futile to "dump" a technology into an existing practice without any clear idea of how this particular tool will play a role in the ecology of existing communicative practices and infrastructural arrangements. A thorough understanding of key elements of an existing practice can be key in such cases. As in this case, the value of the structure provided by the regular face to face meetings was probably underestimated. These meetings gave the activity structure by providing rhythm and regularity, but also by having a defined agenda and a division of labour for each meeting. This structure probably helped to overcome issues of asymmetric participation and different knowledge interests. In addition, the regularity (and the low frequency) of the meetings gave a dedicated and circumscribed amount of time to use on this activity. When the web-based tool was introduced there was no clear limits in how much or little time the use of the forum should occupy. In this way it is easy to give less priority to tasks that are considered "secondary" in relation to the day-to-day tasks. A participation model based on voluntariness can be very fragile, and it is easy to give less priority to these kinds of activities in the competition with other activities. These challenges could have been addressed by assigning concrete tasks to the participants and allocating time dedicated to this activity.

Forums where you can ask open questions and address work related problems are probably best suited for large numbers of users. Such forums are for example central for many programmers working with specific programming languages. These are dependent on having a critical mass of users to provide quick and relevant answers to what they post. Still, the activities of a dedicated subject group with a very limited number of participants other aspects will be crucial. Understanding the conditions of an existing practice is key when trying to transform a practice by, for example, introducing a new medium for communication.

In the study at Telenor (Chapter 8), it became apparent that there are a number of issues that can be crucial when introducing new infrastructural tools. There will be different stakeholders with different agendas and what I have labelled as multiple rationalities that are key in such practices. These rationalities point to the importance of balancing between different interests and agendas when making arrangements for supporting learning activities. It might, for example, be a fruitful exercise to look at potential limitations a certain tool can impose on pedagogical issues or how certain tools give rise to a set of procedures with which to assess or control the learning activities. A strong focus on logistics of learning might also have pedagogical implications. An organisation faced with the challenges of offering learning material and end-user training to a large number of employees will have to find the balance between offering standardised material to all employees and giving relevant material to the ones who need it. As a top down model, the choice of offering the same material to everyone will inevitably make the actual content less relevant for some.

With regard to the distinction between tools for acquisition and tools for participation, there are some potential implications worth mentioning. As it is emphasised in much of the literature on e-learning (e.g., Zhang & Nunamaker, 2003), one of the advantages of using ICT to support learning is that it might improve the logistics and delivery of learning material and thus make the opportunities for learning more flexible. If the acquisition metaphor is used as a model for learning, this aspect can be seen as a key improvement in learning. Still, as I discussed above, the aspect of delivery is not the only aspect taken into consideration within an acquisition model of learning. *How* the material is presented and delivered, for example, is another aspect of how these opportunities will influence learning. The point I want to make,

however, is that an improvement of the logistics of learning should not be taken as an improvement of the process of learning. The logistic arrangements are a part of an infrastructure for learning, but this does not necessarily imply an improvement in pedagogy or learning. When faced with the challenge of delivering learning material to 6000 employees, the use of a LMS might improve the logistics and standardisation of this process, but what the pedagogical consequences are, is another question. Going through online tutorials might be as inspiring (or uninspiring) as sitting in the back of a classroom and listening to a teacher, and it may yield the same effects. This is the dilemma of any educator. This also resembles the problem I discussed when looking at how they logged the users interactions with the e-learning modules at Telenor. It is possible, to a certain extent, to say what actions (at keyboard and mouse-click level) the users have done, but what effects this has with regard to learning, I would claim, cannot be derived from such data.

Using the participation metaphor for learning can make this aspect clearer. To be offered access to infrastructural tools and resources of a community provides opportunities for participation in the respective practice, which in itself is seen as important for learning. An improvement in the logistics will then only be important if it can restructure the patterns of participation and the practice within a given community. The introduction of a new tool in a community will only be successful if the tool is adopted and transparently supports the practice of the community. That is, *when* the tool becomes infrastructural it transparently supports the particular practice.

Many design experiments show us how we can approach the question of integrating a tool into a learning practice. The idea of designing an infrastructure for learning can be very close to what it means to set up a design experiment. The view of taking existing organisational and technical arrangements into account when designing a learning scenario (e.g., Rysjedal & Baggetun, 2003; Wasson & Ludvigsen, 2003), and seeing the links between pedagogy, technology and organisation (Fjuk & Sorensen, 1997) teach us important lessons about such an approach. In addition, the contingencies of the practice should also be considered, or at least be expected. An inherent problem with design experiments, however, is sustainability (see Cole, 1996). The 5th dimension project was designed with this particular aspect in mind. The project has also spread to many locations (internationally) and has taken on many

local variations[97]. In a recent reflection over the 5th dimension project Kaptelinin & Cole (2001) gives an account of the design rationale behind the project. From the start (in 1986) there was a focus on how the computer-based tools were only a part of the arrangements they needed to design and integrate into existing institutional contexts. "The target setting was designed as a "model culture," with its own rules, norms, artefacts, and mythology" (p. 307). The objective was to make a "generic social setting" that could provide improved conditions for children's learning and development. Thus they had a focus that was much wider than one on technological innovation. There was also a concern for how the model could fit into the particular institutional settings and the demands these put on the design of the activities in the 5th dimension. Such considerations are key in trying to design social and technical conditions for learning, and this could be considered a prominent example of an effort to design what I have labelled an infrastructure for learning.

Other examples of how such an integrated approach has been used are CSILE (Scardamalia & Bereiter, 1996) and computer supported problem-based learning (Koschmann, Kelson, Feltovich & Barrows, 1996). Such approaches can give substance to how it is possible to use the notion infrastructures for learning to meet the design challenges that emerge when introducing technology to support learning practices. These researchers have engaged in designing more than just the technology, and have included pedagogical methods and taken seriously the challenge of integrating these elements, which can be seen as an infrastructure for learning (see Lipponen & Lallimo, 2004, for a similar argument).

Final Remarks

In this dissertation the main aim has been to contribute to the understanding of how ICT is introduced and used in institutional settings in order to transform institutional practices aimed at learning. This have been done through putting forward the notion of *infrastructures for learning* as a way of giving emphasis to the interrelated social and technical conditions of learning practices. In addition, I have looked at the fundamental relation between humans and technology and discussed this in terms of mediation. Infrastructure for learning can in this way be seen as an extension of the

[97] See http://www.5d.org (accessed 10th of May, 2005)

understanding of ICT as single-standing artefacts, one that encourages a view of ICT as part of a set of interrelated resources and arrangements. To further elaborate on this issue I have presented three case studies of different institutional settings where ICT was introduced with the purpose of changing existing practices. The three case studies each focus on different aspects of infrastructures for learning. The first provided a detailed account of how students organised their work and dealt with various dimensions of the infrastructure in their interaction, and in this way gave important insights into challenges that can face students engaged in distributed collaborative learning. The second case study looked at how a new tool was to be incorporated into an existing infrastructure for learning, and thus provided a rich example of the challenges and difficulties of successfully adopting a new tool into existing institutional and technical arrangements. Both these case studies also presented some relevant findings in relation to understanding distributed learning practices. The third case study focused on training offered to the employees in a large corporation, and the concerns and agendas that emerged when introducing and using this new infrastructure for learning. This case provided a thorough account of the different issues at stake and how different concerns come to bear on the introduction of new technology to support training activities. In all three case studies ethnographic methods were used and I also discussed some methodological and practical challenges that can emerge when engaged in ethnographic studies of infrastructures for learning.

In the preceding chapter I elaborated further on the interconnectedness of artefacts and institutional and pedagogical arrangements through a discussion of how infrastructures for learning can be inscribed with pedagogical decisions and a discussion of infrastructure and design.

Through this work I have tried to contribute to the understanding of what it means to adopt and use technologies to support learning, both for the participants involved in the actual practices and for those who contribute to managing, designing, and creating technologies and practices that are supposed to provide opportunities for learning. It is my hope that this account provides insights well beyond those found in much of the rhetoric surrounding ICT and learning.

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