Computer Support for Distributed Collaborative Learning. Exploring a Complex Problem Area.

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Preface

This Dr. Scient. thesis is submitted to the Faculty of Mathematics and Natural Sciences, Department of Informatics, at the University of Oslo. The thesis is a result of my work between January 1994 and January 1998.

My work lies in the intersection between the research domains of *Computer Support for Collaborative Learning* (CSCL) and *distance education*. In joint collaboration with Lone-Dirckinck-Holmfeld (University of Aalborg, Denmark) I have introduced the notion of Computer Support for *distributed* Collaborative Learning (CSdCL) to underline the physical distance between the collaborating students.

The motivation for this research is my work between 1990 and 1994 at the Norwegian NKS Distance Education. NKS Distance Education is, both nationally and internationally, known in distance education and made lifelong learning possible long before it became an objective of modern society. Rooted in correspondence education, NKS has during the last two decades experimented with communication technologies to support various models of distance learning. During my own work, I was responsible for organizing collaborative learning through text-based computer conferencing systems. I experienced a number of problems regarding the combination of these systems and good pedagogical practice. I found these problems in sharp contrast to the increasing enthusiasm associated with the use of the technologies to education and learning. These problems motivated me to do further investigations, both empirically and theoretically.

The importance of this research became evident during the last years' increasing public and political debate on adult education and life long learning. The focus of the debate is on the importance of competence development and further education alongside work, in a society finding itself in radical social and economic change:

> "Production relationships and conditions of employment are changing. Corporate organization is increasingly turning towards flexibility and decentralization. The search for flexibility, the development of networked-based cooperation, the increased use of subcontracting, the development of work in teams, are some of the consequences of information technology. (...). The new technologies have a twofold effect. On the one hand, they considerably increase the role of the human factor in the production process while on the other hand make workers more vulnerable to changes in work organization because they are mere individuals within complex network. (...) Information technologies are making significant inroads into production-related activities and into education and training, thus bringing the 'learning system' and 'the producing system' closer together" (European Commission, 1994, p. 23)

In Norway, lifelong learning is given considerable attention in public debate and political reports (Report no. 43 (1988-1989); Report no. 24 (1993-1994); NOU, 1992; NOU, 1997; IT in Norwegian Education, 1995).

The building of a society — in which work-life quality is understood in terms of lifelong learning — depends on the ability to organize educational alternatives based on open and flexible approaches to teaching and learning (European Commission, 1994; IT in Norwegian education, 1995). *Distance education* has received renewed interest for organizing learning situations that are flexible with respect to the lives and obligations of the adult workforce. *The Internet* has received particular attention to bring work and learning closer together.

The political emphasis given to the role of the Internet in organizing lifelong learning is important. My argument is, however, that an uncritical emphasis compels the educational institutions to apply the Internet *to something*, without any clear idea of why or how it can be used to provide learning benefits for the adult learners. The Internet can thus become an obstacle, rather than a support for learning and teaching. Reflection on past practice of, what I in this thesis term CSdCL, is therefore essential to create new and worthwhile solutions for lifelong learning.

Summary

This doctorate thesis is an exploratory study of distributed and computer-mediated collaborative learning. The work lies in the intersection of the research domains: *Computer Support for Collaborative Learning* (CSCL) and *distance education*. The notion of Computer Support for *distributed* Collaborative Learning (CSdCL) is introduced in this thesis to focus on collaborative learning situations where the students are individually separated by physical distance.

The thesis presents and discusses findings from my investigations on a number of CSdCL cases. Based on these investigations I argue that the students' collaborative processes are affected by various factors. These factors manifest themselves in a field of tension between *existing institutional practice* on learning and teaching, *physical separation* of the collaborating students, and computer systems that serve as mediators of collaboration. To what extent this field of tension is critical to the students' collaborative processes and to individual outcome of collaborating, is dependent on *subject matters* and *pedagogical principles* prescribed in the pedagogical method. I argue, however, that existing practice and methods must be *reconsidered* for CSdCL purposes. Concerning systems design, I argue that *heterogeneous computer environments* and networked computers must be taken seriously to make computer systems that work as resources for distributed collaborative learning. Based on this argumentation, I have developed two frameworks that are aimed at guiding an institution's planning of CSdCL and computer systems design, respectively. The first framework focuses on issues that treat CSdCL differently from more conventional forms of learning and teaching. The second framework focuses on tensions between computer systems and central principles of collaborative learning. I have used the frameworks in a practical design situation. The CSdCL designs were based on the pedagogical ideals of project-based learning and on the opportunities that World Wide Web gives to communication across a wide range of platforms. The results are a pedagogical approach to CSdCL and a computer system. I conclude, however, that it is still complicated to develop solutions for CSdCL that result in good practice. Good practice is not only dependent on good design ideas but also on organizational as well as individual maturity with respect to using new technology in learning. Today, CSdCL is just in the beginning of a path to such a practice.

Acknowledgments

Several colleagues and friends have supported me during the research. First, I am extremely grateful to Leikny Øgrim, my supervisor, for her encouragement through every messy emotion during the whole process, and for very insightful cooperation and interesting discussions. She has been a hard but very constructive supervisor. I also would like to thank Kristen Nygaard, who critically guided me through the initial phase of my research. I am also very grateful for the insights offered by Lone Dirckinck-Holmfeld. Her thoughts and perspectives have been very inspiring both in our joint cooperation and in a number of discussions taking place during my stay at the Aalborg University. She has also given very valuable comments on various versions of the thesis. I have also been graced by occasional mind-blowing discussions with Joan Greenbaum, who helped me to crystallize many of my thoughts.

I would like to thank those who introduced me to the field of distance education, and taught me the practice; My former colleagues at the Norwegian NKS Distance Education. Special thanks to Erling Ljoså for providing insightful comments on parts of the thesis. Then, ultimately, Elsebeth Korsgaard Sorensen, who, through our cooperation and friendship over several years, has provided new insight into my thinking. She has also given very fruitful comments on drafts of the thesis. Other people have patently listened to my thoughts, and critically but gently contributed to me thinking. I owe a special thank to Ole Smørdal and Markku Nurminen for many interesting discussions and fruitful cooperation. I also owe a special thank to Ola Berge for the discussions we had during his master thesis study, but also for his useful comments on drafts of the thesis. I owe very special thanks to Ole Smørdal, Anders Mørch and Eevi Beck for reading the same things over and over again, and for giving valuable feedback. Other members of the Systems Development Group, Tone Bratteteig, Ole Hanseth and Dagny Stuedahl, have provided feedback on drafts of the thesis. I would also like to thank Bjørn Faugli for setting aside time to read drafts and for discussing central topics from practice.

I owe thanks to the people who helped me with the non-academic work through the last phase. Special thanks to my colleague and friend during several years, Tone Irene Sandahl, who helped me with the final layout. I would also like to

thank Elsa Ruud and Karina Ruud for correcting the English of the thesis. Last, but not at least, deepest thanks to the people of my family who have helped me beyond my ability to thank them: My parents. Then finally, Sigmund, who has showed me what love is for the months during which my gaze was locked on the computer screen, and, Natalie for her precocious patience during the last months.

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Part I

Part I

1 Computer Support for Distributed Collaborative Learning

This doctorate thesis is an exploratory study of distributed and computer-mediated collaborative learning. The work is in the intersection of two research domains: *Computer Support for Collaborative Learning* (CSCL) and *distance education*. The notion of Computer Support for *distributed* Collaborative Learning (CSdCL) is introduced to underline a collaborative learning phenomenon where the collaborating students are separated by geographical *distance*.

CSdCL is understood in terms of the three aspects:

- Collaborative learning: Includes perspectives that place emphasis on interpersonal interaction with respect to learning and knowledge construction.
- Distance education: Includes perspectives that place emphasis on interaction, organized for the purpose of individual and independent studies.
- Asynchronous computer-mediated communication systems: Potential mediators of actions embedded in interactional processes[1].

These aspects constitute a field of tension[2]. In the thesis I analyze reasons why, and argue that CSdCL designs need to recognize that each CSdCL situation is a product of complex interactions between these aspects. Therefore, the thesis questions the majority of related research that views *computer systems,* established practice from *collaborative learning* and *distance learning* as separated aspects. That is, separated in the sense that distributed and computer-mediated collaborative learning situations are *defined by* either traditional and conventional practice of learning and teaching, or capabilities of computer systems.

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[1] I use the notion of 'interactional processes' because interaction is crucial with respect to learning. I have adopted this notion from Strauss (1988).

[2] I base this view on practical experiences of designing and organizing CSdCL situations over a four year period. These experiences are briefly presented and discussed in section 5.1.

The goals of my research are to:

1. Identify critical factors that influence distributed and computer-mediated interactional processes.
2. Develop frameworks that guide systems designers and CSdCL organizers to identify possible contradictions in the problem area
3. Point out possible directions for resolving problematic issues in new CSdCL situations.

1.1 The Problem Area

CSCL has recently emerged as a new field (Koschmann, 1994; O'Malley, 1995; Schnase and Cunnius, 1995; Koshmann, 1996a). The field has mainly been focused on instruction taking place in classrooms (Roschelle, 1996; Koschmann et. al., 1996; Neuwirth and Wojahn, 1996) and across classrooms (Pea, 1996), and when children and youngsters constitute the target group of research. Although computer systems have been used to connect students at one site with students at another, research concerned with learning situations where *adult students* are *individually separated by distance*, has been limited. This particular focus has for several generations, however, been the issues of distance education.

Teaching and learning by correspondence is the origin of distance education. In contrast to collaborative learning practice, the key concept of distance education has been *flexibility* in terms of *when* and *where* to study (Peters, 1993; Holmberg, 1995; Moore and Kearsley, 1996). The basic assumption is that a student learns entirely and independently of peers at her/his own pace. In line with this key concept, adults have an opportunity to participate in educational programs alongside work, and from places that are chosen by themselves—typically at home or a work place. Special instructional methods have been developed to offer the adult student a worthwhile learning situation independent of peers and geographically dispersed from teachers and the teaching institution.

Although it has roots in correspondence courses, distance education represents an educational discipline where its practice has been influenced by the development of communication technology. Concerning computer support for geographically separated and collaborating students, powerful new applications may provide interesting new functionality. However, the gap is still large between teaching and learning based on high performance computer systems, available in the lab or in the market, and having computer-based tools that work in the practice

of distributed and collaborative learning settings (Bannon, 1995; Bates, 1995). Access to networks and computer-based resources from individual's home, reliability, costs and robustness are crucial issues in these settings. The text-based and asynchronous communication systems are the computer systems that support these issues. In these distance education settings, computer support for collaborative learning does not necessarily imply learning in a group, involving, e.g., joint construction of problem solutions and different alternatives in argumentation. Rather, the focus has been on the possibility of being able to rely on peers and teachers to support one's own learning (e.g., Mason and Kaye, 1989; Harasim, 1990; Kaye, 1992; Harasim et. al., 1995).

Some of the related research focuses on the importance of a theoretical grounding in human interaction and collaboration, in pedagogical design (Sorensen, 1997) and in systems design (e.g., Schmidt and Bannon, 1992; Pea, 1996). Other researchers tend to focus on the computer systems' capabilities to support, or enrich, interactional processes that have historically been associated with distance education and collaborative learning (e.g., Harasim, 1990): Text-based interaction and, place and time independent interaction (distance education) and interpersonal interaction (collaborative learning). In line with this view of the roles of computer systems, some studies make direct comparisons between courses delivered through CSdCL, and through conventional forms of distance education and collaborative learning, to explain potential benefits of the new learning situations (e.g., Hiltz, 1988; Wells, 1990; Hiltz and Turoff, 1994; Harasim et. al., 1995). The studies tend to focus on the medium of instruction and learning, *separately* from issues like pedagogical methods and potential learning outcome, target groups, subject domains, etc. Moreover, the studies include few considerations on how the computer systems influence and change existing pedagogical practice and thinking.

I argue that focus on existing educational practice and theories developed for the purpose of conventional ways of organizing learning and teaching on the one hand, and focus on the computer systems' capabilities to support or enrich the embedded interactional processes on the other, do not provide insights for CSdCL designs. CSdCL is resting on its *own* conditions. These conditions, I will argue, are shaped by *contradictions* between computer systems and theoretically and practically founded understandings of interactional processes. Computer systems are *more than* value-neutral means to support, or represent, activities that take

place in conventional ways of learning and teaching. The computer systems are intertwined with interactional processes. In use, they influence the way human actions are performed, and the course of interactions. In turn, this influences computer systems design and pedagogical design. However, there are recent insights into what the nature of the interactional processes in distributed and collaborative learning communities is like, and how the computer systems and other factors influence the students' processes. Such insights are totally decisive for CSdCL designs.

Thus, my main perspective is that computer systems design and an institution's planning of a CSdCL activity, are not concerned with problems that can be solved by addressing the three aspects of CSdCL separately. I argue that it is a problem of *integrating* all three of them in designs. One goal of my research is therefore to analyze the practice of various CSdCL cases on this ground, with the purpose of understanding and identifying the critical factors that affect the students' distributed and computer-mediated interactional processes. Then, my second objective is to develop frameworks that guide systems designers and course designers towards recognizing the contradictions inherent in the situation under consideration. Based on the two first objectives, my third objective is to point out possible directions towards solutions.

1.2 Structure of the Thesis

The thesis is structured into two parts. The six papers, presented in Part II, constitute the core of my contribution. Part I presents and discusses the background of my research, leading up to the contributions in a broader context than the papers do.

1.2.1 Part I

Part I has the following structure: Section 2 presents the fundamental research philosophy, which lay at the core of my research. Research approaches are discussed with respect to the chosen problem area. Section 3 presents and discusses the theoretical background. Section 4 presents the research questions. Section 5 presents and discusses the results from the analysis of a number of CSdCL cases. The main motivation of this research was initiated during my work at the Norwegian NKS Distance Education during the period 1990-1994. My examination of this early instance of CSdCL is not outlined in any of the included

papers. The section starts with a brief analysis. Then follows a discussion of the results based on my investigations of other CSdCL cases. The findings from the latter cases are described and discussed in detail in part II of the thesis. Section 6 presents frameworks for CSdCL. Section 7 shows how I have used the frameworks in computer systems design and planning of a CSdCL activity. Section 8 concludes the research. Section 9 presents further research.

1.2.2 Part II

Part II is the six papers that constitute the core of my thesis. Each of the papers discusses empirical findings in accordance with the theories presented in sections 2 and 3 of part I. References to these papers in the other parts of the thesis are indicated by underlining the references. The original papers, and their abstracts, are in alphabetic order:

1. Fjuk, A. (1995): Towards an Analytical Framework for CSCdistanceL. Schnase, J. L.; Cunnis, E. L. (Ed.): *CSCL´95: The First International Conference on Computer Support for Collaborative Learning*, pp. 130-134. Lawrence Erlbaum Associates.

   This paper presents a framework for evaluation of computer applications in relation to the new and unique phenomenon of learning: Computer supported collaborative distance learning (CSCdistanceL). The framework may also be considered a means for designing computer applications mediating human actions of collaborative learning. Problem-oriented project pedagogy is used as a pedagogical foundation to understand collaborative learning. The crucial aspects of this pedagogical viewpoint are interpreted into dialectical contradictions. The contradictions constitute a basis for understanding the incorporated role of the computer application in the various human actions of collaborative learning.

2. Fjuk, A.; Dirckinck-Holmfeld, L. (1997)[3]: Articulation of Actions in Distributed Collaborative Learning. Submitted to *Scandinavian Journal of Information Systems*.

   This study is aimed at exploring how a CMC (Computer-Mediated Communication) system and other factors influence distributed collaborative learning processes. The study is based on ten years of practice and research at the Aalborg University in Denmark, however focused through an exploratory experiment. By applying Anselm Strauss concepts of articulation—within his more comprehensive interactionist theory of action—the study indicates that distributed collaborative learning entails additional work for the geographically dispersed students rather than being a means for active construction of

[3] Annita Fjuk is the first author. A previous version of this paper—Sammenføyningsarbeid i distribuerte kollektive læreprosesser—is published in: Danielsen, O. (Ed.): Læring og multimedier, pp. 145-176. Aalborg Universitetsforlag, Denmark.

knowledge and social negotiation. The computer system cannot, in and of itself, support the collaboratively based processes of learning. Rather, distributed collaborative learning is accounted for by entirely different and far more complex factors grounded in the pedagogical approaches to learning, and its renewed interests to distributed situations.

3. Fjuk, A.; Smørdal, O. (1997)[4]: The Computer's Incorporated Role in Work. Submitted to *Information Technology & People*.

Networked computers are increasingly being used in cooperative work settings, seriously impacting the way we work together. An understanding of the relationship between networked computers and collaborative human work is necessary. Further, systems developers need frameworks that address both social and technical issues in order to be able to analyze work with computers and design of computer systems. Some theoretical accounts of this relationship exits, but in terms of usefulness for systems design and how the role of the computer in work is regarded, they have shortcomings. - This paper develops a conceptual framework for understanding computers as *incorporated* into work, focusing the computer as a tool and as a sign in the aspects of work, production, exchange and distribution. The framework is based on activity theory, further enriched by interaction theory.

4. Fjuk, A.; Sorensen, K. E. (1997)[5]: Drama as a Metaphor for Design of Situated, Collaborative Distributed Learning. *European Journal of Open and Distance Learning*

This paper deals with the complexity of designing distributed collaborative learning (CSdCL). The complexity is found in the integration of those pedagogical,- organizational- and technological aspects that influence a collaborative learning process. From a basic understanding of this complex triadic feature of CSdCL, a metaphor from theatre is suggested as a framework for understanding and approaching design of CSdCL situations. Three CSdCL-examples from practice are analyzed and critical aspects of CSdCL are explored from the perspective of this new framework to demonstrate the benefits of using a holistic metaphor to comprehend and capture the challenge of CSdCL design.

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4 Annita Fjuk and Ole Smørdal have a shared responsibility. The paper is based on: Fjuk, A.; Smørdal, O.; Nurminen, M. I. (1997): Taking Articulation Work Seriously. An Activity Theoretical Approach. TUCS TR 120 (Technical Report). University of Turku, Finland. ISBN 952-12-0036-7.

5 Elsebeth Korsgaard Sorensen has the responsibility of the section named 'Interaction: The Basis of Human Existence'. Annita Fjuk has the responsibility of the section named 'Perspectives Behind Distributed Collaborative learning'. The responsibility of the rest of the paper is held by both authors.

5. Fjuk, A.; Øgrim, L. (1997a)[6]: The Dichotomy of Distributed Collaborative Learning. Approached through Dialectical Analysis. *Proceedings of ICDE'97. Internet Anthology of ICDE'97 Conference Papers.* Editors: The International Council for Distance Education (ICDE) and The Pennsylvania State University.

   Designing distributed collaborative learning situations of good quality is a complicated problem. The problem is identified into a dichotomy of aspects, historically found in the traditions of distance education and collaborative learning respectively. In order to improve good conditions for learning, we suggest that the contradictory aspects of these traditions need to be considered more thoroughly than up till now.

6. Fjuk, A.; Øgrim, L. (1997b)[7]: Towards Transcendent Thinking in Design of Distributed Collaborative Learning Environments. *European Journal of Open and Distance Learning*

   Studies conducted at two educational institutions—each rooted in the traditions of distance education and collaborative learning—indicate that principles and methods from these traditions have been directly transformed and adjusted to distributed collaborative learning situations. Based on the Scandinavian critical tradition on system development, we argue for another position: Pedagogical design and systems design should explicitly seek to view the tension between tradition and transcendence. This is applied in a prototyping process discussed: The process was aimed at building on and transcending perspectives related both to distance education and collaborative learning.

2 Research Approach

The research approaches I have used are discussed in this section. It presents the institutions that designed, organized and delivered the studied CSdCL cases as well as how the research goals were approached according to these situations.

2.1 Research Philosophy

The goals of my research are to:

1. Identify critical factors that influence distributed and computer-mediated interactional processes.
2. Develop frameworks that guide systems designers and CSdCL organizers to identify possible contradictions in the problem area

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6 Annita Fjuk is the first author.

7 Annita Fjuk is the first author.

3. Point out possible directions for resolving problematic issues in new CSdCL situations.

The basic goal of my research is to analyze a number of CSdCL cases (section 2.3) for the purpose of understanding the new conditions of *distributed and computer-mediated interactional processes*, and of identifying critical factors that affect these processes. Moreover, my intention is not to solve problems, but to *identify* them in order to suggest directions towards solutions with respect to courses and computer systems.

To approach this, I base my research on social constructivist/ phenomenological research approaches. From a view that gives priority to human behavior and experiences, it clearly follows that it is necessary first to review and understand the nature and conditions of distributed and computer-mediated interpersonal interactions before planning CSdCL situations, and making computer systems for them. Especially, this is crucial in situations where one is about to investigate and define *new* learning situations in which collaboration and computer-mediation have significant status in the learning process. The idea behind phenomenological approaches is that the world is socially and subjectively determined (Easterby-Smith et. al, 1991). The basic aim is to search for *the totality* of a situation and to appreciate the different constructions and implications that people place upon their experiences. The effects of distributed and computer-mediated collaborative learning interactional processes then, I argue, are sought to be understood through participant observation and through collaboration with those involved: The students, the teachers and the CSdCL organizers.

Hence, I argue that positivist research approaches imply shortcomings with respect to the problem area. The key ideas of positivism are, that the social world exists externally and objectively, and because of that, the aim of the researcher should be to reduce phenomena to the simplest elements (Galliers, 1992; Easterby-Smith et. al., 1991). An essential aim is to make concepts operational so that they can be objectively measured. If following a pure positivist approach, the effects of distributed and computer-mediated collaborative processes can be quantified in terms of objective measurable variables like e.g., number of written contributions, number of connections to the system made by an individual, etc. The student's learning outcome can be measured by the student's mark. As I will point on in section 5.1, a student's mark only give a prediction of the individual's learning outcome.

2.2 Theoretical Approach

> "The map is not the territory" (Korzybsky, 1933; quoted in Aboulafia and Nielsen, 1997).

Whether walking in the mountains or sailing on the fjords, we need a map to guide us from our point of departure to our destination. However detailed the map may be, it proves insufficient when unexpected situations like storms, etc. arise. We then have to rely on our intuition, creativity or on other available means such as a compass, to come out of the problem situation.

Similarly, a theory is a manifestation of thought related to a phenomenon. It does not integrate all different relations and characteristics of a phenomenon, but it gives us an idea. Like a map, it is an abstraction or model of the reality. A theory constitutes an indispensable guiding principle to understanding practice often in combination with other theories (Øgrim, 1993; Mellin-Olsen, 1993). On the other hand, new theories and knowledge are constructed through unique cases of practice (Schön, 1983).

CSdCL is a new field of research and practice. Theories and concepts from various disciplines and research domains are needed to explain and understand CSdCL in terms of its own conditions and, moreover, to develop theoretically based frameworks for CSdCL designs. With this as a starting point, my research has sought to use theories that, separately or in combination, capture the interwoven phenomenon that CSdCL is.

I argue in section 3 that *socio cultural* views on learning are useful theoretical points of departure for CSdCL. Learning in this view is fundamentally both socially and instrumentally mediated. It provides a theoretically based understanding of the meaning of instrument-mediated and interpersonal processes. This becomes particularly evident in Fjuk and Smørdal (1997) and in Fjuk and Øgrim (1997b) in Part II of the thesis. Theories from *distance education* are useful for understanding interaction in learning over distances, and how this is approached in theoretical developments and course design. Also, *dialectical systems approaches*, combined with *systems approaches to distance education*, provide insights into viewing CSdCL as a phenomenon where different factors support and exclude each other. This is explained in section 3, and becomes particularly evident in Fjuk (1995), Fjuk and Øgrim (1997a) and in Fjuk and Sorensen (1997) in Part II of the thesis.

I have also used theories and concepts applied in the research domains of CSCL and CSCW[8]. CSCL, CSdCL and the rather established field of CSCW govern similar variables. The fields are concerned with computer support for collaboration. Some researchers, however, consider a complicated relationship between CSCL and CSCW. Kolodner and Guzdial (1996) relate the differences to interface design, and emphasize that the goals of supporting learning are both different and broader than the goals of supporting work. Designing interfaces for CSCL (or CSdCL) is argued to enhance structure for beginners who need guidance. Heeren (1996) discusses the relationship between CSCL and CSCW by relating it to a process- and product-oriented view on collaboration:

> "while CSCW technologies can be assumed to be designed for efficiencies of task performance, technology support for collaborative distance learning should be designed for active collaborative involvement and deep processing by investing mental effort in learning." (Heeren, 1996, p. 22).

Heeren (1996) thus emphasizes that systems designers should consider whether the primary aim is the collaborative *processes* themselves or the efficiency of obtaining a *common product.* I find it difficult to make a clear distinction between the two fields. Problem-oriented project pedagogy is an example (See Fjuk and Dirckinck-Holmfeld (1997) in Part II of the thesis and section 3). The collaborative *processes* constitute the core of this pedagogical method. The students' alternative perspectives in argumentation and joint construction of problems, are essential principles. The processes then become a goal for the course designers. When it comes to the students, the incentive for collaboration can turn out to be a totally different one than the intended philosophy. That is, to obtain good marks for the final report that concludes the process. Although some CSCW research has contributed to an understanding of computer-mediated collaborative processes (e.g., Fitzpatrick et. al., 1995), the object of the studied activity is to a limited extent *intentional* learning, i.e., situations where *learning* is the primary object for collaboration, as well as for research and design activities.

Access from homes is a basic issue concerning computer support for CSdCL. This has to a limited extent been the focus of CSCW, but has been the key element in distance education research and practice (c.f. Bates, 1995). Also in

[8] Computer Supported Cooperative Work

contrast to the majority of CSCW research, the users I refer to with respect to CSdCL, are short-term users. *Who* the users are, and their *access* to the computer systems, become, I argue, as important, as the distinction between product and process. Compared to work situations and on-campus studies, CSdCL makes huge differences regarding accessibility to networks, computer equipment and technical support**.** These issues become evident in my discussions in sections 5.1 and 5.2.

I have, however, used some of the CSCW literature that focuses on collaborative communities and the conditions for building the same. That is literature particularly concerned with Anselm Strauss' (1985; 1988; 1993) concepts of *social worlds* and *articulation.* Social worlds develop through the conditions embedded in interpersonal interactions. This view is particularly interesting when considering the problem area of CSdCL: The students are not co-present and they do not share a common cultural and organizational context. Strauss (1993, p. 87) defines articulation as "the coordination of lines of work". Collaborative communities, such as projects, involve a course of actions that entails a division of work in the sense of both actors (students) and actions. The concept of articulation work constitutes a basis for the work presented in e.g., Schmidt and Bannon (1992), Schmidt (1994) and Simone et. al. (1995), that place emphasis on management of work flow and coordination mechanisms. In contrast to this work, I apply Strauss' concepts of articulation within his more comprehensive *interactionist theory of action* and interaction. This is close to the interpretations made in Fitzpatrick et. al. (1995) and Fitzpatrick et. al. (1996). In Fjuk and Dirckinck-Holmfeld (1997), I show how these concepts are useful for analyzing the students' distributed and computer-mediated interactional processes. But, as I argue in section 6.2 and in detail in Fjuk and Smørdal (1997), I do not share Fitzpatrick et. al.'s view with respect to systems design.

I also find the notion of *awareness* (Dourish and Bellotti, 1992; Bellotti and Bly, 1996) particularly interesting with respect to my work of understanding the conditions of distributed and computer-mediated interpersonal interaction. Awareness has clearly impacts on the students' collaborative processes, since it includes the "understanding of the activities of the others, which provides context for your own activity." (Dourish and Bellotti, 1992, p. 107).

The application of this briefly reviewed literature becomes particular evident in Fjuk and Dirckinck-Holmfeld (1997), Fjuk and Øgrim (1997b) and Fjuk and Smørdal (1997) in Part II of the thesis.

2.3 The CSdCL Cases

Reflections on CSdCL cases are approached both as a researcher and as a pedagogical- and systems designer. Andersen et. al. (1990) argue that systems design can be regarded as research, since there is no clear difference, on grounds of principles, between the practice of systems design and research. The main difference is, however, related to the object of the activity. The practice of systems design results in products and, research results in knowledge (ibid.). Concerning my research, the first research goal is directed towards knowledge. The second research goal is concerned with the link between understanding the nature of computer-mediated interactional processes, and systems design. The third research goal is directed towards products, i.e., possible directions towards solutions, including computer systems. I find my approaches close to Schön's (1983) message on design:

> "Our knowing is *in* our action" (Schön, 1983, p. 49).

When a designer reflects in action she/he becomes a researcher in the practice context, and defines the problems interactively with the situation (ibid.).

In what follows I outline how my investigations on the practice of CSdCL are conducted, and how they are connected to the research goals. The section is structured according to the sites that designed, organized and delivered the CSdCL cases under observation.

2.3.1 Research Sites

My selection of research sites has been done in accordance with *their long-range experience* on CSdCL. The difference between CSdCL in self-financed runs and in external funded projects is significant with respect to the experiences. I base this argument in my practical work of designing and organizing CSdCL at the Norwegian NKS Distance Education. Bates (1995) reflects upon this:

> “There are real dangers though in being driven by funding specifically linked to the use of new technologies. The first is the question of sustainability. If the technology is not cost-effective, an institution will find it difficult to continue with the technology when external funding or subsidies cease. Secondly, external funding for new technologies tends to be limited to capital investment in the technology, or subsidy of transmission costs, both of which are usually minor compared with the costs of course production and educational support during presentation of the course.
>
> Novelty then is very much a two-edged sword” (Ibid., p. 12)

Projects often bear the marks of experimenting with new technologies for the purpose of testing its usability. Resources with respect to money and people are dedicated to the experiment. Run situations are, however, dependent on available resources with respect to course design and production, administrative organization, maintenance and re-design of the computer system, user training and technical user support, etc. It is only through usage of the technology in real practice that we get to know its conditions with respect to specific learning situations and the institution's capability to deliver CSdCL.

There are few institutions that have long-range experience on CSdCL. The Norwegian institution NKS Distance Education, the British Open University and the Danish Aalborg University are of the few institutions that have offered CSdCL as a permanent learning approach during the last ten years. These three institutions constitute the sites for my research — both with respect to reflection on practice (NKS Distance Education, Aalborg University and to some extent the British Open University) and to apply the developed frameworks in a practice of developing courses and computer systems (NKS Distance Education).

These institutions differ with respect to pedagogical tradition, but in particular to the opposite and general approaches to distance education.

> "Whereas the former [large-scale systems] develop courses for hundreds and thousands of students, often as a result of teamwork, and then engage groups of tutors to comment on students' work and teach in other ways, the small-scale approach implies causing teachers to develop courses exclusively for their own students, so that the course author is identical with the tutor" (Holmberg, 1995, p. 7).

The large-scale approach is typically represented by The British Open University and the Norwegian NKS Distance Education. These distance education institutions can be regarded as innovations outside the traditional educational systems in that they apply industrial working methods (Peters, 1993), such as division of labor, economies of scale, etc. More than the large-scale approaches, the small-scale approaches are placed within traditional educational systems and, when necessary, replace more traditional forms of learning and education found in face-to-face-based situations. The distance education program at Aalborg University (Denmark) is a typical small-scale distance education organization.

2.3.2 NKS Distance Education

Correspondence education, which is the origin of what today is termed distance education, has been practiced at the NKS Distance Education since 1914. NKS made lifelong learning possible long before it became an objective of modern society (Amdam and Bjarnar, 1989, preface). NKS is at stand still leading in distance education system along with e.g., the International Correspondence Schools in the USA (founded in 1891), American School in the USA (founded in 1897) and Hermods in Sweden (founded in 1898) (Holmberg, 1995).

NKS has been important concerning my understanding of practice. Reflection on practice is conducted in three phases:

1. Long-range practice of CSdCL run.
2. The distributed pedagogical seminars.
3. The Dynamix project.

The following sections present these phases and their effects on my research goals.

The Run of CSdCL

During the 80ies, computer-mediated communication (CMC) provided new opportunities for organizing collaboratively approached learning methods in

distance education. Text-based and asynchronous computer conferencing systems are the far most applied (Bates, 1995). Already in 1982, The Western Behavioral Sciences Institute inaugurated the first educational program employing computer conferencing systems as its chief means of delivery (Feenberg, 1991). The various conferencing systems that were available in the market, differed somewhat from one system to another. However, one of the key elements of conferencing systems is the structure provided for grouping messages. New members of a conference can take part in the history of the written contributions, and reflect upon it before actively making contributions themselves. This structure is supposed to mediate the individual's social identity to a community, by means of a collection of written contributions (Mason, 1994).

A pilot project was initiated at the NKS during the spring of 1989. The primary objective was to investigate what implication communication between students had on the established teaching-learning system rooted in correspondence education (Søby, 1990; Fjuk and Jenssen, 1990). A secondary aim was to investigate the new possibility of offering project-based learning at a distance. The text-based conferencing system PortaCOM (See Fjuk and Jenssen (1991) for details) was introduced to support interaction between geographically separated students, and between student and teacher. The experiences gained during the pilot project and the next three years quite correspond (Fjuk, 1992).

Public computer conferences were created for stimulating interpersonal interaction with regard to various subject domains[9]: Marketing, law, organizational theory, statistics, economics, mathematics and computer science. The student's participation in these conferences was voluntary.

The practical experiences which I gained through the processes of designing and organizing CSdCL situations (in the period 1990-1994) [10] constitute the basis and motivation for my research as well as the focus of my research: CSdCL

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[9] Other conferences were created to take care of questions directed towards the administrative staff, technical expertise, and social activities usually taking place at cafés.

[10] 100 students participated during the pilot project. The investigation is based on interviews of 25 students and five teachers, supplemented with observations in the computer conferences (Fjuk and Jenssen, 1990). The number of students increased to 1000 during the period of 1990-1992 (Fjuk, 1992). During the period of 1992-1994, the number of students decreased to 50, and 20 at the lowest. The investigations are based on quantitative questionnaires, observation and informal conversations with the students and the teachers.

situations where the adult student's outcome of interpersonal interactions and their limited access to computer-based resources, are crucial issues of CSdCL practice. Moreover, the experiences taught me the importance of connecting research to practice.

I have analyzed the experiences from the run as a part of my doctoral research (section 5.1). The analysis is conducted in accordance to the existing practice of interaction in distance education: Learner-content interaction and learner-teacher interaction (see section 3). The focus of the analysis differs from that presented and discussed in detail in Part II of the thesis: CSdCL situations where diverse principles of collaborative learning constitute the basis for analysis.

The early run at the NKS has thus a twofold purpose: First, it constitutes the motivation and basis for my research focus. Second, the analysis of the run provides insight into what factors that influence the students' distributed and computer-mediated interactional processes.

Distributed Pedagogical Seminar

The Distributed Pedagogical Seminar was arranged and run by NKS Distance Education (partly in cooperation with the University Center of Information Technology, University of Oslo) as part of the EC-project COSTEL (Course Systems for Telecommunicated Training of Trainees and Innovation Management)[11]. The overall aim of COSTEL was to develop a course system covering 1. Training of trainers in distance and flexible learning, 2. SME (Small and Medium-sized Enterprises) innovation using computer and telecommunication options, and 3. Computer and telecommunication based organizational innovation, and, teleconsultancies.

The principal aim of the seminar was to give future consultants, teachers and educational administrators an appreciation of the strengths and weaknesses of the use of CMC systems in distributed collaborative learning environments (Fjuk and Jenssen, 1993). The actual number of participants was 26, mainly college and university teachers from the Scandinavian countries.

I[12] was the designer of the seminar, and, participant observer also. The pedagogical design was guided by the idea of pedagogical seminars, partly combined with basic principles from distance education (see section 3). The

11 The seminar was designed and run during my work period at the NKS.

12 In collaboration with Astrid Jenssen (University Center of Information Technology, University of Oslo)

overall aim of pedagogical seminars is discussions on scientific topics under professor- or expert guidance.

When it came to observation, it was undertaken by being a passive participant in the computer conference created solely for discussions. The analysis of the seminar was undertaken in collaboration with an external observer/researcher of the seminar (Co-author of Fjuk and Sorensen (1997)). The participants' textual contributions to the discussions formed the basis of our analysis of the interactional processes. The contents of the students' discussions were compared with the theoretical intention of the pedagogical design. Since the analysis indirectly reflected upon my results of the design process it was particularly interesting. It gives an indication on how an institutional tradition (in this case, the principles of distance education) implicitly guided the pedagogical design, and thus the designer's perspectives (my perspectives) into an other direction than originally intended (interpersonal discussions).

PortaCOM constituted the main mediator of the interpersonal activities.

The Dynamix Project

A new pilot project, the Dynamix project, was initiated by NKS Distance Education and Department of Informatics (University of Oslo) in joint collaboration[13]. The aim of the project was to pursue a change in designs and in delivery of CSdCL. The goal was to incorporate available Internet-services, principles from distance education and principles from project-based learning, into course design and computer systems design. To approach this goal, researchers[14] and practitioners collaborated throughout the whole design process. The practitioners as such did not assume roles of informants or respondents, but of collaborating actors of the research.

The theoretically based frameworks I have developed (research goal 2) were used during the project. The frameworks bear the double burden of testing their application area and effecting some change with respect to CSdCL. The development of the frameworks was not an activity of the project itself, but was based on NKS' as well as other institutions' experiences (see section 2.3.3) regarding CSdCL. This approach is almost equivalent to what Argyris and Schön (1991) classify as an important part of action research. That is, it

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13 This project constituted the last part of my research.

14 My supervisor (Leikny Øgrim), a master thesis student of mine (Ola Berge) and myself.

> "builds descriptions and theories within practice context itself, and tests them there through *intervention experiments* (...) (ibid., p. 86)

Whether the project can be classified as pure action research can be discussed. Nevertheless, it has some features in common with this research approach: Planned change, building the future, intervention (Braa and Vidgen, 1995), the change forms part of the research process itself (Easterby-Smith, et. al., 1991), common agreement on change between practitioners and researchers, and a view that places emphasis on collaboration between practitioners and researchers (participatory action research) (Whyte, 1991; Elden and Levin, 1991).

One of the results of the project was a computer system based on World Wide Web[15]. Risk-driven prototyping, inspired by Boehm's (1988) spiral model, was applied (see Berge (1997) for details[16]).

The Scandinavian, critical tradition in academic system development is characterized by user participation. This became a problem since the potential students were cited geographically all over Norway. However, the various versions of the pilot system were applied in different contexts: Earlier versions of the system were applied and evaluated by graduate students of informatics at the University of Oslo and informatics students at the Polytechnical College (in Norway). The use of the system was a voluntary offer to the students' collective activities usually taken place on-campus. The students had, in terms of their study, a professional interest to evaluate the system for the purpose of re-design and re-implementation. Although these students did not represent the assumed target group of the system, their critical evaluation and re-design suggestions, were valuable for further systems developments. The version, which is briefly presented and discussed in this thesis, was applied by employees at the NKS, participating as students in a course aimed at training project management.

2.3.3 The University of Aalborg

The distance education concepts in Denmark, in contrast to those in Norway, do not represent a strong tradition. The interactive potential of CMC systems was meant to correspond with a Danish collaboratively oriented learning tradition (Sorensen, 1997). In contrast to traditional distance education practice in Norway,

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15 Ola Berge implemented the pilot system.

16 http://www.intervett.no/~ola/thesis

based on pre-produced course material and assignments (see section 3), the distance education activity at Aalborg University is in line with the basic principles of problem-oriented project pedagogy (see section 3): Participant's control and problem orientation. The teacher and the students collaborate in organizing the learning and tutoring processes (Dirckinck-Holmfeld, 1990).

Problem-oriented project pedagogy is the pedagogical basis also for the CSdCL activity. Because of the pedagogical basis and its assumed value to adult learning (e.g., Bruffee, 1993) the CSdCL activity at Aalborg University was particularly interesting to study.

My research undertaken at Aalborg University was aimed at the following:

1. *To learn about problem-oriented project pedagogy*. I approached this by being a supervisor for a student project (not in a CSdCL context).
2. *To reflect on the practice of distributed and computer-mediated problem-oriented collaborative learning.* I approached this by discussing experiences with students (a student project) and teachers of distributed learning situations. The students were first year students of humanistic informatics. Their learning goal was to construct a common understanding on an ill-structured subject-domain (the use of CMC in problem-oriented and project-based learning). They were beginners concerning both humanistic informatics and problem-oriented projects. In addition, they were also inexperienced as far as the use of the computer system was concerned and furthermore on participation in a learning community that is distributed in time and place.

   The discussions were organized as reflective discussions where problems of CSdCL were identified. This was approached by drawing rich pictures and identifying contradictions in collaboration, inspired by the systems development technique Soft Dialectics (Bratteteig and Øgrim, 1994). Appendix 1 presents Soft Dialectics in more detail.

   The discussions were video taped and transcribed. The transcripts proved to be useful indications for further reflection and interpretation of the contents of the discussions. In addition, I was passive observer in the students' computer conference created solely for discussions and coordination of individual activities. I was permitted to make observations.

The computer conference system FirstClass was used. In contrast to PortaCOM, FirstClass is not based on a general text metaphor, but on a mail metaphor.

2.3.4 The British Open University

The Online Education and Training (OET) course was run in parallel with the distributed Pedagogical Seminar (as a part of the same EC-project COSTEL) by the Open University and the University of London in joint collaboration. The Open University is a full time distance education based institution, established in 1967 by the British government. It is a nationwide-university system with no resident students. It is large, well funded, employing the fullest range of communications technologies to teach a full university undergraduate curriculum to adults (Moore and Kearsly, 1996).

The principal aim of the OET course was to give students an appreciation of the strengths and weaknesses of the use of CMC in distance learning. The course proved attractive to 47 participants (from the UK, Australia, Iceland, Israel, Russia, Spain, and the USA), including university and polytechnic lecturers, school teachers, educational advisors, nursing trainers, a prison training officer, and computing advisors.

I was passive observer, primary due to NKS' involvement in the COSTEL-project. The analysis was carried out in collaboration with participant observer of the course (co-author of Fjuk and Sorensen (1997)).

The computer conference system used was CoSy.

2.4 Summary

This section has presented and discussed the following:

- My basic *research philosophy*, which is rooted in a phenomenological research paradigm. In line with this research paradigm it is necessary to understand the nature of distributed and computer-mediated interactional processes, and to appreciate the implications that students and teachers place upon their experiences of interactional processes. Especially, this is crucial in situations where one is about to explore and define *new* learning situations in which collaboration and computer-mediation have a central position to learning.
- The *CSdCL cases* of my investigation. My investigation on CSdCL in practice involved a number of cases. These were designed and delivered by

well-known teaching institutions, all delivered CSdCL as a permanent offer during the last decade. The institutions' philosophy and educational grounding represent the traditions embedded in CSdCL: Distance learning and collaborative learning.

- The *theoretical background* of my research. My work is in the intersection between the research domains of CSCL and distance education. CSdCL represents a new and interdisciplinary field, where theories and experiences from diverse disciplines are needed to be integrated. Theories on interaction, established within the two educational traditions, constitute the theoretical background of my research (see section 3). Systems approaches to distance education, combined with dialectical systems approaches, have influenced my research and research focus (see sections 3 and 4).

3 Theories on Interaction in Learning

This section provides the theoretical background for my understanding of interaction in learning. I place emphasis on collaborative learning, and the section starts with presenting and discussing the basic perspectives behind collaborative learning methods. Then follows approaches of interaction, developed for distance education. The section presents also systems approaches to distance education and dialectical systems approaches, and discusses their appropriateness to the problem area of CSdCL.

3.1 Interaction in Collaborative Learning

Collaborative learning is a broad field of study. It is not a theory of learning in itself, but rather a collection of perspectives based on the principles of interpersonal interaction (Sorensen, 1997). A common view is that interpersonal interaction is valuable with respect to learning and personal growth. Although collaborative learning is a collective phenomenon it is inherently an individual process. This process is, however, influenced by a variety of external factors, including group and interpersonal interaction (Kaye, 1992). Collaborative learning does not necessarily imply joint construction of knowledge and negotiations of alternatives. Rather, learning collaboratively can imply a possibility of being able to rely on peers and teachers to support one's own learning and to give feedback (ibid.). Perspectives on collaborative learning thus place emphasis on potential

different goals: 1.) Joint construction of problem solutions by mutual refinement; 2.) Exploring different opposed alternatives in argumentation; 3.) The students are using each other as a resource.

Two major theoretical perspectives that have dominated pedagogical development and have received attention in CSCL research (O'Malley, 1995; Dillenbourg et. al., 1995) are the *cognitive theory* derived from the Swiss psychologist and philosopher Jean Piaget and, the *socio cultural theory* derived from the Russian educationist and psychologist Lev S. Vygotsky. These two perspectives are presented and discussed from the perspective of CSdCL.

Both the Piagetian and the Vygotskian perspectives assume that construction of knowledge has to be based on human interaction with nature and society (Mellin-Olsen, 1993). However, the basis for their interpretations is different. The Vygotskian perspective emphasizes asymmetric roles, whereas the Piagetian perspective emphasizes equal roles combined with the benefits of conflict (Roschelle, 1996). For Vygotsky, learning was primarily a goal-directed activity, and a key concept in his work was the *zone of proximal development*. Piaget, on the other hand, was concerned with experiential methods for learning. The child's development through *static maturational levels* constitutes the core of his theory. According to Mellin-Olsen (1993) these two major approaches to collaborative learning, cannot be viewed separately: A goal-oriented learning approach needs to be based on experiential methods, and, a consideration of methods needs to have the goals for learning in mind. Although Vygotsky was among the first to criticize Piaget's model of equilibrium, he built his theory on Piaget's work (Vygotsky, 1994).

3.1.1 Piaget and Socio Cognitive Theories

In his early work, Piaget emphasized the importance of social interaction on individual development and saw alternative perspectives in argumentation as the driving force for human development. This view has inspired the development of a number of subsequent learning methods, e.g., *experiential learning* (Kolb, 1984) and *problem-oriented project pedagogy* (Illeris, 1974).

According to Piaget, the interrelation between a human being and the social environment takes place through two complementary ways of adaptation: *Assimilation* and *accommodation*. Illeris (1974) has formulated the two styles of learning in the following way:

> "Assimilative learning is a learning style, in which the individual adapts and incorporates his experiences as an expansion and a differentiation of already established cognitive structures (...). Assimilative learning is in its 'pure' form characterized by a steady and stable advancing development in which learning is constructed, integrated and incorporated.
>
> (...)
>
> Accommodative learning is a learning style, in which an individual's cognitive structures are changed through disintegration, when existing learning elements are released from the original learning context and can then be included in new structures." (Illeris, 74, pp. 71-72, translated in Birkenes and Fjuk (1994))

Assimilative learning is described as ‘traditional school teaching’ (Illeris, 1974) where the discrepancy between the new situation and the cognitive structure is too small. The situation does not present inconsistencies and is not novel enough to stimulate interest to motivation leading to action (Patterson, 1977).

Accommodation, in contrast to assimilation, implies discrepancy between present cognitive structures and this presents too much novelty. It is beyond the power of the individual to deal with, or to relate to her/his cognitive structures (Patterson, 1977). The individual has to break down the existing cognitive structures in order to build up new ones. These processes may imply 'pain' and inner contradictions, but are the *prerequisite* for creativity and progress towards building up new structures. An effective learning process contains prevailing assimilation and prevailing accommodation, i.e., none of the learning styles can separately provide effective learning (Olsen, 1993).

Accommodative learning may be carried out both individually and collectively. However, Piaget (1950) emphasizes that the continuous exchange of ideas and meanings with others in a collaborative process is the most effective way of cognitive development. In collaborative situations, contradictions between different perspectives of a phenomenon arise, and then also inner contradictions leading to personal growth.

Computer-Mediation and Piagetian Perspectives

The application of the Piagetian perspective to CSCL is typically addressed by a collection of methods, in which teachers and learners have collegial roles as collaborative actors (Koshmann et. al., 1996). CSCL then becomes a focused study of the use of collaboration technology in instruction (Koschmann, 1994). Whitelock et. al. (1995) use a Piagetian understanding to investigate the effects of conflicting understanding in computer supported collaborative learning. They conclude that the benefits gained were not just because of interpersonal interaction, but because of the physical presence of others sharing the same task (ibid., p. 383). The most influential work along these lines is probably Papert's (1980), who argues that the activity of programming computers plays an important role in learning. Computer programs are, according to him, particularly interesting because in contrast to static media, such as papers, they are executable.

Concerning the problem area of my research, the Piagetian perspectives are not explicitly dealing with *technology mediation*. This important issue of CSdCL, can better be explained by the Vygotskian perspective of interaction and instrument mediation.

3.1.2 Vygotsky and Socio Cultural Theories

Vygotsky, who is considered the founder of activity theory, was among the first to recognize the importance of the societal dimension in the educative process. He therefore sought to define those aspects of social engagement that concern the development of mental processing (McMahon and O'Neill, 1992). A key issue in his research is that intellectual development takes place on two levels. First it appears on a social level, through *interpersonal* processes. Then it appears on an individual level through *intrapersonal* processes. In other words, new construction of knowledge is characterized as *from* inter-subjective mental actions *to* intra-subjective ones (Kaptelinin, 1996b). Learning is thus claimed to be social by its very nature. The individual actions that can be performed in collaboration with others comprise the zone of proximal development. The zone of proximal development is:

> "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

Implicit in this concept is the asymmetric roles amongst teacher and student (Mellin-Olsen, 1993). Instructional support is given to the student, enabling the student to acquire new knowledge through problem solving and interpersonal interaction. In line with this understanding of the zone, comes the notion of 'scaffolding' (creating formats, see Engeström (1987)). The learner internalizes the 'scaffolding' of more capable peers. According to both Engeström (1987) and Lave and Wenger (1991) the notion of 'scaffolding' and problem solving are defined as an

> "unproblematic process of absorbing the given as a matter of transmission and assimilation." (Lave and Wenger, 1991, p. 47).

Central to Vygotsky's theory (and, e.g., his follower Leontjev (1983)) is that human action is fundamentally mediated by a number of *instruments*. These instruments are broadly defined as *signs* and *tools* (Vygotsky, 1978; 1994). The difference between signs and tools rest on the mediating function that characterizes each of them. The function of a tool

> "(...) is to serve as the conductor of human influence on the object of activity; it is *external* oriented; it must lead to changes in objects." (Vygotsky, 1978, p. 55).

Examples of tools are pencils, drawing programs, word processing programs, spreadsheet programs, e-mail systems, and the like. A tool is referring to the indirect function for accomplishing the given action. The signs have a different character. A sign

> "(...) is a means of internal activity aimed at mastering oneself; the sign is *internally* oriented." (Vygotsky, 1978, p. 55).

Signs are means of thinking on a given psychological problem situation, such as remembering, comparing, reflecting, etc. One's language, drawings, writings, schemes, concepts, etc. are examples of signs.

The essence of signs is that they are basic instruments for intrapersonal processes that necessarily have a communicative form. It is the internalization of

social dialogues into an inner dialogue that allows one to plan and monitor cognitive progress and further actions in interpersonal processes. The communicative aspect of an action is the way knowledge is constructed about the phenomenon of question, while the operational aspect of the same action is mediated by the chosen tools (e.g., paper and pencil). A word processing program is the operational means for the individual act of writing, and writing is a communicative means for reflection and interpersonal interactions. The outcome of the action is framed by the embedded conditions of the tools (Leontjev, 1983).

There is thus a *duality* between sign and tool. However, the role of instruments is not limited to the transmission of operational and communicative aspects of human action. The instruments also shape the goals of the people who use, and make them. Kaptelinin (1996b) explains this in the following way:

> "These tools specify their modes of operation, that is, those developed over the history of society. The use of these culture-specific tools shapes the way people act and, through the process of internalization, greatly influences the nature of mental development. Tools are thus carriers of cultural knowledge and social experience. Tool mediation is no less an important source of socialization than formal education is." (Kaptelinin, 1996b, p. 109).

Thus, the instruments shape human actions, and use reshapes the instruments.

Computer-Mediation and Vygotskian Perspectives

Various learning approaches have been inspired by the socio cultural theory. The ones used in my research are presented in the following sections. Some computer scientists and educationists, also find Vygotskian perspectives useful in thinking about computer-mediated collaboration and systems development. Their thoughts are briefly presented here, too.

3.1.3 Problem-oriented Project Pedagogy

The core of problem-oriented project pedagogy (see Fjuk and Dirckinck-Holmfeld, 1997 for details) are the didactic principles of *problem-orientation* and *participant's control*. The idea is, that knowledge needs to be constructed through a collaborative process in which the students create and critically reflect upon a problem. Illeris (1974) relates the didactic principles of problem-oriented project

pedagogy to Piaget's development theory: Problem orientation implies accommodative learning, i.e., learning which breaks down existing cognitive structures and builds up new ones. However, Illeris (1974) emphasizes that Piaget's theories can only be considered as *point of departure* for an alternative learning psychology.

Although Illeris (1974) used Piaget as his point of departure when developing an alternative pedagogy to 'school-teaching,' problem-oriented project pedagogy can also be placed within a socio cultural perspective (Fjuk and Dirckinck-Holmfeld, 1997). The method builds on an integration of socio cultural perspectives and approaches of experiential learning (Piaget, 1950; Kolb, 1984; Illeris, 1974).

This collaboratively approached method has been applied to CSdCL during my research and is presented and discussed in Fjuk and Dirckinck-Holmfeld (1997) and Fjuk and Sorensen (1997) in Part II of the thesis.

3.1.4 Learning by Expanding

Engeström (1987) primarily addresses the relationship between work and learning. Similar to problem-oriented project pedagogy, Engeström's basic argument is that the problem itself must be created by the learner.

> "The problem is that problem solving and structuring are essentially reactive forms of learning. Both presuppose a given context which presents the individual with a present learning task. Learning is defined so as to exclude the possibility of finding or creating new contexts." (Engeström, 1987, p.2)

According to Engeström, learning is the mastery of expansion from actions to a new activity. A *double bind situation* is the key for expansion:

> "In double bind situations, the individual, involved in intense relationship, receives two messages or commands which deny each other — and the individual is unable to comment on the messages, i.e. he cannot make a metacommunicative statement. " (p. 142)

Thus, a double bind situation is a state where it is not possible to go on as usual any more (Cristiansen, 1990). Furthermore, a double bind situation is understood as a social dilemma which cannot be resolved through separate individual actions. Collaboration with others is the key to get out of double bind situations and, thus, to expanded learning.

Through a triadic model (see figure 3.1), Engeström explains how human activity is mediated by rules of communication, instruments and division of labor.

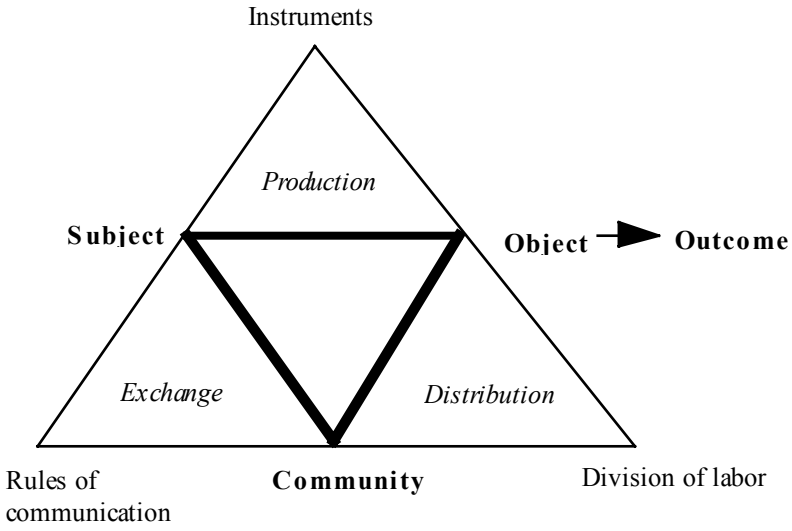

Figure 3.1: Engeström's model of human activity

In an activity, instruments mediate the relation between the individual (subject) and the individual's purpose (object) of the activity. In addition, the individual's relationship to a community is mediated by rules of communication. The community of individuals is mediated by division of labor, i.e., how an activity is articulated among the individuals of the community. A dynamic relationship between the three aspects — production, exchange and distribution — compromises the social- and instrument mediation of human activity.

Engeström considers contradictions the driving force for change and development. The contradictions are separated into different levels, concerning contradictions within the activity and between the activity and surrounding activities. The primary contradiction is "the inner contradiction between exchange value and use value within each corner of the triangle" (Engeström, 1987, p. 87). Engeström suggests studying contradictions between e.g., the instruments used and the object created in order to facilitate a change-oriented perspective on human activity.

Engeström's concept on expanded learning, as well as his triadic model of human activity has inspired researchers within the profession of computer science. Nørby et. al. (1989) and Christiansen (1990) have used the concept of expended

learning to address systems development as a process of mutual learning. Bygholm and Dirckinck-Holmfeld (1997) use Engeström's triadic model to systematize and understand the fundamental problems concerning distributed and problem-oriented collaborative learning. Bellamy (1996) uses the model as a framework for studying the relationship between technology and educational change. Bødker (1996) uses Engeström's interpretation to study computer-based instruments in use. Kuutti (1994) applies the structure of activity to classify the types of (cooperative) work supported by information technology. And finally, Fjuk and Smørdal (1997) (see section 6.2.2 and Part II of the thesis) discuss Engeström's model with respect to systems design.

3.1.5 Legitimate Peripheral Participation

Both Engeström (1987) and Lave and Wenger (1991) extend the study of learning beyond the context of pedagogical structuration and instruction. Their common focus is on the interrelations of work and learning, and that learning is an integral part of social practice. Compared with Engeström's concepts of expanded learning, Lave and Wenger place more emphasis on

> "connecting issues of socio-cultural transformation with the changing relations between newcomers and old-timers in the context of a changing shared practice." (ibid., p. 49).

Lave and Wenger draw attention to the learners inevitably participation in communities of practitioners, and that the mastery of skills and knowledge requires the newcomers to fully participate in the social practice of community. The concept of 'community of practice' is thus underlying the notion of legitimate peripheral participation. According to Lave and Wenger (1991), a community does not necessarily imply

> "co-presence, a well-defined identifiable group, or socially visible boundaries. It does imply participation in an activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their communities." (Lave and Wenger, 1991, p. 98).

To become a practitioner the newcomers need to collaborate with the more knowledgeable and capable old-timers.

In their critical view on situated learning, Aboulafia and Nielsen (1997) argue that the concept of legitimate peripheral participation is adequate to address social

relations. However, Aboulafia and Nielsen argue that the concept does not recognize the psychological processes of learning, i.e., internalization, knowledge acquisition and instrument mediation. Others have found the concept useful in thinking about computer-mediated collaboration. Eals and Welsh (1995) use the notion of situated learning as a background to discuss the problem of computer skill development in the work place. Fisher (1995) stresses a need for new frameworks of learning in order to guide collaboratively oriented design activities. In this respect, he relies on situated learning.

3.2 Interaction in Distance Learning

Teaching and learning by correspondence is the origin of distance education. Correspondence education has been known for several generations, and has provided study opportunities for those who cannot, or do not want to, take part in conventional face-to-face teaching.

The practice of distance education has historically been influenced by the development of communication technology (Ljoså, 1993). In the middle of the last century, the letter (or postcard) combined with the railway system, made quick and reliable delivery possible (Nipper, 1989; Peters, 1993). During the 80ies, computer-mediated communication (CMC) provided new opportunities to organize for collaboratively approached learning methods in distance education. In spite of this development, teaching through letters is still the most practiced form of distance education (Holmberg, 1990).

There is no universal agreement on what distance education is. But as Holmberg (1995) argues, the practice of most distance education institutions is two-way interaction between student and teacher and pre-produced course materials, - sometimes supplemented with local face-to-face classes. These general characteristics make it, however, difficult to directly apply general education theories to distance education (Ljoså, 1993). If doing so, Ljoså underlines, it "is similar to the situation when the inventors of the automobile tried to imagine the car as a sort of carriage with something in front of it which was not a horse." (p. 182). Special instructional methods are developed to offer the adult learner a worthwhile learning process independent of peers, geographically dispersed from teachers and the teaching institution.

In what follows, I will briefly present teaching and learning in distance education in terms of two constituent interactional forms: Learner-content

interaction through pre-produced and printed course materials, and non-contiguous interaction between teacher and student. The aim of these interactional forms is to promote, in the student, critical thinking, through *simulated* and *real* interaction (Holmberg, 1995).

The pre-produced course material is usually printed material, often supplemented with television and radio programmes, video- and audio cassettes, etc. The pre-produced and printed material, function as guides to the study. They are usually divided into units that conclude with invitations of submitting tasks. These tasks are usually referred to as assignments.

The simulated interaction is interaction between the student and the content presented in the printed material. This is a defining characteristic of all education. It is the process of interacting with the content that results in change in the student's understanding (Moore, 1993). Text elaboration has similarities to conversation, although it does not practically mean to think aloud. In line with this basic characteristics of learning, Holmberg (1995) has developed the concept of *guided didactic conversation***.** The idea behind this concept, is to promote critical thinking and reflection through a guided conversation. The student is not considered a passive recipient of information. The student and the author of the text book and course material are, rather, viewed as communication partners. Thus, the pre-produced course material is characterized by a conversational style with invitations to an exchange of views and attempts to involve the student emotionally. The stronger the characteristics of guided didactic conversation are, the stronger the student's involvement with the subject will be. In other words, it is assumed that the individual's learning process is more motivated than if the course material has the impersonal character of a conventional text book (Holmberg, 1995).

The so-called real interaction is maintained through a two-way interactional process between learner and teacher. Learning without any teacher guidance becomes highly isolated:

> "The frequency and intensity of the teacher's influence on learners when there is learner-teacher interaction is much greater than when there is only learner-content interaction. In preparing instruction for learner-content interaction, the educator can design written and recorded material that aims to motivate, make presentations, facilitate application, evaluate, and even provide a degree of student affective support. However, the lack of feedback from individual learner to educator makes these teaching procedures highly generalized, not individual, leaving ultimate responsibility for maintaining motivation, for interacting with the presentation, for analyzing the success of application and for diagnosing the difficulty on the learners themselves, requiring a high degree of learner autonomy." (Moore, 1993, p. 21).

In distance education situations, the learner-teacher interaction is particularly important with respect to the student's motivation and also to reduce misunderstandings in the individual's interpretations and construction of knowledge (Moore, 1993). Frequent submissions of assignments, requiring students to evaluate texts and solve problems, promote a personal interaction between student and teacher (Holmberg, 1995). Thus, real interaction is maintained through the learner's reflections expressed in writings, which in turn are commented by the teacher.

3.3 Systems Approaches

Concerning the problem area of CSdCL, the systems approaches to distance education provide insight into the relationship between new technology and, existing and conventional ways of practicing learning. The systems approaches are means for recognizing the interwoven relationship between different aspects characterizing distance education (von Wright, 1987; Holmberg, 1995; Moore and Kearsley, 1996). Moore and Kearsley (1996) emphasize a systems approach as a means for:

- Recognizing the issues that *separate* distance education from other forms of education.
- Distinguishing *well-organized* distance education from *poorly organized.*

A distance education system consists of all the components that make up distance education, and anything that happens in one part of the system influences

other parts. According to Holmberg (1995), the components of a distance education system are, e.g.,

> "(...) students with their needs and wishes, tutors and others representing the supporting organization, subject and curriculum requirements, goals, the presentation of subject matter, students' interaction with tutors, counselors and fellow students, the assessment of learning, course and system evaluation, and organizational-administrative arrangements." (ibid., p. 28)"

Even such less obvious factors as history and institutional philosophy are included in a distance education system (Moore and Kearsly, 1996).

von Wright (1987) places emphasis on the student's process of knowledge construction, and interprets a distance education system as

> "a model of teaching and learning, showing how various factors influence the personal development of a student" (quoted in Holmberg (1995, p. 28)).

Without explicitly referring to von Wright's view, Moore and Kearsley underline the consequences of not applying a systems approach:

> "A common misinterpretation among educators who are not familiar with a systems approach is that it is possible to benefit from introducing technology into education without doing anything to change the other ways in which education is currently organized. They think that by moving cameras, computers, and microphones into the classroom, schools, universities, and training departments, they can increase enrollments, provide new curricula, and save money without doing anything else. According to this view, once the technology is in place, there is little else to be done except to let teachers get on practicing their craft as they have always done. " (Moore and Kearsley, 1996, p. 7).

In other words, well-organized distance education is more than viewing a technology as an 'add on' (my term) to existing practice or as a bridge between existing practice and new forms of organizing learning and teaching. Concerned with CSCL, Bannon (1995) makes an analogy to this:

> "It is important to note that the technology per se is usually not the crucial issue, rather the social practices surrounding its use. Simply providing a physical or electronic connection between people does not guarantee that any collaborate learning will take place. The important thing is to create a social activity through which learning can occur." (ibid., p. 273)

When considering the problem area of CSdCL, planning CSdCL is about to recognize those factors that affect the student's personal development and learning. It also implies to recognize the factors that affect; the students' and teachers' role with respect to the new learning activity, course development, resources with respect to money and people, the computer system's usability with respect to the pedagogical model and subject matters, etc.

A large body of systems approaches (e.g., Checkland, 1990; Møller-Pedersen et. al., 1993) exists in the discipline of *computer science*. When addressing computer systems, we can not avoid this concept (Dahlbom and Mathiassen, 1993). Systems development is the process of constructing computer systems. There are, however, different kinds of systems approaches. I find *dialectical systems approaches*, combined with the systems approaches to distance education, to be useful for viewing the problem area of CSdCL. Dahlbom and Mathiassen (1993) consider dialectical systems approaches in the following way:

> "The dialectical systems approach is based on the idea that the world is always changing, and that we cannot understand it unless we understand what change is and why it takes place. The claim of the dialectical approach is that we must think in terms of contradictions in order to understand, explain and control change (...) But in the dialectical systems approach, contradictions appear not only in our thinking but in the world itself. Reality is assumed to be a totality of related contradictions, its most dominant feature being change." (Dahlbom and Mathiassen, 1993, pp. 59-60).

Dialectical systems approaches are useful to describe and to understand the wholeness of situations in terms of its basic idea of *contradictions*. A contradiction consists of two aspects, which at the same time are mutually dependent and fighting each other (Øgrim, 1993). Dialectical theory is suitable to describe and understand the wholeness of situations and phenomena that are characterized as complex and difficult to penetrate into (ibid.). Every

phenomenon is understood in interplay with its surrounding environment, and every phenomenon is understood as a number of contradictions that is interconnected. The objective in some situations is to create a balance between the two aspects that constitute a contradiction (ibid.). CSdCL is as a new and complex phenomenon, and the dominating aspect of this phenomenon of learning varies in accordance with what situation under consideration.

I consider Engeström's (1987) activity system (see 3.1.4) as an alternative dialectical systems approach. An activity is influenced by other activities and other changes in its environment. In activity theory contradictions are used to indicate 'misfit' within elements of an activity, and between different developmental phases of a single activity. Contradictions manifest themselves as problems, breakdowns, clashes, etc. (Kuutti, 1996). Cole and Engeström (1991) discuss whether technology can be a catalyst for educational change. Concerned with this, they suggest that it is not enough to consider individual instruments. Rather, any analysis must consider the whole complex of educational activity. Another strong claim of activity theory is the relationship between instruments and practice. In order to understand the use of instruments (e.g., computer systems), one has to understand what kinds of activity that are involved in the practice (Christiansen, 1996).

Dialectical theory has a strong position within the Scandinavian critical tradition in academic systems development (Mathiassen, 1981; Ehn, 1988; Stage, 1989; Bjerknes, 1989; Øgrim, 1993), since dialectics can support both multi perspective thinking and the understanding of change. The belief of this tradition is, that systems development is an uncertain and complex process, a process that can only be partly granulated and planned in detail.

3.4 Discussion

This section has provided the theoretical background of my understanding of interaction in learning. I base this background on:

- *Socio cultural perspectives on learning* derived from Vygotsky's basic principles on human development. Concerning the problem area of CSdCL, I consider socio cultural perspectives on learning as powerful points of departure: First, learning is social by its very nature, and interpersonal interactions are thus fundamental for learning. Second, human activity and corresponding actions are always mediated by a set of instruments

(including computer-based applications). Based on this view, computer systems are integrated parts of individually and collectively oriented actions embedded in the learning activity.

My understanding of collaboration is, however, supplemented with Piaget's emphasis on *conflicts*. My basic perspective on learning, then, goes beyond the widely held view of collaboration as the opposite of conflict. Collaboration is rarely conflict-free (Easterbrook et. al, 1993) as well as free from contingencies (Star, 1991). Sometimes conflicts may reduce stagnation and promote change and progression. Other times they may disrupt and ruin the collaborative community (Easterbrook et. al., 1993). In the face of contingencies, the challenge for the collaborative students is then to get control over the situation, in such a way that the contingencies may be used productively in the collaborative process. Thus, collaborative communities enable students to contribute their interpretations, and to reconcile multiple perspectives, beliefs and experience in order to reflect upon problems and tasks. The confrontations and negotiations are thus centered around the interactional processes taken place between adult students, with different competence areas and knowledge.

- *Interaction in distance education*. When considering the problem area of CSdCL, I base my work first of all on, what Holmberg (1995) terms, the two constituent interactional forms of distance education: Learner-content interaction through pre-produced and printed course materials, and non-contiguous interaction between teacher and student. The aim of these interactional forms is to promote reflection in the individual. In my opinion, the two constituent interactional forms constitute an example on how the conditions of an instrument (the written word) and the conditions of 'physical distance' have been integrated in pedagogical development.

This section has also presented systems approach to distance education and dialectical systems approaches. Concerning the problem area of CSdCL, a combination of dialectical systems approaches and systems approaches to distance education is a powerful means for:

- Recognizing the *differences* between the practice of CSdCL and conventional learning situations, and the *contradictions* the differences imply.

- Identifying the critical factors that influence the interactional processes and, thus, the personal development of the individual.
- Identifying interwoven problems. This is not necessarily for solving them, but to critically reflecting upon them. The socio culturally based approaches to learning — expanded learning, problem-oriented project pedagogy and situated learning — all view learning as a situation where problem identification is placed emphasis on, rather than problem solving *per se*.

4 Research Goals

Based on the problem area (section 1), and guided by the theoretical background presented in the previous section, the goals of my research are to:

1. Identify critical factors that influence distributed and computer-mediated interactional processes.
2. Develop frameworks that guide systems designers and CSdCL organizers to identify possible contradictions in the problem area
3. Point out possible directions for resolving problematic issues in new CSdCL situations.

4.1 Identifying Critical Factors

Collaboration and interpersonal interaction are not phenomena rooted in contexts where students and teachers are separated by physical distance. Theoretical developments and practices have assumed that the collaborating students are situated face-to-face. CSdCL is a phenomenon that contains aspects from both distance education and collaborative learning, and its practice constitutes a mutual relationship between pedagogical principles and uses of computer systems. This relationship may also create conflicts that develop into problematic situations of learning and teaching. I have found this to be the case in early instances of CSdCL at the NKS (the experiences are analyzed in section 5.1).

From socio cultural views on human development, socially and instrumentally mediated interactions form the cornerstones of learning. Thus, an understanding of the students' *computer-mediated interactional processes* and their *effects* on individual learning, are basic issues for CSdCL designs. Combined with dialectical systems approaches and systems approaches to distance education,

CSdCL designs are thus about to identify the *contradictions* that affect the distributed and computer-mediated interactional processes.

To frame the research goal, the following research questions have been identified:

- *What factors affect distributed and computer-mediated interactional processes?*
- *How, and to what extent, is the contradiction between pedagogical methods and technological conditions taken into account in the pedagogical planning?*
- *What are the conditions for interactional processes in distributed and computer-mediated learning, and how do these affect computer systems design?*

4.2 Developing Frameworks

The third research question in the previous section, leads to issues of systems design. I argue that the critical factors that affect the distributed and computer-mediated interactional processes should provide insights that are relevant for systems design. Systems designers will not come to understand why the students use the computer system the way they do without an understanding of what kinds of activities that are involved in their learning situation. Therefore, systems designers need a theoretically based grounding that can explain the problems and crucial issues of distributed and computer-mediated interactional processes.

Several researchers place emphasis on an understanding of collaboration for the purpose of systems design (e.g., Schmidt and Bannon, 1992; Pea, 1996) and of pedagogical design (e.g., Sorensen, 1997). This emphasis is based on theories and practice related to conventional ways of collaborating and interacting, i.e., situations that assume co-presence of collaborating actors. I argue that this is not sufficient for providing insights into CSdCL designs.

Although distance education is not explicitly concerned with computer systems design, I explain my argument by referring to this tradition. Distance education represents a rich tradition where the instrument (here the written word) and 'physical distance' between teacher and student have been *integrated* with basic principles of learning. The conditions set by the written word, by the physical distance, and central principles of interaction are integrated in course design, and are thus not viewed separately like a simplified dichotomy. Similarly, computer

systems design cannot solely be based on a dichotomy like the one between interactional processes and human behavior, and computer-based instruments. The conditions of a computer system influence the way human actions are performed and thus the course of action. This means, that collaboration in distributed and computer-mediated environments develops differently than collaboration in more traditional face-to-face settings.

This claim corresponds with Dahlbom's (1996) discussion on the new informatics:

> "The distinction between people and technology is one of a whole family of similar dichotomies, such as organism-environment, inherited-acquired, mind-body, individual-society, which all seem to take for granted that a complex domain of interactions can be neatly divided into two separate areas. To begin to understand the role of technology in shaping society, we may have to change the way we think and talk of technology" (ibid., p. 38).

In a society where networked computers and the Internet have become de facto solutions for lifelong learning (see preface of the thesis), the interwoven relationship between computer systems and socially based learning activities, becomes a social phenomenon itself. I argue that systems designs need to recognize the possible contradictions that manifest themselves in computer-mediated interactional processes. Thus, systems designers need frameworks for reflecting upon the reality of CSdCL situations.

Concerning an institution's planning of a CSdCL activity, a framework needs to guide the course designers to recognize contradictions that manifest themselves in the differences between conventional ways of understanding and organizing learning and teaching, and the new ones.

To approach the research goal concerning conceptual frameworks, the following research question has been identified:

- *What constitute frameworks, in terms of theories and concepts, for understanding the complexity of CSdCL?*

4.3 Pointing towards Possible Solutions

The objective of my research is not to provide final solutions to problems, but to point towards possible directions of solutions. This is approached by applying the findings from the CSdCL cases and using the developed frameworks (research

goal 2). The Internet services and in particular the World Wide Web, constitute the technological platform I use in this respect.

Since the inception of the Hyper-Text Transfer Protocol (http) underpinning the World Wide Web, the use of World Wide Web has grown from academic milieus to business (Palfreyman and Rodden, 1996) and education (see preface of this thesis). The World Wide Web has the potential for handling issues of heterogeneity by providing information exchange across a wide range of platforms. A wide range of chat facilities has emerged through the World Wide Web, using forms and Common Gateway Interface (CGI) scripts. It has also a potential to provide access to homes at low cost usage. On the other hand, the World Wide Web does not provide sufficient operational functionality to support collaborative activities, e.g., joint authoring, negotiation, creation of contents for the collaborative processes, etc. (Bentley et. al., 1995; Haugsjaa, 1996).

The following research question has been identified:

- *How can Internet services, in particular the World Wide Web, be applied as a meditating instrument for distributed and collaborative learning?*

4.4 The Research Questions and the Contributions

The papers in Part II of the thesis constitute the core of my research. Each of the papers proposes answers to the research questions and integrates the empirical findings with theories on interaction. Sections 5, 6 and 7 discuss further the contributions of the papers. The relation between research questions, the papers in Part II of the thesis and the contributions in Part I, are illustrated in table 4.1:

Research question	Answers and discussions
What *factors* affect distributed and computer-mediated interactional processes?	Fjuk and Dirckink-Holmfeld (1997) Fjuk and Sorensen (1997) Fjuk and Øgrim (1997a) Section 5
How, and to what extent, is the *contradiction* between pedagogical methods and technological conditions taken into account in the pedagogical planning?	Fjuk and Dirckinck-Holmfeld (1997) Fjuk and Sorensen (1997) Section 5
What are the *conditions* for interactional processes in distributed and computer-mediated learning, and how do these affect computer systems design?	Fjuk and Dirckinck-Holmfeld (1997) Fjuk and Øgrim (1997b) Section 5
What constitute frameworks, in terms of theories and concepts, for understanding the complexity of CSdCL?	Fjuk (1995) Fjuk and Smørdal (1997) Fjuk and Sorensen (1997) Section 6
How can Internet services, in particular the World Wide Web, be applied as a meditating instrument for distributed and collaborative learning?	Fjuk and Øgrim (1997a) Fjuk and Øgrim (1997b) Section 7

Table 4.1: The research questions and the contributions.

5 Factors Affecting Interactional Processes

I have claimed that focus on technological capabilities, on the one hand and, an understanding of interaction achieved from conventional practice of it, on the other, cannot separately explain the conditions of CSdCL as phenomenon. I ground this perspective in my work at the Norwegian NKS Distance Education.

This section starts with presenting and discussing the main experiences from this instance of CSdCL: A situation where the pedagogical intention was that the students should use each other as a resource in peer-independent learning processes. That is, the traditional distance education system was supplemented with interactional processes amongst the students in order to offer the distance student a more socially based learning process. The experiences are not presented in any of the papers in Part II of the thesis.

Then I discuss the results from my investigations on CSdCL cases that are based on the following: 1.) Joint construction of problems and solutions by mutual refinement; 2.) Exploring opposed alternatives in argumentation. The details of the findings are presented and discussed in the papers in Part II of the thesis. This section discusses the major results, and compare them with the experiences from the early instance of CSdCL at the NKS.

The following research questions are answered:

- *What factors affect distributed and computer-mediated interactional processes?*
- *How, and to what extent, is the contradiction between pedagogical methods and technological conditions taken into account in the pedagogical planning?*
- *What are the conditions for interactional processes in distributed and computer-mediated learning, and how do these affect computer systems design?*

The third research question is followed up in sections 6 and 7.

5.1 Distance Education Experiences

This section presents and discusses the experiences I won through my work practice at the NKS Distance Education. During the reported period (1990-1994), the distance education system did not imply any changes with regard to course production. The course material as well as the assignments, were mainly developed on the basis of independent and individual study. The course material was delivered to the students by ordinary mail, and the administrative tasks related to this were maintained.

The experiences gained through the reported period quite correspond. In what follows, I will structure the experiences and corresponding discussions in accordance to the basic understanding of interaction in distance education

(presented in section 3.1): Learner-content interaction and learner-teacher interaction. The section concludes with presenting the challenges met with respect to systems development.

5.1.1 Computer-Mediated Interaction and Text Elaboration

This section analyses the relationship between computer-mediated interpersonal processes and learner-content interaction. The aim is to explore what implications the new interactional forms had on the students' interpretation and understanding of subject matters.

According to Vygotsky, one's language constitutes a fundamental sign in learning since it mediates interaction between individuals. Inner speech, Vygotsky maintains, is developed by participating in social dialogue.

> "[I]t is the internalization of social speech into inner speech, that is, the ability to engage in a socially appropriate dialogue with oneself, that allows one to plan and monitor cognitive progress." (Knuth and Cunningham, 1993, p. 171-172).

Some researchers argue that CMC systems support this and change the way text materials are perceived and understood (Harasim, 1990; Mason and Kaye; 1990). The textual dialogues become self-explicit to the learner, since the aspects of an activity that are usually tacit are expressed through the act of writing (Harasim, 1990). Compared to the two constituent forms of learner-content interaction and learner-teacher interaction, I do not interpret this as a radically new opportunity. The idea behind these interactional forms is dialogues aimed at promoting thought and reflection. In contrast to the idea of guided didactic conversation, text elaboration is not based on a static text, but on something dynamic and modifiable created by the students (Mason and Kaye, 1990). An individual's understanding, presented in written contributions to a dialogue, act, then, as a sign for the peer's reflection and thinking. From a theoretical point of view, interactions amongst the students will thus enrich the elaboration of text (in the course material). In other words, the new and the conventional interactional forms will, theoretically, provide benefits with regard to the individual's learning process.

From the experiences I will argue that there was not a clear positive correlation between socially and computer-mediated interaction and learner-content

interaction[17]. The *subject matter* seemed to have implication regarding the student's benefits of peer interaction. The textual dialogues were quite absent in conferences concerning subject matters like organizational theory, marketing and law. These subject domains are close to what Feltovich et. al. (1996) classify as *ill-structured* and *complex*, and have the following characteristics:

> "Many concepts are relevant in a typical situation where knowledge is to be applied, and these many concepts interact in their meaning and interpretation depending on the particular cluster involved and the particular situation of knowledge application (...) there is considerable irregularity in knowledge constitution and interpretation, as well as case presentation, across case." (ibid., p. 27)

According to Feltovich et. al. (1996) collaboratively approached learning forms are particularly appropriate for ill-structured and complex domains as they promote discussions and reflections. But as the authors argue,

> "(...) it seems that the more complex and ill-structured the domain, the greater the difficult people have in applying their knowledge in novel situations" (p. 27)

The process of articulating thoughts into writings, aimed at presenting them in a social community of peers, constituted a novel situation for many of the NKS-students (Fjuk, 1993). Firstly, socially approached learning was new to many adults. Lecturing is a more familiar learning style. Secondly, computer-mediated interaction was a rather new form of interaction both with respect to work and learning. Thirdly, an individual's written contributions were perceived as something static and unalterable (Fjuk and Jenssen, 1990). Therefore, some students preferred to just read the peers' contributions to actively take part with own contributions. In any case, the written dialogues were more present in conferences concerning well-structured domains — such as economics, mathematics, statistics and (in this case) computer science. The dialogues had a

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[17] It has to be made clear that this correlation is difficult to measure. It can only be predicted since there can be several causal factors behind the learning effects of interpersonal interactions. The correlation between learner-content interaction and interpersonal interaction is predicted by examining the contents of the conference messages (Fjuk, 1993).

clear ‘question and answer’ form. That is, students asked questions regarding the subject matter, that were answered by teachers and more capable peers.

The students' experiences with the question-and-answer form are manifested in the quotation below:

> “I don’t think the conferences worked well enough to teach me anything better than the textbooks can, because the study programs that come with this course are very carefully ‘designed.' (...) PortaCOM has mainly meant a lot for me socially. We are not alone. Out there are fellow sufferers sweating under the same problems.” (In PortaCOM[18])

The study- and course material, well designed for independent studies, fulfilled the students’ need with respect to understanding the subject matter. From the students' experiences, it thus seemed that computer-mediated interpersonal interactions did not provide enough learning benefits. But, social interaction had a socio-emotional implication of getting easily in touch with peer students and teacher. This had clear positive effects on the student’s motivation. Research on distance education shows that rapid feedback is important for the student's progress and completion (Rekkedal, 1993). Computer-mediated interaction clearly constituted a potential for this. I have elsewhere reported that there was a positive correlation between social interaction, course completion and success in the final examination (in terms of marks) (Fjuk, 1993; see also Paulsen and Rekkedal, in press). Others have reported analogous tendencies by making comparisons between courses delivered through CSdCL and face-to-face education (e.g., Wells, 1990; Hiltz, 1994). The authors argue that computer-mediated social communities facilitate learning outcomes that are equal or superior to those generated in on-campus based environments. Rekkedal (1995) argues, however, that direct comparisons of marks do not explain potential differences between distance learning situations and face-to-face, with respect to learning outcome. These two situations are different: The students live and study under completely different conditions (ibid.). Whether the positive tendencies with respect to fulfilling courses are an unambiguous result of social interaction, are thus, difficult to state. The NKS-students that did participate in social communities, either as contributors or just as readers, probably had the willingness and energy

[18] Translated in collaboration with Eevi Beck.

to master CMC, both technologically and socially (Fjuk, 1993). These students might have a corresponding motivation and willingness to study in isolation—if this was their only choice.

5.1.2 Computer-Mediated Interaction and Teacher Guidance

This section discusses the relationship between the new interactional forms and learner-teacher interaction. The aim is to identify how interaction amongst students influenced learner-teacher interaction. Compared to learner-teacher interaction mediated by letters, computer-mediated communication offers more cost-effective transmission of written assignments, as well as shorter turnaround times (e.g., Vivian, 1986).

The NKS-students emphasized a significant correlation between rapid feedback and time used to achieve an understanding on the course content[19]. Feedback on thoughts was maintained both by teachers and more capable peers. Compared to correspondence, it was assumed, then, that the teacher's commitment to the individual was reduced since the computer system offered a more collaborative approach with respect to guidance. This did not evolve as a natural tendency.

An experienced teacher in CSdCL reported that he received as many personal questions — via conference messages, telephone calls and ordinary letters — as in conventional distance teaching (Fjuk, 1994). The computer system was to a minor extent used as a means for giving comments on e.g., assignments. Some of the teachers lacked personal willingness and engagement to experiment with the computer system (Fjuk and Jenssen, 1993). Although some teachers used it for this purpose, they found it work demanding: Downloading the file, printing the document, making corrections, appropriately editing the document received, and sending the commented document back to the student. Teachers who had been involved in correspondence education were the most outspoken about these problems. They missed the ordinary, and according to them, the most effective instruments for correcting assignments: Red pencils and paper margins. The result was that the learner-teacher interaction (concerning assignments) was accomplished through ordinary letters (Fjuk and Jenssen, 1993).

[19] A discussion in PortaCOM.

5.1.3 Systems Development

The new interactional form implied challenges for systems developement. Compared to work situations the NKS-students were often short-term users. The time needed for learning the use of the computer system often became too long compared to time of actual use. Most of the students studied from their homes, connecting the computer system via modems and time-taxed telephone networks. Combined with the individual's rather low level of technical skills, active participation thus implied personal expense. This constituted a practical problem regarding active participation in the computer conferences. One of the students explained:

> "There are many possibilities I do not know....that I certainly would have learned if I could afford it. I perceive this a huge obstacle....." (quoted in Fjuk and Jenssen (1990), my translation)

CSdCL represents situations where *heterogeneous machines and software* are the reality. The objective of systems development activities was thus to offer the students computer-based solutions that worked despite heterogeneous equipment, with minor cost for both students and the institution (Fjuk, 1992). The problem of cost was resolved by adjusting PortaCOM[20] with different scripts that simplified the operational aspects of actions. Examples given were procedures that simplified the connection to the host site, down-loading news, up-loading written contributions, etc. During the second half of the reported period, a CMC solution based on a bulletin board system and communication scripts, was used. Although this system provided better opportunities with respect to cost-effective and simple transmission of individual contributions, it was based on one particular computer platform. Thus, the communication scripts did not resolve the problems of heterogeneous computer environments. This important issue, combined with the issue of low costs to usage, constituted a complicated problem in the early instance of CSdCL.

5.1.4 Discussion

Concerning the problem area of CSdCL, the early run of CSdCL indicates contradictions that manifest themselves in relationships between socially based

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[20] Other systems such as e.g. Lotus Notes were examined. Lotus Notes was evaluated to be too expensive for short term-use and too difficult to install for the students.

learning, existing distance education practice and the computer applications used (including the CMC system). These considerations can be explained by the systems approaches to distance education (section 3). The CMC systems constituted an 'add-on' to the traditional distance education system. The CMC system was not thoroughly incorporated into the education system, in such a way that *the combination* of new and more conventional ways of interactions provided sufficient learning benefits. The crucial factor that affected the students' interpersonal processes, was the *existing practice of interaction* itself. If computer-mediated interpersonal interactions should provide learning benefits, the ideals of guided didactic conversations must be reconsidered for CSdCL purposes.

This practice of CSdCL contrasts the educational discipline that NKS represents: A discipline that has integrated the *embedded conditions* of the available instrument (the written word) and the issues of 'physical distance' between teacher and student, with a basic view on interaction in learning. In this discipline the written word has a two-fold role that can be explained by Vygotsky's notion of instruments (see section 3). The written word is the basic instrument for intrapersonal interaction**:** Elaboration of texts through guided didactic conversation and the act of articulating thought into assignments. In turn, the assignments constitute a communicative means for interpersonal interactions between the student and the teacher. Tools like paper, paper margins and pencils mediate the operational aspect of the same action. From the early instance of CSdCL, I claim that the available computer-based tools have not been considered analogously in pedagogical design and development. But, this has a practically conditioned explanation: In order to offer CSdCL the computer-based instruments must work. Because of the new application area of the CMC systems, combined with minor resources available, the focus easily becomes the technology rather than pedagogical developments where the computer-based instruments should be integrated parts.

In any case, my analysis indicates a complicated relationship between ill-structured subject domains and learning benefits of computer-mediated interpersonal interactions. The basic question resulted from my work was: How can distributed communities of collaborating students gain better understanding of *complex* and *ill-structured* subject domains, and how can CMC systems aid students to *collectively* understand such subject matters?

5.1.5 Summary

This section presented and discussed the main experiences I won through my work practice at the NKS Distance Education. The experiences are analyzed in accordance to the existing distance education system: Learner-content interaction and learner-teacher interaction. The section presented also challenges met with respect to systems development. My analysis indicated the following:

- The learning benefits of computer-mediated interpersonal interaction seemed to be dependent on what *subject matter* studied. Interpersonal interactions provided some benefits for the students' interpretation of well-structured subject domains (mathematics, economics, statistics, etc.). The distributed communities were basically developed on a 'question and answer' interactional form. This means that the students used each other as a *resource* in constructing knowledge. This interactional form corresponds well with the characteristics of well-structured subject domains: It is easier to formulate a clear question to peers and teacher than in ill-structured ones (law, organizational theory, marketing, etc.). In contrast to ill-structured domains, there are, also, ready-made answers to subjects like e.g., mathematics.
- Interpersonal interactions did not offer the individual student more than the preproduced course material did. The course material was developed for the purpose of individual and independent study, and the original principle of guided didactic conversation was maintained.
- Computer-mediated interaction amongst the students did not imply a reduced work-load for the teachers. The teachers received as many personal inquires (via other media) and the exchange of assignments was accomplished as before. Computer-mediated interaction offered, however, a new possibility for *rapid feedback*. This has, unarguably, a huge socio-emotional effect on student's motivation and progress.
- Concerning *systems development*, the situations of the students implied the following considerations. The students were studying from home. This implied that they used time-taxed telephone networks, which in turn implied personal expenses. Personal expenses, combined with a low level of technical skills, became an obstacle to active participation. The objective of approaching low costs to usage, contradicted another critical issue of CSdCL; the reality of heterogeneous computer environments.

5.2 Collaborative Learning Experiences

This section presents and discusses my findings from CSdCL situations where joint construction of problems and opposed alternatives in argumentation, are emphasized in the pedagogical methods. I interpret the subject domains of the studied cases[21] in line with Feltovich et. al.'s (1996) definition of ill-structured subject domains (see section 5.1). The subject domains open for irregularity in interpretations, and thus for multiple perspectives in argumentation.

The results from my investigations are presented and discussed in detail in the papers of Part II (see Fjuk and Dirckinck-Holmfeld, 1997; Fjuk and Sorensen, 1997; Fjuk and Øgrim, 1997b).

Several researchers emphasize collaborative learning methods for adult education (e.g., Bruffee, 1993; Kaye, 1994), since the methods have features in common with working-oriented methods such as, project and team work. The field is rich with literature that stresses distributed collaborative learning thanks to the CMC systems' capability of communication (Harasim, 1990; Hiltz, 1990; Wells, 1993; Hiltz and Turoff, 1994; Harasim et. al., 1995). In particular, Hiltz and Turoff (1994) argue that in distributed communities

> "one can do far more to encourage collaborative learning and utilize it as a learning mechanism than is possible in the normal face-to-face classroom environment" (ibid., p. 472).

These authors tend to focus on the instrument of instruction and learning as if we can compare the instruments directly, without taking into account other issues such as; pedagogical principles prescribed in the pedagogical methods, the target groups, the subject domains, etc. In line with this view on the role of the CMC systems, the computer systems do not only support collaborative activities but *enrich* them in various ways. Harasim et. al. (1995) make this explicit by considering a CMC system as powerful means regarding mediation of actions embedded in collaboratively oriented activities :

[21] The discussion is based on the follwoing cases in section 2: Distributed pedagogical seminar (NKS Distance Education), problem-oriented projects (The University of Aalborg), and to some extent Online Education and Training (The British Open University).

> "Any course that emphasizes in-depth coverage and discussion of materials can be effectively conducted entirely online, as can any course with extensive writing assignments. The sharing of ideas and collaborative tasks, such as seminars and joint writing, are particularly effective online. Generally these activities use discussion, brainstorming, problem solving, group work, and reflective and analytical contributions based on special projects or research." (ibid., p. 25)

Based on my investigations, I question this line of thought. The analysis presented in the previous section, indicates a complicated relationship between socially based learning, existing distance education practice and the computer applications used (including the CMC system). An analogous tendency is present in the other cases studied: I have found that several interconnected factors affect the students' actions in such a way that the above described potential of CMC systems becomes too simple. In what follows I argue that the students' interactional processes are affected by factors that manifest themselves in a *triadic relationship*. That is, contradictions that are found in a field of *tension* between *organizational*, *technological* and *pedagogical* aspects. This triadic complexity is illustrated in figure 5.1.

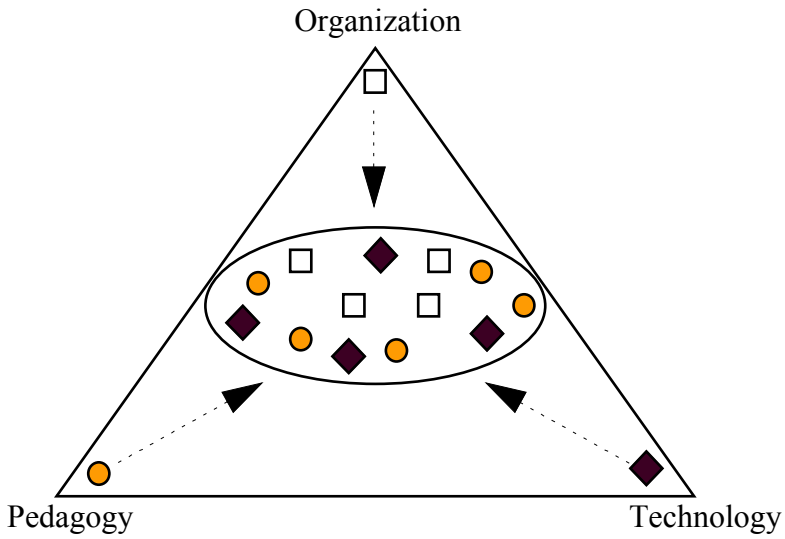

Figure 5.1: The field of tension between organizational, pedagogical and technological aspects

The *organizational aspect* is related to the institutional tradition and the education system. The *pedagogical aspect* is related to theories and methods of learning. The organizational and pedagogical aspects may align to a greater or lesser extent. One example: An institutional tradition is distance education, and the pedagogical model is based on collaborative learning. Another example: The institutional philosophy and the pedagogical model are rooted in principles of collaborative learning (I give examples in Fjuk and Sorensen (1997) in Part II of the thesis). The *technological aspect* is connected to the conditions of available computer-based resources (including the CMC system).

Because of the interwoven relationships between these aspects, it is complicated, sometimes even impossible, to give clear answers regarding what aspects that are *most critical* with respect to the interactional processes. In what follows, however, I structure my investigations by analyzing pairs of aspects embedded in the triadic structure.

5.2.1 Tensions between Pedagogical and Technological Aspects

Schmidt (1991) notes that a computer system that embodies a formal representation of social worlds will inevitably come up against boundaries beyond which the representation will be inapplicable. According to Schmidt, such boundaries will always be encountered sooner or later because no representation can be adequate for all actions, contingencies and the situated nature of collaboration. The analysis I present in section 5.1, shows that the CMC system has a potential for mediating actions embedded in question-and-answer interactional forms. These forms correspond well with so-called well-structured subject matters. The critical question is therefore: What happens to the collaborative community when the underlying pedagogical model and the subject matter are beyond the boundaries of the used computer system?

Text-based and asynchronous dialogues persist in a linear record whose history can be examined during the subsequent course of discussion. This introduces a second dimension of reflectivity, allowing the students to examine the ongoing discussion in a way that is impossible in oral conversations. McDaniel et. al. (1996) shows that the textual conversations are, on average, almost three times longer than oral conversations. At the extreme, oral conversations and writings differ in that the former is highly interactive and dynamic while the latter has a character of imagined and simulated interaction. Others emphasize that the written and the asynchronous structure of the interactions does not encourage closure or

coming to decisions, unless a leader emerges from the discussion group (e.g., Mason, 1994).

My investigations, presented in Fjuk and Dirckinck-Holmfeld (1997) and Fjuk and Sorensen (1997) in Part II of the thesis, show that the underlying communication structure in most CMC systems becomes particularly critical in learning situations based on problem-oriented project pedagogy. This method requires mutual commitment amongst the students; both in the course of argumentation and in completing a common objective of the learning activity.

Although the students in the situations I have analyzed managed to gain a better understanding of their subject matter in collaboration, they had huge difficulties when it came to negotiating of it (Fjuk and Dirckinck-Holmfeld, 1997). One group of students reports:

> "We did not make a good job of the ideals of digging deeply to our studies, it only became superficial digging, where we did not succeed in getting to grips with the subject. Possibly because our basic knowledge was not certain enough, but also because the mutual challenge did not come off in CMC (...) Then it later became evident in the project work that the fact that we had not been able to discuss our way to a conclusion about a common understanding (...) created a lot of problems in the project organization." (Løth and Køhler, 1995, p. 34[22]).

The text-based and asynchronous communication form contradicted the dynamic and reflective actions characterizing argumentation and in-depth discussions. A common understanding amongst the students constitutes an important basis for further actions and division of work. As I will point on in section 5.2.2. joint planning and joint agreements are, paradoxically, particular critical in distributed situations where the collaborating students have limited opportunities to physically meet each other.

Mutual commitment calls for involvement, motivation, energy and time. The lack of surplus energy with respect to reflective argumentation and negotiations became a threat against the necessary involvement and feeling of responsibility that collaboration implies. The students of my analysis claimed:

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22 Translated in Fjuk and Dirckinck-Holmfeld (1997).

> "In some cases it is difficult to solve problems and if this happens too often, or that we come to a standstill or do not understand each other, then the energy disappears" (Løth and Køhler, 1995, p. 41[23]).

Interactional processes like in-depth discussion, argumentation and other reflective and analytical actions became time-consuming and problematic to fulfill. The students of my analysis found it easier to accept negative criticism or the peers' perspectives, rather than take actively part in resolving it through joint discussions. To use Goffman's (1959) theatrical metaphor for interaction: It is easier to go 'off-stage' than to be an actor responsible for handling the problems 'on-stage'. This behavior can appear as a lack of individual commitment to the collaborative processes. This observation can however be seen in light of social relations and interpersonal conflicts. The communicative structure of the CMC system may create and direct the course of conflict, since the system has shortcomings with respect to consensus seeking. As I interpret it, the CMC systems prevent latent conflicts and hidden problems to surface.

The CMC system seemed to constitute a contradiction together with prescribed principles like joint construction of problem and opposed alternatives in argumentation. In Fjuk and Øgrim (1997b) I identify an analogous tendency, by focusing on the contradictions *within* the students' available computer-based applications. I explain this by using the Vygotskian notion of a duality between sign and tool (section 3). The students' available computer-based applications — the CMC system together with drawing programs, word processing programs and the like — contradicted the learning benefits associated with articulating thought into drawings, writings, schemes, and the like. A student's computer applications (e.g., a drawing program) did mediate the individual student's reflection and thinking. But, because of software incompatibility between the students' programs, the thoughts manifested in drawings, writings, schemes, etc., did not appear as appropriate signs for articulating the students' argumentation of perspectives and negotiations of meaning (beliefs, perspectives, knowledge, experience, skills, etc). In other words, the students' computer-based applications contradicted each other in use.

The cases thus indicated that use of the computer applications, hampered the object of the collaborative learning activity. Due to internalization of the

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23 Translated in Fjuk and Dirckinck-Holmfeld (1997).

applications' properties and behavior, the use of them was not conducted automatically. Rather, the use of the computer applications involved thought that stemmed from problems of using them due to breakdowns, or due to unfamiliarity with them. These practical problems have consequences for what Gutwin et. al. (1995) term *concept awareness*: Awareness of how peer students' interpretation and perspectives fit into the student's prior knowledge. Awareness of the peer students' activities and progress is essential for the individual's commitment and engagement to the others (e.g., Dourish and Bellotti, 1992).

Although the students' computer applications constrained effective interactional processes at an individual and collective level, I have found that there are other fundamental factors that affect the computer-mediated interactional processes as well. These factors are presented in the following two sections.

5.2.2 Tensions between Pedagogical and Organizational Aspects

The objective of an institution's education system is learning. This objective is mediated by multiple instruments, including theories or methods of learning. A method reflects the different roles individuals play within the education system.

I conclude in section 5.1, that the established education system affected the interpersonal processes in such a way that combination of *conventional* and *new* interactional forms, did not provide the benefits anticipated. A secondary aim during the early pilot at the NKS, was to explore the new possibilities of organizing project-based learning at a distance. Also in this case, the existing distance educational system created a contrast to the prescribed objective of project-based learning. The students had chosen the NKS because of flexible learning. The required individual's engagement and responsibility with regard to the collaborating peers, created a contradiction to this flexibility. The students were not prepared for peer interdependence that project-based learning implied (Fjuk and Jenssen, 1993), as such the individual's motivation for collaboration was almost absent.

Similarly, in (Fjuk and Sorensen, 1997) I give an example on how the *rhetoric* used in preproduced course material, mediate the students' interactional processes differently than what was prescribed in the pedagogical design: The pedagogical intention was discussions amongst the students, yet the rhetoric mirrored a focus on the individual students' interpretation of the readings and reflection on predefined tasks. Thus, the course material motivated the students to focus on readings and assignments, rather than on discussions. The result was that the

interactional processes evolved almost identically to that of correspondence courses. CSdCL thus evolved as a modern form of correspondence, and the intention behind the pedagogical design was pushed in the background.

In Fjuk and Sorensen (1997) I argue that the *theoretical foundation* that appeared to be the most problematic with respect to CSdCL, was problem-oriented project pedagogy (Fjuk and Sorensen, 1997). The pedagogical grounding places an emphasis on a working form that itself is *distributed*: Schmidt (1991) argues that cooperative work in complex settings is distributed in the sense that collaborative communities are divided into myriads of small social worlds, each with their own particular views of the world (p. 6). In problem-oriented project pedagogy the individual adults' different perspectives, interpretations and knowledge have an essential meaning for learning. The objective is that the differences amongst the individual's perspectives should be negotiated in order to create a common understanding. A pedagogical philosophy that presupposes that mental and social 'distances' must be overcome, not only *physical* ones, can be too idealistic when it concerns CSdCL. The prescribed roles of the students, as responsible actors, ideally, require social presence of all the actors any time. In Fjuk and Dirckinck-Holmfeld (1997) and (Fjuk and Øgrim, 1997a) we indicate that ill-structured subject domains, combined with the ideals of different alternatives in argumentation, have their best conditions in conventional collaborative learning situations, i.e., situations where the students share time and physical places. The *physical separation* between the students constitutes the most critical factor due to the ideals of problem-oriented project pedagogy.

In conventional collaborative learning situations, the students have the opportunity to share time and place, and the institution's academic (e.g., face-to-face tutoring) and technical resources (photo copier, advanced software, advanced computers, scanners, etc.). These special characteristics of conventional collaborative learning situations, implicitly maintain an individual's awareness of what the others are doing and how they are progressing. The characteristics play also integral parts of how well an environment creates opportunities for collaborative learning (Gutwin et. al., 1995). Compared to traditional collaborative learning situations, the learning and work processes of distributed communities require *new* forms of articulation that contribute to make collaboration more demanding. Explicit articulation — like planning, continuos coordination, control and meta communication— seems to be a must in order to

maintain an awareness of each other's understanding and progress (Fjuk and Dirckinck-Holmfeld, 1997).

These explicit articulations can partly be maintained through tutor guidance and control. Compared to conventional collaborative learning situations, commitment by the tutor to the students' collaborative processes is more time-consuming and complicated to maintain. In contrast to collaborative learning, distance education represents a rich tradition where text-based tutor guidance has a significant part to play to ensure learning and progress (see section 3). However, it is far more complicated to apply this type of guidance *to groups* than to individuals. In conventional distance education tutor guidance is mainly related to the student's written assignments. In conventional collaborative learning, interpersonal interaction is the foundation for learning, and tutor guidance needs to be directed towards these processes as well as their outcomes. I, therefore, argue that tutor's control and continuous guidance of *the processes*, are musts in distributed collaborative learning.

Concerning my first research goal, I conclude that tensions between physical separation of the students, and the collaborative learning methods, constitute a main contradiction with respect to CSdCL. This becomes particularly evident in situations where the focus is on joint and interdependent activities amongst the students. However, this contradiction seems to be present both from a distance education perspective and from a collaborative learning perspective. In e.g., Fjuk and Øgrim (1997a) I argue that the principles of problem orientation and participant's control, as well as the prescribed roles of the students and teachers, are needed to be *reconsidered* when it regards CSdCL. Although with a different focus on interaction, my analysis of the NKS case supports such an argument. That analysis indicates a need for reconsidering the institutional practice of interaction in such a way that a combination of conventional and new interactional forms creates benefits with respect to distributed collaborative learning.

5.2.3 Tensions between Organizational and Technological Aspects

Concerning my first research goal, the contradiction between pedagogical methods and technological conditions appears to be weakly recognized in pedagogical design. I explain this further by using dialectical systems approaches (see section 3): Any instrument, technology or otherwise, has the potential to *change* an education system and, as we have seen in the previous section,

established pedagogical methods. In addition, the constellation of instruments within the education system will affect the introduction of a particular technology in such a way that the situation is changed (Cole and Engeström, 1991). In other words, a change with respect to mediating instruments (technological aspect) of learning and teaching, indicate changes both with respect to the institutions original education system and to the tradition of educational delivery (organizational aspect), and with respect to learning theories and pedagogical thinking (pedagogical aspects) (see figure 5.1). New instruments develop new conditions on established practice.

In Fjuk and Øgrim (1997b) I discuss changes in the education systems with respect to the studied CSdCL cases. I distinguish between three types of changes: Adjustment, transformation and transcendence (See Fjuk and Øgrim (1997b) for details). *Adjustment* is the simplest form, and denotes the replacement of elements in a situation with new elements of the same type. *Transformation* means replacement of elements with new ones, but with other properties. *Transcendence* is the most complicated and challenging type of change. Change of this type means that the relationship between the elements of a situation is changed, so that the organization of it is abolished. The relation between the elements of the established situation is changed, and a totally new situation is created. Transcendence thus means to create something new, something extraordinary or exceptional. Creativity (thinking new) and innovation (acting new) are both parts of transcendence.

The studied CSdCL cases clearly represent changes with respect to the institutions' original education system. In Fjuk and Øgrim (1997b) I however conclude that the CSdCL cases did not represent exceptional new phenomena. The changes can only be considered as adjustments and transformations of traditional practice of education. The early instance of CSdCL at the NKS (section 5.1) is an example of adjustment of distance education. Compared to the tradition of distance education the computer-mediated interactional processes amongst the students represented a change. But, the run of CSdCL was highly influenced by the tradition of distance education, and lacked the necessary reflective and creative activities of how to interpret the useful knowledge of this tradition into distributed *collaborative learning situations*. In practice, the CMC system occupied a role as an electronic post office.

To develop a CSdCL situation on its own conditions, I therefore argue that CSdCL designs need to recognize the *dialectics* between the various mediating factors and their possible implications for interactional processes. This way, designers can achieve the overview required to design good learning situations while maintaining sensitivity to the implications of the inevitable design tradeoffs. But, the ideal of dialectical thinking is impossible without knowledge or experience from the situation in question. To be able to understand the new conditions of distributed and computer-mediated interaction one has to experiment with the technology in *practice* and within *familiar situations* (Fjuk and Øgrim, 1997b). In other words, we need to know the principles of educational traditions in order to change them with respect to new technologies. Creative and new ways of thinking that will work in practice are thus fundamentally dependent on prior understanding of the knowledge, experience and principles that underpin that tradition of practice. Successful technological and pedagogical *transcendence* is facilitated by knowledge of existing technology and of the pedagogical intentions that constrain and condition its use.

An obstacle for 'transcendent thinking' is, as I point on in section 5.1, *resources*: Because of the new application area of the CMC systems, combined with minor resources available, the focus easily becomes the computer system rather than conceptual development where the computer system is an integrated part. Another obstacle is *time*. When the idea of Norwegian correspondence education was born in the beginning of 1900, this educational form implied something new compared to that age's educational practice. The main principles of learning and teaching were maintained, but reconsidered to find ways of integrating them with the new conditions set by the written word, the physical separation of student and teacher, and the postal services. During several years of practicing 'learning by doing,' distance education became what today is manifested in theoretical foundations and good practice. In other words, good learning situations are not born over night. Similarly, a fruitful integration of pedagogical methods and computer-based instruments that works in practice is a time-consuming activity.

5.3 Summary

In this section, I have analyzed a number of CSdCL cases in order to approach the basic research goal of my research: To identify critical factors that affect distributed and computer-mediated interactional processes. The CSdCL cases

were delivered by institutions that have their theoretical foundation in either distance learning or collaborative learning. I have found that several interconnected factors affect the students' distributed and computer-mediated interactional processes. Although different theoretical background and educational practice, the critical factors are found in a field of tension between the following: Pedagogical, technological and organizational aspects. The *pedagogical aspect* is connected to theories and methods of learning. The *technological aspect* is connected to the embedded conditions of the available computer-based resources. The *organizational aspect* is related to the institution's education system and tradition. The students' interactional processes are affected by the following:

- The traditional *education system* with respect to practice and to theoretical foundation. The institutional tradition mirrored, more or less unconsciously, the planning and organisation of the CSdCL activities. The results were that the students' interactional processes developed into other patterns than prescribed in the CSdCL planning. Examples are: Given the distance education tradition, the distributed and computer-mediated interpersonal interactions, in combination with the grounding in interaction, did not provide *enough* benefits with respect to learning. Given a collaborative learning tradition, the principles of joint construction and different perspectives in argumentation, became too work-demanding to maintain in a distributed context. From both traditions, I argue that existing theoretically and philosophically based principles, are insufficient for CSdCL purposes and needed to be reconsidered.
- *Physical separation amongst the students*. The basic elements of distance education and collaborative learning, constitute possible contradictions. The consequence of this contradiction depends on what principles that are emphasized in the collaborative approach. The most appropriate basis for CSdCL seemed to be situations where the students are using each other as a resource for interpreting course contents and for solving predefined tasks. Such interactional processes have a question-and-answer form, and do not require personal commitments in argumentation and in completing joint tasks. On the contrary, collaborative methods that assume 1.) joint construction of problem solutions by mutual refinement and 2.) opposed alternatives in argumentation, are — in their original form — less appropriate for CSdCL.

Concerning *subject matters*, it is assumed that collaboratively approached learning forms are particularly appropriate for ill-structured and complex domains since these domains promote discussions and argumentation. However, ill-structured subject domains, combined with in-depth discussions, are challenging foundations for good CSdCL practice.

- The *computer-based resources*, including the CMC systems. Contradictions between pedagogical methods and *technological conditions* are weakly considered in pedagogical planning and design. Again, this is most critical in situations where the students are dependent on each other to complete a common task and to maintain a common process. Incompatibility between the students' equipment and software constituted a serious practical problem in this respect. In order to design computer systems for CSdCL situations, I conclude that *heterogeneity* and *networked computers* must be viewed as the reality for future systems development.

6 Frameworks for CSdCL

Physical separation between the collaborating students, particularly combined with the pedagogical ideals of joint construction of problems and multiple perspectives in argumentation, constitute a *double bind situation* for pedagogical development and planning. These pedagogical ideals, combined with the fact that an infrastructure must work across heterogeneous computer-based solutions, also constitute a double bind situation for systems design. A double bind situation is, as presented in section 3, a situation where it "is not possible to go on as usual any more" (Christiansen, 1990, p. 117). To get out of the double bind situations and expand the insights into how to organize for new CSdCL situations, I argue that pedagogical organizers and systems designers need some guidelines. This is not to predict what they should do, but to recognize and if possible avoid some of the pitfalls of earlier practice. In line with dialectical thinking, the aim is not necessarily to *solve* contradictions. Rather, the aim is to consciously reflect upon them to organize for CSdCL anchored in the situations the adult students find themselves. Efforts to make frameworks with this purpose in mind, need a theoretical grounding in *distributed* and *computer-mediated collaborative learning*. Sections 6.1 and 6.2 discuss theories and concepts that are presented in detail in Part II of the thesis. The sections conclude with frameworks developed.

The following research question is answered in sections 6.1 and 6.2:

- *What constitute frameworks, in terms of theories and concepts, for understanding the complexity of CSdCL?*

6.1 A Framework for CSdCL Planning and Evaluation

In Fjuk and Sorensen (1997) in Part II of the thesis, I present a framework that concerns planning of CSdCL activities, and corresponding courses. This section presents and discusses the framework developed.

Spatial concepts are frequently used to conceptualize CSdCL. Some examples are virtual school (Paulsen, 1990), virtual classrooms (Hiltz, 1994) and electronic college (Fjuk, 1992). Lakoff and Johnson (1980), not concerned with CSdCL, underline the role of spatial concepts since they create imaginations close to our understanding of human socialization and interaction:

> "[Spatial concepts] are relevant to our continual everyday bodily functioning, and this gives them property over other possible structuring of space—for us. In other words, the structure of our spatial concepts emerges from our constant spatial experience, that is, our interaction with the physical environment. Concepts that emerge in this way are concepts that we live by in the most fundamental way." (ibid., p. 56-57)

Metaphorical concepts are parts of human thinking (Lakoff and Johnson, 1980). They are instruments to structure how we perceive, how we think, and what we do. Sorensen (1997) emphasizes spatial concepts as powerful instruments to design pedagogical models for distributed learning environments. She stresses the role of *imagination* for navigating and interacting in distributed communities to avoid break downs in use.

Spatial concepts provide insights into interpreting a new learning phenomenon in terms of conventional and well-known collaborative learning situations. But, they do not provide insights into the process of planning new learning phenomena anchored in their *own conditions*. The problems we are facing in organizing CSdCL situations are not a loss in terms of decreased power and effect of metaphors. It is rather a problem of applying concepts that allow CSdCL planning to depart from an understanding of CSdCL as a coherent and holistic phenomenon, instead of splitting it up and keeping track of the various aspects of which it consists.

Inspired by the systems approaches to distance education (Moore and Kearsley, 1996; von Wright, 1987), my framework concerns with issues that *separate* CSdCL situations from conventional learning situations. Using dialectical systems approaches, the framework concerns 'the wholeness' of a situation in terms of related *contradictions*. CSdCL planning is considered in terms of contradictions in order to understand, explain and control the changes the new learning situations imply. In other words, the framework deals with contradictions that manifest themselves in the differences between CSdCL situations and more conventional learning situations, and that can develop to be critical with respect to the students' interactional processes.

As I note in section 3, I consider Engeström's (1987) activity system as an alternative dialectical systems approach. Bødker (1996) sees, however, problems of applying Engeström's activity system from a point of view of the instrument. An instrument is shaped and used in several different activities, and consequently making it difficult to identify the activity system that is of interest for the analysis. As Bødker notes, "[t]his would potentially include all use activities, all teaching and artifact production activities, as well as ideas for change in the use activities" (p. 151). I support this view and argue that the process of identifying contradictions has to be guided by some *structure*. This is approached by using Aristotle's concepts of *designing a play*. A play metaphor is taken from theater and drama. As such, it gives associations to spatial concepts. This is not the background for using Aristotle's concepts for play design. Rather, it is to some extent inspired by Brenda Laurel's book (1991) *Computers as Theatre*. Laurel is concerned with interface design, and makes an analogy to Aristotle's concepts of designing plays. Her argument behind this analogy is that both kinds of designs aim at developing representations of situations that are similar to reality, yet different. In contrast to Laurel, my interpretation of Aristotle's concepts is not explicitly related to design of *computational representations*. Rather, the framework is a means for recognizing the *differences* between conventional learning situations and, distributed and computer-mediated learning situations, with a purpose of planning CSdCL situations. Although the goal of a student's learning process may be the same in traditional and new situations, my investigations of the CSdCL cases show that the conditions for performing the actions are different. The set of conditions embedded in the available computer-based resources, and the geographic separation between the collaborating

students, are factors that guide the course of actions differently from that in conventional situations.

To structure the design of a play Aristotle suggests six qualitative elements, each with a certain relationship to each other. These elements are *(the whole) action, character, thought, language, melody and spectacle*. The interwoven complexity of CSdCL is interpreted in terms of a 'whole action', consisting of the five other elements. That is, the 'whole action' of a CSdCL phenomenon is created by tensions between different factors manifested in the triadic complexity of organizational, pedagogical and technological aspects. Figure 6.1 illustrates the combination of the play elements and the triadic relationship characterizing CSdCL.

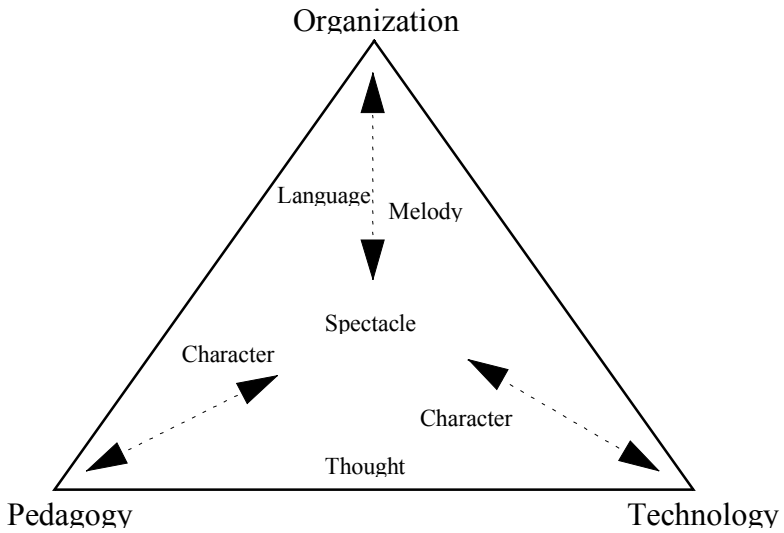

Figure 6.1: The triadic relationship of CSdCL combined with Aristotle's elements of play

The elements of character, thought, language, melody and spectacle constitute the way of structuring the triadic complexity (see Fjuk and Sorensen (1997) for details). Aristotle suggested a hierarchical structure of the elements.

Elements of a play	**Elements of a CSdCL situation**

Character *"Good characters are those who successfully fulfill their function—that is, those who successfully formulate thought into action." (Laurel, 1991, p. 50).*	Pedagogical (and technological) aspects: The expectations of the students and the teachers found in the pedagogical model. The Aristotelian concept of 'good character' is related to those actors (students and teachers) that successfully fulfill their functions and roles according to the expectations. A computer application can be considered as a 'good character' if it fulfills a role as mediator of the interactional processes found crucial in the pedagogical model.
Thought *"Inferred internal processes leading to choice: cognition, emotion, and reason. " (ibid.)*	Pedagogical and technological aspects: The methods for performing the actions are determined by the conditions of the mediating instrument. Indirectly, thought refers to the *contradiction* between the collaborative learning approach and the operational functionality of the available computer-based resources.
Language *"The selection and arrangement of words; the use of language." (ibid.)*	Organizational aspects: The rhetoric manifested in e.g., course material and selection of technology, and the possible impacts on human activity and roles.
Melody *"Everything that is heard, but especially the melody of speech." (ibid.)*	Organizational aspects: The signs manifested in the existing education system and the institutional tradition, and their impacts on designs and practice.
Spectacle *"Everything that is seen." (ibid.)*	Organizational, pedagogical and technological aspect: The designer's perspective, and how this is shown in the practice of CSdCL.

Figure 6.2: The conceptual framework

Each element has a causal or material (technological) relationship to the elements above or below. Even though Aristotle emphasizes such a hierarchical structure as an instrument for designing a play, CSdCL planning must, additionally, recognize the interwoven, non-hierarchical relationship between the elements.

Figure 6.2 shows the relationship between Aristotle's elements of a play, and how I interpret them with regard to CSdCL. The elements constitute a means for structuring the contradictions. The elements themselves and, their interconnections, represent possible contradictions.

The process of identifying contradictions can be approached by using Soft Dialectics (Bratteteig and Ømgrim, 1994; Appendix 1). The process of drawing 'rich pictures' is useful to structure thoughts and to identify critical factors due to the suggested elements (Fjuk and Ømgrim, in progress).

The application of the framework to CSdCL designs is presented in section 7.

6.1.1 Discussion

The framework is developed for the purpose of evaluating present CSdCL situations and planning future ones. The framework is not developed for the purpose of understanding the students' distributed and computer-mediated interactional processes as such, or the specific conditions for systems design. However, I find it interesting to *initiate* a discussion, based on the idea of play, with the purpose of systems design. Following this, a distributed collaborative learning community can be interpreted in terms of an *ensemble*. A distributed collaborative learning community then becomes 'an arena' where the students become actors mutually dependent on each other, to perform a good play. When a student enters the distributed community (ensemble), she/he follows a manuscript (pedagogical model) related to her/his role as a student. Goffman (1959) uses a theatrical metaphor to describe different modes of interactions. He points explicitly to the similarity between reality and theater, since both are plays where manuscripts are used. These manuscripts mediate a person's objective of creating a certain illusion towards peers of the society. Our understanding of the reality is, he argues, based on expectations of behavior and interaction. Goffman suggests that the performers are those who control the situation, the others form the audience. In a lecture, for example, the teacher is the actor of the play. The students are the audience. Following Goffman, the students who actively participate in a distributed community constitute the performers. The students

who only passively read their peers' written contributions form the audience. An interpretation like this will, nevertheless, include problems. Firstly, the analogy breaks down when a passive student (member of the audience) joins the distributed community (ensemble). A clear distinction between actors and audience, as is common in many plays[24], disappears. Secondly, the basic principle of manuscripts, i.e., a pre-defined plan for a play, contradicts the *situated* and *unforeseen* nature of collaborative processes. Collaborative processes are difficult, or almost impossible, to predict. Breakdowns, contingencies and conflicts are inseparable parts of any collaboration (Star, 1991; Easterbrook et. al., 1993). With respect to learning, these events are even considered as fruitful for personal and collective progress and growth (Fjuk and Dirckinck-Holmfeld, 1997).

Thus my argument so far, is that the idea of play is useful for recognizing possible contradictions connected to the differences between conventional, and new learning situations in the process of analyzing and planning CSdCL situations. The idea of play design may be less useful, however, with regard to understanding distributed collaborative communities, and how this should provide insight for systems design. Concept and theories for the latter are discussed in next section.

6.2 A Framework for Systems Design

This section deals with the element of 'thought' in the play-based framework presented in the previous section. This section presents and discusses a framework that deals explicitly with *tension*s between pedagogical and technological aspects with the purpose of systems design.

I claim in section 4.2 that systems design cannot be based on a dichotomy like the one between interpersonal processes and behavior, and computer systems. My argument is then that systems design cannot solely be based on a theoretical understanding rooted in situations where physical places are shared by the collaborating actors. Efforts to build computer systems to support the complex socially and computer-mediated reality of the new learning phenomenon, need

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24 During the modern times several dramatist have designed plays with the purpose of engaging the audience. One example is the German dramatist Bertolt Brecht, who introduced the epic theater. Other modern forms of theater, such as impro theater, streets theater and action theater, focus on participation from the audience and, thus, unforeseen happenings.

thus a theoretical grounding in *distributed* and *computer-mediated collaborative learning*. This claim includes a theoretically based grounding that can work as a link between understanding its conditions, and designing computer systems for it. This conceptual link constitutes a framework that can help systems designers to design and implement computer-based tools that provide support for interactional processes.

The section starts by discussing *spatial concepts* and *social worlds* with respect to; 1.) understanding the conditions of distributed and computer-mediated interactions, and 2) designing computer-based tools for it. The section concludes with presenting a framework for systems design. The framework is presented in detail in Fjuk and Smørdal (1997) in Part II of the thesis.

6.2.1 Spatial Concepts and Social Worlds

In Fjuk and Øgrim (1997b) I discuss spatial concepts for the purpose of systems design. Systems designs are often driven by technological advances, and a transformation of understandings of collaboration in physical domains to computational ones (see e.g., the discussions in Harrison and Dourish (1996) and Fitzpatrick et. al. (1996)). The patterns of interaction and human behavior are then sought to be implemented in computational equivalents of physical environments. The desktop metaphor of single-user systems is one example. Others are the MUD/MOO applications, that have received special attention from pedagogical milieus (Lindeman et. al., 1995; Cherny, 1995; Fanderclai, 1995). The MUDs are based on an assumption that behavior- and interactional patterns can be transformed to computational representations. Thus, design is aimed at building the same milieus for interaction that physical environments exhibit — rooms, doors, walls, etc. Many MUDs are based on text-based representations. However, there is an increasing trend to also make graphical and 3D representations (Curtis and Nichols, 1994). A concept that logically creates an imagination of, for example, social co-presence, may cause both enthusiasm and few break downs when entering the computer system the first time. On the other hand, it may constitute an obstacle for 'quick navigation' when the user gets more experienced.

Although spatial concepts are linked to our conventional way of collaborating, I question (in Fjuk and Øgrim (1997b)) the power of them with respect to CSdCL. I argue that spatial concepts are situated with respect to *the learning and teaching objectives*, and to the *bandwidth* available for interactions. Concerning the former, computational equivalents of physical environments may be helpful when the

objective of design is school teaching of pupils in classrooms. Contradictory, collaborative learning situations where adult workers have the position of students, common physical spaces such as meeting rooms and school buildings, do not necessarily have a strong impact on learning. I explain this by using my basic understanding of distance education (see section 3). In distance learning situations, where the students are physically in different contexts as well as being part-time students, the students do not share cultural roots and physical work places. Although many distance education programs give opportunities for face-to-face lecturing, a common space between student and teacher has a lesser meaning for interaction and learning. Rather, interaction is constrained by the conditions set by the available instrument (the written word) and the aspect of 'physical distance'. In section 5, I conclude that the students' interaction in distributed and computer-mediated collaborative learning communities is constrained by similar conditions. In other words, it is the conditions for performing actions that frame the course of interactional processes. Thus, it is not the structure of spaces, or common spaces, which frames an adult student's interactional processes. In addition, many of the actions involved in collaborative processes are carried out by the individuals at home, at work, on the train, etc., and not always in joint collaboration with peers.

Following these lines of considerations, a distributed collaborative learning community is a 'place' that is created by the students through their individual and collective actions, framed by the conditions of performing these actions. These 'places' are not developed by the systems designers. The designers' role is to make computer-based tools that support the students' work of creating that community, and in such a way that the computer systems become integrated parts of the students' activity.

Different media have different spatial properties, too. Text, graphics, 3D images, audio, video exhibit different properties. In (Fjuk and Øgrim, 1997b) I argue also that spatial concepts are not especially useful as long as the systems are *text-based*. The users really have to *imagine*, or even be told about, the rooms, doors and so on. However, when virtual reality-like applications are more available for the target group, spatial concepts may become more useful to rely on, in systems design.

My arguments, supported by Harrison and Dourish (1996), are thus that spatial concepts cannot blindly be adopted in systems design. The utilitarian value of

spatial concepts is dependent on what learning practice we design for, and on what bandwidth is available.

I have sought to use theories that describe aspects of my argumentation. Socio cultural perspectives on learning explain how individual actions, and thus learning, are influenced by social factors. They do not, however, explicitly give an account of how individual actions influence the building of social communities (Roschelle, 1996; Kaptelinin, 1996a). In order to make computer systems for collaborative communities, I find it as important to integrate this feature of socially-based interaction. I thus find concepts from Anselm Strauss' (1993) *interactionist theory on action* useful for, theoretically, describing these specific issues of my argumentation. In part II of the thesis, I discuss these concepts in detail: In Fjuk and Dirckinck-Holmfeld (1997) I discuss Strauss' concepts with respect to problem-oriented project pedagogy, and use them to analyze the students' distributed and computer-mediated interactional processes. In Fjuk and Smørdal (1997) I discuss the concepts with respect to systems design, and compare them with central features of activity theory/socio cultural perspectives. In Fjuk and Øgrim (1997b) and in section 7, I follow the argumentation in the two previous mentioned papers, and show how this provides insight into designing a computer system. In what follows, I will thus only briefly present and discuss Strauss' concepts.

Strauss (1993) is concerned with interactional processes, and how these have implication on the building of *social worlds*. Strauss' notion of social worlds does not contrast spatial concepts, but as he argues in his early work of observing life in the city, he places emphasis on effective channels of communication:

> "The important thing about any given urban world is not that it is rooted in space. That is merely what often strikes the eye first (...). What is important about a social world is that its members are linked by some sort of shared symbolisation, some effective channels of communication." (Strauss, 1961, p. 67; quoted in Fitzpatrick et. al., 1996)

Similar to Lave and Wenger's (1991) definition of 'communities of practice' (See section 3), the creation of social world is not determined by geographical or socially visible boundaries. It is only constrained by the limits of effective communication (Strauss, 1993). Social worlds can compose themselves to sub worlds.

Moreover, the dynamic interplay between *problematic* and *routine* action is the basic of the interactionist theory of action. Problematic actions—such as confrontation and negotiation of perspectives, common problem solving, consensus seeking, etc.—cannot take place without the routine actions and the usually taken for granted skills and abilities. The routinized skills and abilities are integrated to every action since they play into creativity and innovation in face of e.g. unexpected contingencies. In time, the actions "flow back into the realm of the routine" (Ibid., p. 207). The plurality of individual and collective actions, the relations of actors to actions, and the available technologies, are all factors that influence the interactional processes and, thus, the shaping of social worlds.

Strauss' interactionist theory on action is powerful for understanding interactional processes and the conditions for building distributed communities. Fitzpatrick et. al. (1995) support this view. However, the authors also propose that the interactionist theory on action is useful for bridging the 'social and the technical system', i.e., the link between understanding collaboration and, designing computer systems. An important lesson learned from Strauss' theory is that distributed communities need computer-based solutions that do not constrain effective communication. Although this basic issue, I conclude in Fjuk and Smørdal (1997) that the concepts are not powerful *enough* to serve as a framework for systems design. The next section discusses Engeström's (1987) triadic model of human activity (section 3) as a point of departure for this.

6.2.2 Incorporation of Computer Applications in Collaborative Learning

In Fjuk and Smørdal (1997) I present and discuss a framework developed. The background for the framework is networked computers and their increasing use in collaborative settings. The complicated relationship between pedagogical ideals of collaborative learning and the fact that an infrastructure for CSdCL must work across heterogeneous computer-based solutions, confirms a need for such frameworks for systems design. The idea behind the framework is to provide a link between the 'social and the technical system' in such a way that systems designers can recognize the contradictions that manifest themselves in the relationship between collaborative learning and computer systems.

A framework based on this view was first initiated in Fjuk (1995)[25]. In this paper, I suggest problem-oriented-project pedagogy as a theoretical foundation. I

[25] In this paper I use the notion of CSCdistanceL to present the problem area.

use dialectical theory to integrate this theoretical foundation with conditions embedded in the computer applications. The dialectical contradiction that constitutes computer-mediated collaborative learning is (Fjuk, 1995):

1. Human actions directed towards the collaborative learning process.
2. The computer applications.

The aim is simply to assess to what extent computer applications support or hinder the actions involved in collaborative learning processes. In Fjuk (1995) I consider the *ideal* role of a computer application as follows:

> "(...)if a computer application should mediate collaborative learning, it should mediate human actions directed towards *both* individual work tasks and cooperation. If the application mediates actions related to only one of these aspects, it does not mediate the whole collaborative learning process. For example, if a computer application only mediates actions directed towards cooperation—and only *some* aspect of it—it does not mediate the whole process of collaboration" (Ibid.).

To what extent the prescribed role of a CMC system is ideal, is open for debate. It might be ideal with respect to creating something exceptional and unique. However, it is hardly ideal in practice. A collection of computer applications, no matter how powerful they may be, cannot support the whole process of collaboration. In any case, my point is that a collection of instruments, computer-based or not, is viewed as being incorporated into the mutuality of individually and collectively oriented interactional processes. In practice this means that instrument-mediated interpersonal interactions should not contradict the mediation of the intrapersonal ones, and vice versa.

I have brought these thoughts further in Fjuk and Smørdal (1997), where I apply and discuss Engeström's (1987) triadic model of human activity with respect to systems design. Engeström explains how human activity is affected by social factors. Similar to problem-oriented project pedagogy (Fjuk and Dirckinck-Holmfeld, 1997) and socio cultural views on learning (Kaptelinin, 1996a), Engeström is not clear on how individual actions influence the making of collaborative communities. The model clearly recognizes computer mediation of individual action (production), but it does not provide insight into computer mediation of actions embedded in the *collective aspects* of human activity (exchange and distribution). Individual actions constitute the core of any

collaboration in the sense that each activity is conducted through the actions of individuals directed towards an object or a peer (Bødker, 1996, p. 149). In spite of this feature of activity, my argument is that computer mediation of actions related to the collective aspects of activity (exchange and distribution) must be included also in systems design. My investigations indicate that individual computer applications hamper the actions embedded in argumentation and articulation of contributions. Another example is taken from video conferencing systems with a shared worked space. Seeing the collaborators' facial- and bodily expression may be used to control access to the shared work space. However, bad image quality may hamper this important aspect of awareness of the others' intentions and views.

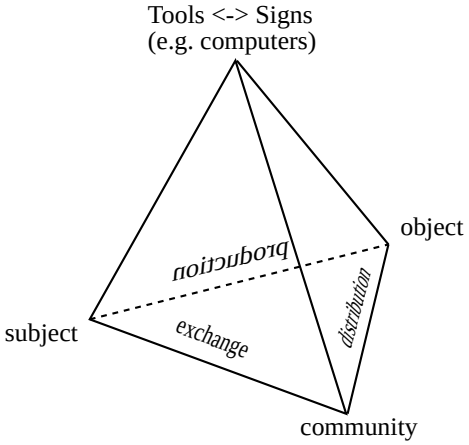

Figure 6.3: Incorporation of instruments into collaboration (Fjuk and Smørdal, 1997)

In Fjuk and Smørdal (1997) I therefore argue that the model does not give ready-made answers to systems design. In spite of these weaknesses, the model is an useful *point of departure* for linking an understanding of, one the one hand, the conditions for creating a distributed communities (approached by an interactionist theory of action) and, on the other, how to approach this in systems design. My contribution to a framework for systems design is illustrated by the pyramid in figure 6.3.

The sides of the pyramid illustrate the three mutually dependent aspects of Engeström's model (figure 3.1): Production, exchange and distribution. The collection of computer-based instruments has a mediated function in the actions embedded in the relationship between the three aspects. In other words, the collection of computer-based instruments should mediate individually and collectively oriented actions, and not become obstacles for the duality between them. Computer-based tools that mediate the students' distributed collaborative processes is thus defined as instruments that do not hinder the web of socially and instrumentally mediated actions to be performed (Fjuk and Smørdal, 1997). In other words, a computer application has become a tool if it is an integrated part of a student's activity (Christiansen, 1996).

In line with Vygotsky's (1978; 1994) broad definition of instruments, and supported by my analysis of the CSdCL cases, the core of the framework is the duality between sign and tool (section 3). A computer application's role as a sign has an important implication to collaborative situations where mediation of thought and common understanding have central positions: The signs are basic instruments for intrapersonal and interpersonal interactions. The signs also guide the student's use of computer-based tools. Therefore, the signs constitute the basis for the designer's process of making computer-based tools. To be able to make potential tools for the students, the designers need to know the meaning of signs with respect to collaborative learning and work.

Analogous to my dialectically oriented framework (suggested in Fjuk, 1995), the aim of this framework is to guide the designers in identifying contradictions that manifest themselves in the relationship between human actions and available computer-based resources. Each side of the pyramid in figure 6.3 constitutes possible contradictions with the instruments: Computer-based instruments may work as mediators of actions embedded in the relationship between the three aspects. But at the same time, each aspect and the instruments can struggle and contradict each other. The designers using the framework should then look for possible contradictions between signs and tools, in order to select or, implement, computer applications that do not hinder computer-mediation of individually and collectively oriented actions. What to look specifically for, is presented in Fjuk and Smørdal (1997) in Part II of the thesis. The use of the framework for design and implementation, is shown by an example in section 7.

6.3 Summary

This section has focused on the second goal of my research, i.e., to incorporate my main results from the studied CSdCL cases into conceptual frameworks. The two developed frameworks have different purposes: CSdCL planning and course design on the one hand, and computer systems design, on the other:

- Concerning *systems design*, spatial concepts have received attention to make computational equivalents of conventional ways of interacting and collaborating. I have argued that the usability of spatial concepts is situated with respect to the objective of learning activities as well as the bandwidth available for interaction. Based on my studies of various CSdCL cases I conclude that distributed collaborative communities are not defined by

spatial renderings of e.g., rooms, schools, etc. Rather, distributed and collaborative communities are constrained by the conditions embedded in the socially and instrumentally mediated nature of human actions. The basis of the framework developed is *socio cultural perspectives* on human activity, enriched by an *interactionist theory on action*. I have argued that none of these theoretical foundations provide detailed enough guidelines for systems designs. A combination, however, is fruitful to link an *understanding* of distributed and computer-mediated collaboration (interactionist theory on action), and *systems design* (socio cultural perspectives/activity theory). Contradictions constitute the basic technique of the framework. The designer is encouraged to look for possible contradictions that manifest themselves in the relationship between human actions and available computer-based resources.

I believe that such an *action-oriented approach* is necessary in the increasing work- and learning situations marked by heterogeneous computer environments and networked computers.

- Concerning *CSdCL planning and course design*, others use spatial metaphors to conceptualize CSdCL. Examples are virtual classrooms, virtual schools, etc. I have argued that such concepts do not provide insights into the process of analyzing and planning CSdCL situations on its *own conditions*. I have used a combination of *dialectical systems approaches* and *systems approaches to distance education* as a basis for viewing 'the wholeness' of a situation in terms of interconnected contradictions,- contradictions that can affect the students' interactional processes in learning. Aristotle's concepts for *designing a play* are used to structure the contradictions. The argument for using these concepts, is the similarity between distributed and computer-mediated collaboration and, a play. Both are like reality and conventional forms of interacting, yet different. Thus, the framework concerns contradictions that manifest themselves in the differences between CSdCL situations and more conventional learning situations.

7 Using the Frameworks

The third goal of my research is to point out possible directions of solutions. In this respect, I have used the Internet, and in particular the World Wide Web, as technological platforms. From the CSdCL cases studied, I concluded that heterogeneity and networked computers must be viewed as the reality for future systems design. The World Wide Web has a potential to handle the argued problems of heterogeneity and functionality across computer platforms. The World Wide Web also has a potential to provide access to homes and to low costs usage.

This section concerns the following research question:

- *How can Internet services, in particular the World Wide Web, be applied as a meditating instrument for distributed and collaborative learning?*

The frameworks developed were used to approach this research question. The frameworks were used in the Dynmaix project, initiated by NKS and Department of Informatics (university of Oslo) in collaboration. The early experiences from the NKS (see section 5.1) as well as experiences from other CSdCL cases (see section 5.2) constituted the background for the project. Distributed and project-based learning constituted the double bind situation of the project. The aim of the project was to explore the problem area through designing a course on *project management* and a computer system[26] that served to mediate the interactional processes.

To test the new concept of CSdCL, some employees at NKS participated as students.

This section is structured in accordance to the elements of the framework presented in section 6.1. The contradictions were identified by the help of drawing rich pictures in collaboration with the practitioners at the NKS: Management, teachers and administrative staff. The contradictions identified with respect to the differences between conventional learning situations and the new learning situations and corresponding suggestions towards expansion, are presented in this section. The section discusses some of the problems met while designing the

[26] Ola Berge implemented the pilot system as a part of his master thesis. As Berge's supervisor, I collaborated closely with him in the design of the pilot system.

course and the pilot system. It presents some of the experiences gained from the use of the computer system, also.

This section is a contribution in itself, since it shows the application of the frameworks developed. This is not explicitly shown in the papers in Part II of the thesis. The section concludes with discussing the experiences of using the frameworks in CSdCL designs.

7.1.1 Character: The Students' and the Teachers' role

In section 5.2 I argue that the ideals of problem-oriented project pedagogy must be reconsidered for the purpose of CSdCL. The students and the teachers have problems with successfully fulfilling the expectations prescribed.

The project came up with some alternative solutions to these problems. The basic assumption was that distributed project-based learning has best conditions in situations where the collaborating students share a work practice. The point of departure for their collaboration, was that the students should have a shared frame of experience and a shared problem related to the their work practice. To obtain this, the students were expected to participate in a common project during their daily work situation. Then, the issues related to the subject domain represented a strong link to their daily practice of participating in a common project. This was viewed as important because of two reasons: First, it was a means to promote the students' motivation and commitment to the collaborative learning process. Second, in-depth discussions and argumentation related to the subject domain were expected to be carried out during their daily work and, ideally, at a common work place.

In section 5.2 I argue that a *balance* between the students' control and shared responsibility for the collaborative process, and the tutor's role of guiding and controlling the processes, is a must in distributed collaborative learning. To obtain this, we regarded frequent submissions of project assignments as the solution. The students were required to submit many and small assignments, instead of a report that concludes their collaborative process.

7.1.2 Thought: Collaborative Learning through the World Wide Web

In sections 5.1 and 5.2 I discuss how the computer systems constrained interaction on an interpersonal and intrapersonal level. This was particularly due to practical problems of handling incompatibility and costs, but also to a weak correlation between the CMC systems and the situated and dynamic nature of collaboration.

Concerning the former, the World Wide Web provides new opportunities. Concerning the latter, the World Wide Web does not provide sufficient operational functionality with respect to collaboratively oriented actions, such as joint authoring, negotiation, creation of the contents of the collaborative processes, etc. (Bentley et. al., 1995; Haugsjaa, 1996). Therefore, the conceptual link between project-based learning and the rather document/page-driven approach of most hypertext designs is rather weak.

The idea was that services available via the Internet, such as e-mail, news groups, chat, Web-pages, and the like, should constitute a collection of tools presented in a common World Wide Web interface. The collection of tools was named Dynamix[27].

Instead of grounding our understanding on spatial renderings of e.g., rooms, schools, etc., we focused on the conditions embedded in socially and instrumentally mediated nature of human actions. The basic philosophy behind systems design was to develop a collection of computer-based tools that should make the underlying understanding of project-based learning visible for the students without forcing them into prescribed or pre-established patterns of collaboration relations. Instead, Dynamix[28]should be conceived as a resource for collaboration, allowing the students to use what tools they felt confident with according to the situation at hand.

We used the systems design framework (presented in section 6.2.2.) in the design process. In line with the framework, the aim was to identify basic signs. We used the framework to identify what Internet services (and other available services) that could serve as tools and further to identify a positive relationship between signs and tools. Figure 7.1 illustrates possible instruments related to the three, but interwoven aspects of production, exchange and distribution.

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27 http://www. ifi.uio.no/~annita/dynamix (User name: anonymous, Password: guest).

28 Appendix 2 shows the opening 'Web-page'.

Aspects of colla-boration	The role of instruments in collaboration
Production	*Tools and signs are targeted toward the object of the activity. Tools are means of changes upon the object, while signs are aiding thought and reflection upon the object.* Examples: Signs: Text, painting, calendar, etc.(thought, questions, answers, reflections) Tools: Text processing programs, drawing programs, spreadsheets, etc.
Exchange	*Signs mediate thought, knowledge and perspectives among the students in the collaborative learning community. Tools are means of changes upon the object, but the interpersonal aspects involved are also focused.* Examples: Signs: Text, painting, calendar, Web-pages, etc. (Common understandings, questions-and-answers) Tools: Chat-systems (UNIX's YTalk, IRC (Internet Relay Chat)), e-mail systems, html-tools (Word 1997, HoTMetaL)
Distribution	*Signs mediate the division of labor, like common decisions, commitments, and articulation of work. Shared tools are means for a community to collectively make changes upon the object.* Examples: Signs: Scheduler, project directives, milestones plan, activity responsible charts, etc. (Common plans and decisions) Tools: Awareness-function (UNIX's Finger, IMAP (Internet Message Access Protocol)), applications for; calendars, project directives, milestones plan, activity responsible charts, etc.

Figure 7.1: The relationship between signs and tools

In Fjuk and Øgrim (1997b) I discuss some of the problems met during the design and implementation of Dynamix. Although the students were expected to use Dynamix at work, we emphasized the same opportunities from home. Some of the services (see figure 7.1) were not available for the target group. That is, many users working at home do not, yet, have direct access to Internet and e.g.,

ISDN and do not have powerful computers (e.g., UNIX work stations) and software available (e.g., Word 1997). I will illustrate some other problems below.

The problems were most obvious due to the collectively oriented aspects; exchange and distribution. When it comes to the aspect of exchange, I argue in Fjuk and Øgrim (1997b) that a chat-function is considered as an important resource to support the interactive and dynamic nature of e.g., argumentation, brainstorming, etc. However, the considered chat-systems (e.g., UNIX's YTalk) were not available for the target group, or not sufficient for closed group discussions (e.g., IRC). Thus, a chat function was developed from scratch (Berge, 1997).

When it comes to the aspect of distribution, I argue in section 5.2.2 that explicit articulation, like planning, is crucial for maintaining awareness of each other's actions and progress. Milestones plans and activity responsible charts were considered as basic signs for making joint plans regarding *who* is doing *what*, *when* during the collaborative processes. The students' shared activity of filling in the charts and plans, was also considered a central part of the course. The original layout and format found in the paper-based forms were emphasized by the course designers. However, the implementation of these forms in World Wide Web implied problems. A milestones plan includes circles to be filled in, and this was not possible to implement in a Web-page (Berge, 1997)[29]. The result was that the original paper-based forms were used. When it came to activity responsible charts, similar problems were present. A third form, project directive[30], did not imply considerable problems, since only text was aimed at being entered by the students (See Berge (1997) for details).

When a student presents a thought or an idea, it will help if she/he knows whether the peers have seen it or not. Today's services do not, however, provide a way of tracking the status of messages. In Fjuk and Dirckinck-Holmfeld (1997), I argue that time is critical for an adult student since she/he is committed to different social worlds; daily work practice, family and peer students. Also

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29 CGI (Common Gateway Interface) scripts were chosen for implementing the system. CGI-scripts were written in Perl (Practical Extraction and Report Language) as it enables quick (further) development of prototypes. Some of the problems met can be reduced by using Java.

30 The Project Directive is shown in Appendix 2.

concerned with awareness, a scheduler[31] was viewed as a significant sign for articulating time.

The problems of systems design were most obvious due to collectively oriented aspects. The problems thus confirm a need for a framework that seriously takes these aspects into consideration. The practical use of Dynamix, which will be briefly discussed in section 7.1.5, also confirms this.

7.1.3 Language: The Selection and Arrangement of Words

In section 5.2 I argue that the rhetoric in course material as well as the instruments of the existing education systems, implicitly mediate the course of interactions differently than prescribed in the pedagogical planning. In section 5.1 I also show that the idea of guided didactic conversation contradicted the assumed learning benefits of social interaction.

In the Dynamix project, the course material was developed on the principle of guided didactic conversation. The course designers needed, thus, to carefully integrate this basic view on interaction, so that they provided benefits for collaborative learning. The language applied in the course material was therefore aimed at mirroring collaborative learning and corresponding roles of the students; it was not an independent study.

7.1.4 Melody: Supporting the Institutional Tradition

In contrast to the established education system the focus was on interpersonal interaction, but, integrated with established principles of interaction (learner-content interaction and learner-teacher interaction). The basic philosophy of flexibility in terms of *when* and *where* to study, was also maintained through Dynamix.

The early run of CSdCL was mainly based on income from the students. Because the number of students using the CMC systems decreased during the period in question, the CSdCL activity became too costly. The fundamental requirement for our project was therefore that the new CSdCL situation should not imply costs for the institution, when it came to run of Dynamix and user training. The individual student was required to take care of access to the Internet as well as to achieve skills using it.

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[31] The Scheduler is shown in Appendix 2.

7.1.5 Spectacle: Everything that is Seen

This last element of the framework is concerned with results of the project, and mirror the designers' perspectives. Because of the project members multiple experiences and knowledge regarding CSdCL, the conditions for collaboratively achieving broader insights on CSdCL were present. But, several unexpected problems arose.

The Dynamix system did not work as a sufficient collection of tools for the collaborating students. In other words, it did not become an integrated and natural part of a student's collaborative learning process. One implicit explanation can be the fundamental requirement of maintaining the original forms of milestone plans and activity responsible charts. Because of problems with implementing these forms in World Wide Web, the paper-based forms were used. This implied time consuming work for the students, and in particular for those that were located at different sites (although working in the same organisation): In order to make a common plan, they needed to fax the forms back and forth. Other explanations are summarized by Berge (1997) in the following way:

> "The participants reported insufficient knowledge about Internet as a major obstacle for using the technology efficiently. Most participants had no prior experience with Internet or WWW, and they did not receive any instructions before or during the course. This problem was manifested in the problems regarding distribution of individual contributions to the group product. Because they did not know how to publish documents on WWW, they could not use the Documents service for this purpose. They also had problems with carrying out this task by using e-mail attachments. The main problem was that they did not have sufficient technical knowledge about formats, which is required in order to exchange documents across platforms." (Ibid., p. 140)

This underlines the important issue of ensuring that the students have sufficient knowledge about Internet before using it. Although the development and growth of the World Wide Web have widened people's access to Internet, its *application* has not yet been sufficiently made way into a lifelong learning society. The institution's requirement of reducing costs connected to run and user training —

that also constitutes one argument for selecting the World Wide Web and the Internet as technological aspects — thus contradicted effective use of Dynamix.

During the marketing of the new World Wide Web-based concept, it becomes obvious that the marketing division at the NKS did not understand the concept sufficiently. Consequently, the marketing division was not able to inform potential and external customers (students) about the concept. This does not mean that the marketing division did a bad job. Rather, it was the project that did not sufficiently take care of informing and teaching this department about the new concept. Thus, one important lesson learned from the project was that good design ideas resting on practical problems cannot, in and of itself, create new and good practice. Good practice is dependent, also, on organizational maturity to offer a new concept. The new concept has to be incorporated into the delivery institution's culture and work structures. For an institution that is dependent on *creating income*, this is an essential requirement.

7.2 Discussion

The basic idea behind the frameworks is dialectical contradictions. That is, the designers shall look for possible contradictions that can affect the students' interactional processes both with regard to learning and to use of computer-based applications.

Concerning the use of the frameworks, they allowed us to view the practice of CSdCL in a new light. It recalled earlier experiences to mind, and new thoughts came up through collaboration with others. Sometimes, the process of identifying contradictions and drawing rich pictures, caused breakdown in argumentation and thoughts. The focus easily became the contradictions themselves, rather than open-minded discussions. A focus on identifying contradictions can thus become a hinder for creativity. In situations like this, the appliance of additional media — such as audio or video recording — was useful. In studying the transcriptions of the tapes, contradictions connected to the problem area became clearer, and new one generated.

The basic of dialectical analysis is to identify both the dependency and the struggle between the aspects that constitute a contradiction. A focus on contradictions can imply a too much attention on problems and conflicts.

The frameworks provide guidelines for *what* elements that constitute possible contradictions (e.g., character, thought, language, melody and spectacle). This can

hinder creativity, since the elements may structure the situation under consideration too much and eliminate other important elements of that situation. However, I argue that creativity and new thinking also need structure and guidelines. Creativity and structure are close connected in expanded learning (Fjuk and Øgrim, in progress).

Finally, the idea of play design can be vague and unnatural for some. But, at the same time it promotes new ways of thinking, and allows the user of the framework to recognize new aspects and relations connected to the problem area.

7.3 Summary

This section has concerned with my third research goal, i.e., to point towards possible directions of solutions. The developed frameworks are used to provide insight into the field of tension between pedagogical, technological and organizational aspects with regard to a new CSdCL situation. The technological aspect was Internet services, and in particular the World Wide Web. The pedagogical aspect was project-pedagogy, inspired by the ideals of problem-oriented project pedagogy. The organizational aspect was primary distance education. The results of the project were:

- A *computer system.* The objective for systems design was to make a collection of computer-based tools that served as a resource for the students' collaborative processes. The design and implementation of the pilot system implied some challenges. This was primarily because of the fact that some services were not sufficient available for the target group. Also, some fundamental schemes like milestones plans and activity responsible charts, were complicated to implement in World Wide Web. My conclusion from the project, is that there are still some practical problems left to be solved — both with respect to design and to practical use.
- A *course.* In line with my leading argument throughout the research, the basic principles of project-based learning and distance learning were thoroughly integrated with the conditions of available Internet services. However, the project indicated that a good design idea resting on practical problems cannot, in and of itself, create new and good practice. Good practice is dependent, also, on the delivery institution's maturity and

capability to incorporate new pedagogical products in the institution's established education system and division of work.

Although the core points of my research were practiced, the results from the project clearly show that there is still a long way to go to master a field of tension present in many CSdCL cases. The students' use of the pilot system showed that distributed and computer-mediated project-based learning is still complicated to maintain in practice. The Internet is not that available as expected, - viewed from technological, pedagogical and organizational points of view.

8 Conclusion

The goals of my research have been to:

1. Identify critical factors that influence distributed and computer-mediated interactional processes.
2. Develop frameworks that guide systems designers and CSdCL organizers to identify possible contradictions in the problem area.
3. Point out possible directions for resolving problematic issues in new CSdCL situations.

Concerning the first research goal, I have analyzed a number of CSdCL cases. The studies were conducted at institutions that have their theoretical and philosophical foundation in either distance learning or collaborative learning. I have found that several factors affect the students' distributed and computer-mediated collaborative processes. These factors are found in a field of tension between pedagogical, technological and organizational aspects. This means, that the critical factors that affect the students' processes are not only due to one of these aspects, but to the interwoven and contradictory relationship between them. *Organizational aspects* constitute an institution's educational system and tradition. The *pedagogical aspects* constitute methods and theories of learning. The organizational and pedagogical aspects may align to a greater or lesser extent. The *technological aspects* constitute the computer systems and their conditions for performing learning activities. In what follows, I will summarize the field of tension in terms of pairs of aspects:

- Tensions between *pedagogical* and *technological* aspects. The relationship between collaboratively oriented activities and computer systems, can be problematic. Incompatibility between the students' individual software and

machines contradicts processes of performing actions embedded in collaboration. This becomes particularly crucial in collaborative learning methods that place great emphasis on joint construction of problems or solutions, and opposed alternatives in argumentation. In order to offer the students computer-based solutions that work as integrated parts of their learning activity, I conclude that heterogeneous computer environments must be taken seriously in systems design.

- Tensions between *pedagogical* and *organizational* aspects. The embedded signs of traditional educational practice mediate the students' interactional processes into other patterns than emphasized in the pedagogical basis of the CSdCL activity. A combination of so-called ill-structured subject domains (including subject matters that are open for irregularity in interpretation and, thus, for opposed perspectives in argumentation) and physical separation of the students, constitutes a crucial contradiction. I conclude that pedagogical methods and educational practices, anchored in other learning and teaching situations than CSdCL, are needed to be seriously reconsidered in order to make solutions that provide benefits for the students.
- Tensions between *organizational* and *technological* aspects. A CMC system has a potential to change an educational practice. The studied CSdCL cases clearly represent changes, but the changes developed only as transformation or adjustment of existing educational practice. Therefore, the studied CSdCL situations do not represent *exceptional* new phenomena of learning and teaching. But, I argue that new learning situations that will work in practice, are fundamentally dependent on initial phases of transforming and adjusting traditional practice. I conclude that successful technological and pedagogical *transcendence* is facilitated by knowledge of existing technology and of the pedagogical intentions that constrain and condition its use.

Concerning the second research goal, I have expressed the field of tension in *two frameworks*. These frameworks are:

- *A framework for systems design*. The framework concerns contradictions that manifest themselves in the relationship between basic principles of collaborative learning and computer-based resources available for the situation under consideration.

The theoretical basis for the framework is *socio cultural perspectives* on learning, enriched by an *interactionist theory on action*. I have argued that none of these theories provide detailed enough guidelines for systems designs. A combination, however, is useful to link a theoretically based understanding of distributed and computer-mediated interactional processes and the making of computer systems.

- *A framework for CSdCL planning*. This framework concerns the 'wholeness' of a CSdCL situation in terms of pedagogical, technological and organizational aspects. It provides suggestions for structuring this triadic complexity in CSdCL planning and course design.

  The theoretical basis of the framework is *dialectical systems approaches* combined with *systems approaches to distance education*. This basis allows the systems designer to look for contradictions that manifest themselves in the differences between conventional and new learning forms, and that can affect the students' interactional processes.

Concerning the third research goal, both frameworks have been used in a project aimed at exploring some directions towards solutions. Through influencing the systems design and the course design, the results from the project can be said to mirror the final synthesis of my research. The results from the project are the following:

- *A World Wide Web-based computer system*. The World Wide Web provides a potential for exchanging information across a wide range of platforms. However, it does not provide sufficient opportunities for supporting collaboratively oriented activities. I have presented some of the problems met in developing the system, and I conclude that it is yet a huge challenge to offer the students, often collaborating from homes, computer-based solutions that serve to support their collaborative learning process.
- *A course.* Basic theories and perspectives from distance education and collaborative learning are integrated in such a way that the combination of them can provide benefits with respect to collaborative learning at a distance. However, a design process, resting on reconsideration of established methods and educational practice cannot, in and of itself, create new and good practice. I conclude that good practice is dependent, also, on organizational as well as individual maturity and willingness to make use of a new learning concept.

The results of my research show that it is extremely difficult to develop good CSdCL products anchored in the principles of lifelong learning: This reality is that adults need flexible learning forms, to obtain an increasing need for further education and competence development alongside work. The political emphasis of giving the Internet a particular attention to bring work and learning closer together, do not yet provide clear benefits with respect to this reality. Good CSdCL practices are only developed through evolutionary experimenting of the technology and of various pedagogical methods that constrain and condition its use. It is only through such practice successful CSdCL is recognized. The old discipline of distance education, with its roots in the correspondence schools, practiced several years of 'learning by doing' until what today is termed an own education discipline of practice and theory. I claim that CSdCL puts us in similar situations, and that we cannot assume that what has until now been considered 'good' practice of distance education is so with respect to CSdCL. Today, I would claim, that CSdCL is just in the beginning of a path of finding good solutions.

9 Further Research

My research has identified problems for further research. This section focuses on three of them.

9.1 Organizational Changes

My research has indicated that the relationship between CSdCL and organizational changes, is a complex problem. Research that concerns this issue is both recent and limited.

There exists, however, a rich body of literature devoted to the relationship between development and use of information technology, and organizational changes. The studies done by Bullen and Bennett (1990), Orlikowski (1992a; 1992b) and Karsten (1996), that connect this problem to group-ware (e.g., Lotus Notes), are particularly interesting. Their results are that the use of groupware changes established work patterns and organizational cultures, and thus create new ones. The literature emphasizes that introduction as well as use of new technology, are not intuitive, but problematic because of an established understanding and practice of work.

In the literature one can find problems similar to those which gave origin to my further research. But, the focus differs significantly since the employees of educational institutions are not the true users of the new technology. The introduction of new technology influence, however, the institution's division of labor and ability to effect internal changes. Thus, an objective for further research is to provide insight into this area of CSdCL and, if possible, to integrate knowledge from research that is concerned with analogous problems.

9.2 Situated Design

Many Scandinavian research projects in systems development have subscribed to the ideas of user participation and situated design (*Utopia*, see Bødker et. al. (1987); *Florence*, see Bjerknes et. al. (1985)). Lessons learned from these projects, are that every system development project must be organized to design a unique computer-based system, optimally adjusted to the user organisation.

The conditions for systems development are rapidly changing. More and more people are working from home, and are finding themselves as temporary, part-time and supplementary workers (Greenbaum, 1995). As in the Dynamix case, design that is aimed at integrating different kinds of computer applications, across organizational and cultural boundaries, is becoming more important. The ideal of situated design and user participation becomes then problematic. A future research question thus is: How, and to what extent, can experiences from the last decades of systems development be creatively integrated in future systems developments?

In order to handle issues across groups and organizational boundaries, Bjerknes and Bratteteig (1995) suggest more emphasis on the organizational level than in the early Scandinavian systems development projects. As I note in Fjuk and Øgrim (1997b) in Part II of the thesis, the new problem is to handle the contradiction between flexibility and situatedness: Situated design may result in computer systems only usable for a specific user group, and flexible design may result in computer systems so general that they have no use for anybody.

9.3 Use of the Frameworks

The frameworks developed proved to be of an usability for pedagogical planning and systems design where World Wide Web served as technological basis. I claim

that their area of application is broader than the situations with which I have concerned myself in my research.

I consider that the triadic complexity is as present in CSdCL situations where advanced technology is applied. Ongoing research[32] is aimed at analyzing the learning effects of lecturing transferred via so-called *distributed classrooms* (Bringsrud and Pedersen, 1993), combined with project-based learning supported by Dynamix. The background of this research is the increasing political interest in offering education to all groups of the Norwegian society, and in this particular case, to handicapped people.

The idea behind the systems design of the distributed classrooms was to simulate lecturing, so as to distribute and exchange lectures between Norwegian colleges and universities (Bringsrud and Pedersen, 1993). A distributed classroom consists of two or more special designed classrooms connected to Internet and ISDN. Each classroom contains components for transmitting audio, video and electronic blackboards. The shared electronic blackboard has corresponding functionality as an ordinary blackboard, and requiring the teacher to use a special designed pen to write.

Earlier experiences indicate that the distributed classrooms reinforce the traditional role of the lectures, i.e., the lecturer as the main actor and the student as passive recipient of information (Holden, 1992). The experiences from the project indicate, so far, that the 'technical magic' behind the distributed classrooms embodies too much attention, whereby pedagogical and organizational developments suffer. Because of this, further research is aimed at using the frameworks to design learning and teaching concepts integrating distributed classrooms and Internet services, for handicapped students.

32 The Ped-Tek project. The project is initiated by Department of Informatics (University of Oslo), The College of Hedmark, The College of Oslo, NKI Polytechnical College, in joint collaboration.

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Part II

Towards an Analytical Framework for CSCdistanceL

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Abstract

This paper presents a framework for evaluation of computer applications in relation to the new and unique phenomenon of learning: Computer supported collaborative distance learning (CSCdistanceL). The framework may also be considered a means for designing computer applications mediating human actions of collaborative learning. Problem-oriented project pedagogy is used as a pedagogical foundation to understand collaborative learning. The crucial aspects of this pedagogical viewpoint are interpreted into dialectical contradictions. The contradictions constitute a basis for understanding the incorporated role of the computer application in the various human actions of collaborative learning.

Keywords — Problem-oriented project pedagogy, distance learning, dialectical analysis, evaluation and design of computer-based applications

1 Introduction

This paper is a short version of a paper with the title *An analytical framework for evaluation and design of computer applications mediating collaborative distance learning*. In this short version, only the basic argumentation and suggestions are described. The empirical basis for the framework is only briefly presented.

The framework has been developed on basis of various studies (over a period of four years and still continuing) of mainly two different learning situations in which computer-based applications—based on asynchronous and text-based communication—have a crucial, but different role: One learning situation has its foundation in the tradition of distance education—correspondence education. The pedagogical model is based on an information-transmission paradigm of learning and communication, in such a way that individual production of texts and distribution of these for comments are emphasized. The computer-based application is considered a medium for socialization in learning situations characterized as highly individual and independent.

The other learning situation has its foundation in a pedagogical viewpoint introduced (in Denmark) by the Danish pedagogue Knud Illeris, who developed what he called an alternative didactic (Illeris, 1974). This pedagogical viewpoint is problem-oriented project pedagogy. The fundamental principle is that the students constitute an indivisible community in the collaborative process of analyzing a phenomenon in relation to present conditions and problems of society. In contrast to a learning situation analogous to an information-transmission paradigm of communication, the intention has been to integrate a computer application *not* only to distribute written texts, but to articulate individual contributions and to mediate interaction between the peer-students, to get the whole cooperative work done.

In spite of the two different pedagogical viewpoints, the both learning situations are considered a complex and conflicting frame of computer supported distance learning because of various factors, and the interdependence between them: Pedagogical aspects, technical factors directed towards the limitations and possibilities of available computer applications, administrative and organizing factors, factors directed towards design of courses and subject matters, human attitudes, etc. These interconnected factors are crucial to understand CSCdistanceL as a new and unique phenomenon of learning, and indicate that the computer application does not necessarily have the crucial meaning of a successful learning process. But, the signification of available computer applications has most critical *pedagogic consequences* in learning situations emphasizing the students interdependency in their work. In such situations, the communication structure presented in the available text-based and asynchronous

computer applications, constitutes a conflicting frame in relation to the dynamic process of inter-human actions.

This paper is restricted to focus on the interconnection between 1. *Human actions directed towards the collaborative learning process*, and 2. *The computer application.* This relationship is the point of departure for a framework developed for evaluation of computer application in relation to CSCdistanceL. A fundamental assumption is that a framework developed on basis of problem-oriented project pedagogy, will cover the most crucial aspects of collaborative learning in such a way that the framework can be applied in relation to *other and less complex viewpoints* on collaborative learning at distance.

Section 2 presents the problematic domain of this relationship. Section 3 presents the analytical framework based on this problematic domain, and section 4 briefly discusses how it can be applied.

2 The contradiction between computer-based applications and collaborative learning

A fundamental requirement of collaborative learning is that a common environment of shared recognition and experience is established (c.f. e.g., Schrage, 1990). Such a community is not created by simply a process of information transmission and distribution (Schrage, 1990, Lave and Wenger, 1991) or assimilation (Piaget, 1950, Illeris, 1974), but in a process in which the students have a certain degree of obligation to each other. The students may have different interests, hold various viewpoints and meanings, and make diverse contributions to the actions. However, the participating students need to have a shared understanding concerning what they are doing and what that means for their individual development process and for the development of the learning community which they are a part of (c.f. Lave and Wenger, 1991).

The primary target group for most distance- and open learning situations, is the adult work force of our society. The student—the adult worker, usually with an established life with family and friends—needs a flexible (further) educational situation, free from place-, and often time, constraints. In collaborative learning at *distance*, a computer application designed for collaborative activities is a fundamental means to create a community of shared experience and recognition. Such a community is only created if the computer-based application mediates the

human actions in such a way that the individual students *do have a feeling of participating* in such a community. A basic assumption for this is that the computer-based artefact is incorporated in various human actions varying in relation to the situation at hand. With basis on this assumption, CSCdistanceL must be understood as two incorporated aspects: 1. *Human actions directed towards the collaborative learning process*, and 2. *The computer application.*

Computer applications applied in most distance- and open learning situations (cf. Fjuk, 1993, Mason and Kaye, 1989, Kaye, 1992, Georgsen and Dirckinck-Holmfeld, 1993), represent a written and asynchronous communication form (various computer conferencing systems, bulletin board systems and e-mail systems). This category of computer applications is widely used because of their technical and economical *availability* for the target group. Because of the requirement of flexible learning situations, the students need to participate in the learning process from places most convenient for them, from their homes. Consequently she has not powerful, expensive computers and software, and broad-band networks available. These technical means are often considered as a requirement for collaborative activities, and are e.g., available for students participating in CSC(distance)L from the campus of a university and a college.

The text-based and asynchronous communication form presented in most of the available computer applications, represents an information-transmission paradigm of inter-human interactions. Dialogues take place with an analogy to the process of writing, sending and receiving a letter (Sorensen, 1991). Thus, the dynamic and spontaneous nature characterizing a dialogue is fundamentally on the premises of the written language. The dialogue lacks the expressive power and interpretative cues resulting from the loss of visual information and feedback opportunities (Eklundh, 1986). In distance learning situations, the written and asynchronous dialogue is the dominating aspect of cooperation, because the students to a large degree do not have any other possibilities to cooperate.

The students report that in a collaborative learning process—based on problem-oriented project pedagogy (see next chapter)—it is extremely time consuming to carry out inter-human actions directed towards consensus seeking and inter-human conflicts. This is particular problematic in the fundamental problem formulation phase, and in the articulations of each other's contributions to the project (Løth and Køhler, 1995; c.f. e.g., Georgsen, 1995; Dirckinck-Holmfeld and Fjuk, 1995). The students emphasize that the computer application is a means

to support competition and authority, rather as a means to support creativity, mutual respect, tolerance and trust. This may imply a feeling of independence and freedom (Eklundh, 1986), and the students may have a reduced perception of being an active participant in a common learning community (Georgsen, 1995). The feeling of mutual commitment and mutual interdependence, which is essential to create the common learning environment, may not appear in the individual student's mind.

Thus CSCdistanceL as a phenomenon of learning, implies a conflicting relationship between the two incorporated aspects: *Human actions directed towards the collaborative learning process*, and *the computer application*. These two aspects are presupposing each other. At the same time the aspects are conflicting each other and may cause a dissolution of the relationship between them. This conflicting frame may have crucial pedagogical consequences. But, the degree of the consequence is dependent on the fundamental perspective on collaborative learning. In learning situations not having the main focus on inter-human interactions and mutual commitment, but having the main focus on production of texts and information distribution, this conflicting frame is not so obvious. In such situations, the communication structure presented in the computer application and the basic view of learning, represent both an analogy to an information-transmission paradigm of communication. The conflicting frame may, however, be present because of other aspects (out of the scope of this paper).

The relationship between the two aspects is fundamental to understand CSCdistanceL as a phenomenon; It distinguishes and characterizes the learning form from other learning forms.

Such an understanding of CSCdistanceL is analogous to Mao Tsetung's (1972) concept of *fundamental dialectical contradictions*: The contradiction that characterizes a phenomenon and distinguishes it from other phenomena. A contradiction consists of two aspects, simultaneously and mutually presupposing and conflicting each other. In general, dialectical theory is suitable to describe and understood the wholeness of situations and phenomena that are characterized as complex and difficult to penetrate into (Øgrim, 1993). Every phenomenon is understood in an interplay with its surrounding environment, and every phenomenon is understood as a number of contradictions that is interconnected. Mao's interpretation of dialectical contradictions is to a larger degree than Hegel's these-antitheses-and-syntheses schema, concentrated on the dynamics within a

contradiction (ibid.), i.e. one of the aspects of the contradiction will—dependent on the situation—dominate the phenomenon. The objective in some situations is to create a balance between the two aspects (ibid.). CSCdistanceL is understood as a new and complex phenomenon of learning, and the dominating aspect of this phenomenon of learning has been the computer application. The artefact forces the participating students into rigid and artificial structures of human actions, similar to an information-transmission paradigm of communication. An analytical framework considering collaborative learning a complex whole phenomenon of human actions — and not simply as information transmission and presentation — is thus needed.

By using Mao's concepts of dialectical contradictions, CSCdistanceL is understood as the fundamental contradiction consisting of the two presented aspects. This contradiction is considered as the point of departure for developing a framework emphasizing the dynamic balance between the two aspects.

3 The analytical framework

Problem-oriented project pedagogy is applied as a basis for the framework, because it emphasizes crucial aspects for creating a common learning environment: Inter-human interactions and -relations, and a certain degree of commitment between the participating students to gain both individual and collective development of knowledge and experiences. The fundamental principle is to contribute to changes and development in society through critical attitudes and awareness in relation to the conditions of society. Learning is organized as *cooperative work in projects* and this organizing of learning can then be considered as a certain kind of work. The analytical viewpoint has, because of these facts, a close relationship to the social practice of work and cooperative work. Totally, project oriented project pedagogy can be analyzed in combination with theories from work and cooperative work. When it comes to the computer application's role in this—to understand CSCdistanceL as a learning phenomenon—theories and empirical research from the close related field of CSCW can be applied.

Figure 1 illustrates the analytical framework. The fundamental contradiction is shown to the left of the figure.

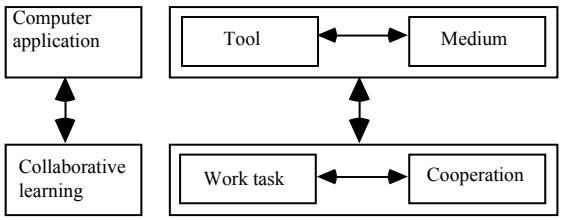

Figure 1: The analytical framework of CSCdistanceL

The fundamental contradiction is further analyzed by considering two sub-ordinated contradictions: 1. The contradiction between *work task and cooperation*, and 2. The contradiction between *tool and medium*. These contradictions — and the relationship between them — are presented in the next two sub-sections.

3.1 The relationship between work task and cooperation

Problem orientation is a work-method, which prerequisite that there exist a problem that can be recognized and experienced as a conflict, a need, and a wish of changes. A problem does not have a prerequisite solution for the students, but is considered as something to understand and to penetrate into. The work tasks have to be directed towards conditions and problems of society. According to Illeris (1974), problem orientation can not alone be considered as fundamental. An other critical aspect is participants' control (Danish: deltagerstyring), i.e., the students have the responsibility for their own actions through active participation. The students represent an indivisible community that manage the participants' control, in such a way that they have a shared understanding concerning what they are doing and what that means for the individual learning process and for the development of the collaborative community. The relationship between participants' control and problem orientation is dialectical.

The fundamental principle of problem-oriented project pedagogy can be interpreted as a dialectical contradiction between *the superior problem presented in various work tasks* and *cooperation*. Cooperation is the common term of *inter-human interactions* — and mutual commitment — and *articulation of the students' contributions*. Such an understanding of collaborative learning can be

interpreted analogously to what Schmidt (1994) has termed cooperative work: Interdependency in work. Although cooperative work is a collective phenomenon of work, each action is often conducted by an individual actor directed towards a work task. This means that most work tasks are carried out by an individual, but the peer-actors are mutually interdependent in their work (ibid.) in the sense that they need to coordinate and articulate their actions to get the whole work done. In collaborative arrangements, there is a web of actions; informal and formal information ex-change, individual (and sometimes collective) work tasks are discussed, handled, solved, etc. All of these actions are more or less interwoven and incorporated, dependent of the current situation.

3.2 The relationship between tool and medium

The dialectical contradiction between (problem-oriented) work tasks and cooperation, are considered fundamental to understand how a computer application should mediate the web of human actions in a collaborative learning community. The dynamic interplay between the web of human actions, implies that a computer application has different roles in different situations. In some situations the application has the mediating role between an individual and her peer-students. In other situations the application has the mediating role between the individual and her work tasks. Thus, the application has to be understood analogous—and as a support to—the contradiction between cooperation and work tasks. The computer application can not simply be understood as a medium for communication (cf. Maaß and Oberquelle, 1990)—information transmission—but as a medium for inter-human interactions and articulation of individual work. The application should also be understood as a tool to allow the student to concentrate on the goal of her work tasks (Ehn, 1988; Maaß and Oberquelle, 1990).

The computer application should then be understood in terms of a dialectical contradiction, to support the whole phenomenon of CSCdistanceL. The relationship between the two rectangles in figure 1 (illustrated with the vertical arrow) illustrates how an application is incorporated in a web of human actions in collaborative learning. Thus, the analytical framework for evaluation — and further for design — of computer applications is understood as a dynamic interplay between aspects of the computer application (tool and medium) and aspects of collaborative learning (problem-oriented work tasks and cooperation).

4 Final remarks

The expanding usage of e-mail, WorldWideWeb, computer conferencing systems, group-ware, etc., has reached the educational part of our society. But changes in how learning is organized put new or other requirements to the applications as a consequence of their usage in 'real situations' outside the laboratories.

The analytical framework presented in this paper can be applied to evaluate what applications that are most useful in what learning situations. The framework can also be used as a means for designing new applications for collaborative learning.

The dialectical contradiction between work task and cooperation, indicates that if a computer application should mediate collaborative learning, it should mediate human actions directed towards *both* individual work tasks and cooperation. If the application mediates actions related to only one of these aspects, it does not mediate the whole collaborative learning process. For example, if a computer application only mediates actions directed towards cooperation — and only *some* aspect of it — it does not mediate the whole process of collaboration.

The asynchronous and text-based communication applications available for the target group of most distance learning institutions — 'the home-students' — represent *some* premises for cooperation: Distribution, transmission and presentation of information in written form. A learning situation in which individual and independent production of written contributions and distribution of these are emphasized, the applications do not cause a crucial conflicting frame. Interdependency in work is not emphasized. This factor is, however, crucial in learning situations in which a *shared environment* for recognition and experience is fundamental. In such situations, the available applications do only mediate a limited part of the whole process of creating and manipulating a collaborative community.

Computer applications supporting the dynamic interplay between various human actions of collaboration are on their way out of the laboratories. These applications are not technical and economical available for the adult working people of society — having the need to take part in a collaborative learning community from the places most convenient for them — from their homes. The further challenge is to develop applications supporting *their needs*.

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Articulation of Actions in Distributed Collaborative Learning

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Abstract

This study is aimed at exploring how a CMC (Computer-Mediated Communication) system and other factors influence distributed collaborative learning processes. The study is based on ten years of practice and research at the Aalborg University in Denmark, however focused through an exploratory experiment. By applying Anselm Strauss concepts of articulation—within his more comprehensive interactionist theory of action—the study indicates that distributed collaborative learning entails additional work for the geographically dispersed students rather than being a means for active construction of knowledge and social negotiation. The computer system cannot, in and of itself, support the collaboratively based processes of learning. Rather, distributed collaborative learning is accounted for by entirely different and far more complex factors grounded in the pedagogical approaches to learning, and its renewed interests to distributed situations.

1 Introduction

Computer-mediated communication (CMC) applications—such as e-mail, computer conferencing and recently the World Wide Web—have been considered promising with respect to integrating pedagogical principles from collaborative learning methods to new distributed learning situations where the students are separated geographically (Mason and Kaye, 1989; Harasim, 1990; Kaye 1992; Garrison, 1989; Harasim et. al., 1995). This has particularly been emphasized through the European Commission's declaration of 1996 as the year of lifelong

learning (European Commission, 1994). Lifelong learning is about the practice of adults and adolescents, in the interrelations of work and learning. Flexible learning situations in respect of place and time, allow adults to get new or further education alongside work (Peters, 1993; Holmberg, 1995).

In this paper, the interpretation of collaborative learning is based on social-constructivist perspectives on learning, with its roots in the 1930's and Vygotsky's (1978) theory on human development. Based on this perspective, the individual processes of knowledge construction and the collaborative processes of negotiation are viewed as mutually constitutive (Jonassen et. al., 1993; Engeström, 1987; Lave and Wenger, 1991; Pea, 1994). The individual learner makes a contribution to the social development and thus indirectly to her own individual development (Engeström, 1987). In other words, the individual student's learning is dependent on full participation in a collaborative learning community (Lave and Wenger, 1991).

There are recent and limited insights into what the nature of the collaborative processes in a predominately distributed environment is like. Very little is actually known about the collaborative process itself and how the computer system and other circumstances influence the processes. Studies of *computer support for collaborative learning* (CSCL) involve studies of the computer's role to support effective two-way communication between students and between tutor and students (see e.g., Mason and Kaye, 1989; Kaye, 1992), rather than focusing on joint activities and social negotiations. Others are focusing on the new opportunities the various computer systems give to established principles of collaborative learning (see e.g., Schnase and Cunnis, 1995), and are to a minor extent focusing on the new problems that might come up when integrating traditional pedagogical methods and computer-based applications.

A basic understanding of the nature of distributed collaborative processes is totally decisive in the respect of designing qualitatively good distributed learning situations. Based on such a need for understanding, we rest on *problem-oriented project pedagogy* as method to collaborative learning and its applications to distributed situations. Problem-oriented project pedagogy is of particular interest since its pedagogical principles are fundamentally based on social interactions, including confrontation and negotiation of individual knowledge and interpretation. Also, problem-oriented project pedagogy has been the pedagogical foundation of the ten years of practice in delivering distributed collaborative

learning situations at Aalborg University (AAU) in Denmark. However, practical experiences and research at AAU show that this pedagogical method is particularly demanding and problematic in distributed situations—both seen in relation to the student's benefits with regard to improved understanding of her subject and in relation to the students' mutual process of developing a distributed collaborative environment (Lorentsen, 1988; Dirckinck-Holmfeld, 1990; Dirckinck-Holmfeld and Lorentsen, 1990; Georgsen, 1995). These experiences constitute the empirical basis for our study, focused through an exploratory experiment at AAU undertaken by the first author. Concepts from articulation work, developed by Anselm Strauss (1985; 1988; Strauss et. al. 1985), applied within a more comprehensive theory on action and interaction in Strauss (1993), constitute the theoretical approach for the analysis. By applying Strauss' concepts, collaboration is understood as a comprehensive phenomenon concerning the interdependent relations of *who* (the individual student) is doing *what* (actions, outcome, objective), *where* (the context of actions in terms of time and place, cultural and organizational belongings, etc.) and *how* (the process of putting the actions into operation).

The paper begins with a review of features of development and pedagogical approaches to distributed collaborative learning situations. Then follows a more detailed presentation of collaboration as phenomenon focused through concepts of articulation and action. These theoretical concepts are then applied to a rethinking of collaborative processes that take place in distributed project-oriented learning processes. The paper closes with a general discussion related to the design of distributed collaborative learning situations.

2 From distance education to distributed collaboration

Research into CSCW (Computer Supported Cooperative Work) has stimulated the more recent research field of CSCL (Computer Support for Collaborative Learning) (Koshmann, 1994). The overall aim of CSCL is to design collaborative situations so that an active construction of knowledge takes place according to the chosen pedagogical approach.

A general understanding of CSCL is that it departs from a view where the teacher is considered the only resource of knowledge and skills, and where teaching is about 'filling up' the students with knowledge. Instead, primarily the

social-constructive perspective --with its roots in the 1930s and Vygotsky's (1978) theories on human development—has received renewed interests and is adopted. Central to the social-constructivist perspectives is that collaboration between students, and between student and teacher, is seen as being of particular importance in the process of learning.

In section 2.1 we present two main approaches to CSCL that are of importance to the empirical basis and problem area. One approach has its roots in distance education. The other has its roots in institution-based collaborative learning situations. In section 2.2 we present problem-oriented project pedagogy, which is the pedagogical method applied in the distributed situations of our analysis.

2.1 Approaches to CSCL

One approach to CSCL—in particular practiced under the conditions of *distance education* —focuses on two-way *communication processes* between distance learners and between distance learners and teachers (Mason and Kaye, 1989; Harasim, 1990; Kaye, 1992). In contrast to traditions centered on *collaboration processes* (see below), that have their theoretical and practical basis in institutional situations, the key concept in distance education has been flexibility in terms of *when* to study and *where* to study (Peters, 1993; Holmberg, 1995; Moore and Kearsley, 1996). Distance education as a form has among other things been carried along by democratic ideals of peoples right and opportunity to take part in advanced education or continuous competence development. In agreement with the basic concept of flexibility, students have the possibility to participate in educational programs from the places that are most suitable for them—typically home or work place—and at the times that are most convenient. CMC systems based on asynchronous and textual communication, such as computer conferencing systems and recently Internet services like the World Wide Web and e-mail—are regarded as promising in this connection exactly because they support this flexibility.

The pedagogical argument for using CMC systems has moreover been its text-based communication and the learning benefits from writing. Vygotsky (1978) offers insight into how writing can contribute to knowing:

> "The change from maximally compact inner speech to maximally detailed written speech requires what may be called deliberate semantics—deliberate to structuring of the web of meaning." (pp. 99-100)

The text-based communications thus hold certain learning advantages because it gives the students the possibility to read, reflect, write and revise their arguments and comments before they answer questions or share knowledge with each other (Harasim, 1990).

Another important argument is the socio-emotional factor of get easily in touch with peer students (Fjuk, 1993), short turnaround times (Holmberg, 1995), and not least the better conditions to break down the feeling of isolation as a distance student (Dirckinck-Holmfeld and Lorentsen, 1990).

The leading principle of learning is in this approach based on the socio-emotional factors of two-ways communication, and problem-solving of pre-defined tasks (O'Malley, 1992; Dirckinck-Holmfeld, 1995). Thus focus is to a higher extent on preparation of teaching material and tasks than on developing forms of dialogue and collaboration as such among students and between teachers and students.

Another approach to CSCL has its foundation in theory and practice from institution-based collaborative learning situations. The role of the computer systems in such situations is not solely aimed at communication and tasks-solving, but as a means to perform mutually dependent activities. Social-constructivist perspectives with roots in Vygotsky's (Vygotsky, 1978) work has often been used as the theoretical foundation of this approach (Bannon, 1995; O'Malley, 1995; Dillenbourg et. al. 1996). Vygotsky's concept of the *zone of proximal development* is regarded as a key concept of how learning take place. The zone of proximal development is:

> "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

The zone, as Vygotsky describes it, is the area between two levels (Mellin-Olsen, 1993). The basis for the one level is the prior knowledge of the individual

related to a phenomenon. The basis for the other, is appropriate knowledge but fully constructed by problem-solving guided by an expert.

The proponents of the social-constructivist approaches stress the nature of learning as mediated by artifacts. Computer systems are included in learning processes as tools for thinking and for collaboration between students (at different schools), and for use in guidance (Crook, 1995; Newman, 1995).

This second approach has its focus on collaborative processes, but those which primarily take place at common physical localities. Its starting point is in formal learning processes for children and young people, i.e., school education.

The basis for our analysis comes under a third approach to CSCL, which has its roots in both of the approaches above. It shares areas of study with the first approach about distance education, and the theoretical foundations with the other. As CSCL has not primarily been aimed at distributed learning situations (such as distance education) we have chosen to expand the concept to CSdCL (*Computer Support for distributed Collaborative Learning).* The point of departure of the approach to CSdCL is social-constructivist. But, it also builds on an integration of the approach of experiential learning (Kolb, 1984; Olesen, 1985; Illeris, 1974, Illeris, 1981). The approach relies on a special pedagogical method, which is the institutional profile of Aalborg University, namely *problem-oriented project pedagogy* (Illeris, 1974; 1981; Borgnakke, 1983; Adolfsen, 1985; Dirckinck-Holmfeld, 1990; Olsen, 1993). This approach has been characterized as the Scandinavian approach to CSdCL (Heeren, 1996).

2.2 Problem-oriented project pedagogy: A Scandinavian approach to CSdCL

Problem-oriented project pedagogy can to some extent be compared with problem-based learning and case-based learning. The basic principle of an active learning process in the approaches of problem-based learning is solving of a pre-defined task or a problem (Jonassen et al., 1993). Problem-oriented project pedagogy is distinguished from such a principle in that problem solving is not the primary condition of active knowledge construction. *Critical reflection* on a (scientific) problem or a phenomenon in society is the didactic, basic principle. At the same time critical reflection as a principle and also the development of skills in formulating problems, contribute to problem-oriented project pedagogy

arguably being a more demanding form of learning than the approaches focusing on the solving of a given problem.

According to Illeris (1974) problem orientation does not on its own constitute the foundation of an active process of acquiring knowledge through critical reflection:

> "A problem is not a problem in a psychological sense if the person who has to work with it does not experience it as a problem." (p. 83, our translation).

Creativity, engagement and motivation are crucial aspects in relation to critical reflection. When the students themselves define and formulate the problem they have a conscious relation of ownership to it and implicitly are invited to involvement and motivation. Illeris (1981) refers to this as participant control. Participant control and problem orientation are interdependent and constitute the foundation of the acquisition of knowledge.

Collaboration organized in projects constitutes the frame of the didactic principles. The project organization builds on a social-constructivist perspective that underlines the integration of individual construction of knowledge and the students' joint responsibility of creating a common learning environment. According to constructivist conceptions of learning, the learner constructs knowledge by interpreting perceptual experience in terms of prior knowledge and existing perspectives (Illeris, 1974; Jonassen et. al., 1993). Common understandings among the peer-students are resulted from confrontations and negotiations of perspective and beliefs. Social negotiations constitute the core of active development of knowledge in that the student has to internalize the perspectives of the peer students and alternatively reconsider own knowledge and beliefs. This reconsideration implies inner contradiction, that is viewed as the prerequisite for new learning (Illeris, 1974; Patterson, 1977).

2.2.1 The project organizing

The projects are characterized by various phases. The phases are (Dirckinck-Holmfeld, 1995): Establishing the project (the problem formulation), the research, the production and evaluation. Here we leave out evaluation (examination). The phases overlap, i.e., one phase is not necessarily ended before the next can be started, just as some phases are carried out more than once during the whole

process. Each phase has special characteristics and conditions in relation to social negotiation and discussion.

Problem formulation phase

The problem formulation phase is often the most complicated one (Dircinck-Holmfeld, 1995). The students themselves must delimit and define a problem explicitly, which is summarized in a problem formulation. A successful project is dependent on the fact that the students have established an appropriate common understanding early in the project.

This phase of the project makes great demands on social negotiation that imply student-to-student interaction. Ideas must be generated and agreement must be reached about key concepts and about the core of the project. In order to make the interactions innovative, good conditions in relation to interactions between the students are basic. This circumstance is increased by the fact that the students only rarely know each other at the start of the project, and by the fact that they at this point do not have a common frame of reference with regard to the subject.

The research phase

In this phase relevant literature is obtained, theory is adapted, frames of reference are drawn up, and empirical data collected.

Students often work more independently and individually (perhaps in sub-groups) than in the problem formulation phase. Awareness on how the work is progressing is particularly important in this phase. For the project to keep its common course it is still necessary to negotiate to establishing a common understanding and to agree about the key concepts. In contrast to the problem formulation, the students have the possibility to lean on common studies of literature, on an appropriate common understanding of the problem.

The production phase

The core of this phase is ideally the processes of writing contributions to a common project report, based on the collected material and the planned actions of the project. Discussion and confrontations on the written contributions may change the planned course of action, and affect the original problem formulation. Through confrontation of individual contributions new understanding is created, which may also affect the original problem formulation.

Negotiations and confrontations on contributions make special demands on involvement and the ability to identify oneself with others, the ability and capacity to negotiate, and also the ability to understand and respect the contributions and opinions of others (Dirckinck-Holmfeld, 1995).

3 The nature of collaboration

In order to analyze how the computer system and other factors influence the distributed processes, we find it essential to apply an analytical approach that considers the collaborative processes in a comprehensive perspective. The problem-oriented project pedagogy itself, is not sufficient for this. The pedagogical method has its major focus on the learning benefits of collaboration and not explicitly on how different factors influence the processes. Since learning is inherently an individual process, the individual—and her actions towards own learning and the collaborative processes—must constitute the core of such an approach. In addition, the computer system has an essential meaning in the distributed collaborative processes and should then be considered as a part of the actions. It thus follows that the mediating computer system should not be viewed as an 'add-on' to the actions, but as an integrated part of the collaboration. We find Anselm Strauss' concepts of articulation work (Strauss, 1985; 1988; Strauss el. al. 1985) applied within his more comprehensive interactionist theory of action (Strauss, 1993) useful.

In section 3.1. we present Strauss' central concepts of articulation and action with the principles of problem-oriented project pedagogy in mind. In section 4 we discuss the empirical findings by applying the analytical approach.

3.1 Articulation—coordination of lines of work

Strauss (1993, p. 87) defines articulation as "the coordination of lines of work". Work arrangements, such as projects, involve a course of actions that entails a division of work in the sense of both actors and actions. The plurality of actions, as well as the relations of actors to actions constitute the totality of work, required with respect to the salient dimensions of *who* (the individual actor) is doing *what* (actions, outcome, objective), *where* (the context of actions in terms of time and place, cultural - and organizational belongings, etc.) and *how* (the process of putting the actions into operation) (Strauss, 1985; 1988). These salient dimensions of collaboration are mutually interdependent and connote articulation in terms of the actors and meaning (e.g., beliefs, perspectives, knowledge, experience, skills, etc.), tasks, responsibility, and time and place. With basis in Strauss' interactionist theory on action, we will in the following focus on this interdependence and the required articulation.

Central to the interactionist theory on action is the interwoven nature of interaction and action:

> "Actions are embedded in interaction—past, present and imagined future. Thus, actions also carry meaning and are located within systems of meanings. Actions may generate further meaning, both with regard to further actions and interactions in which they are embedded" (p. 24).

Interactions are shaping conditions for articulation as the individual actors' perspectives and knowledge profoundly influence the course of actions and interactions. The interactional processes (Strauss, 1988) are the strategic means by which actions are maintained, strengthened and supported, i.e., to get the whole work done.

Social negotiation of individual perspectives and construction of new knowledge are particularly related to what Strauss terms problematic actions and interactions:

> "Problematic interactions involve 'thought', or when more than one interactant is involved then also 'discussion'. An important aspect of problematic action can also be 'debate'—disagreement over issues or resolutions" (p. 43).

Problematic actions—either taken place in isolation from peers or in a social arrangement—involve reflection on prior knowledge and may present inconsistencies or incongruities requiring resolution, and may in turn stimulate interest to creativity and innovations.

Following Strauss (1993),

> "[m]ost interactions are routinezed. Actions and counteractions are expectable; often repeated; governed or guided by rules, regulations, standardized procedures, agreements, or understandings." (p. 43).

Moreover, the dynamic interplay between problematic and routine action is the basic of an interactionist theory of action. Problematic actions—such as confrontation and negotiation of perspectives, common problem solving, consensus seeking, etc.—cannot take place without the routine actions and the usually taken for granted skills and abilities. The routinized skills and abilities are integrated to every action as they play into creativity and innovation in face of unexpected contingencies. In time, the actions "flow back into the realm of the routine" (p. 207). By interpreting the routine actions to learning, these do not in any strong sense imply new construction of knowledge as they are assimilated to existing knowledge and interpretation. Still, they are needed to get deeper insight on a phenomenon or a subject.

Both internal factors—such as human-to-human relations—and external ones—such as technological, cultural, organizational, physiological, economical—are *parts of actions* in that they influence and may change the course of actions (Strauss, 1993). Following this, we interpret the computer system—supposed to mediate actions in collaborative arrangements—as an indivisible part of action. Based on such a view, the computer system is viewed as incorporated into the total arc of collaboration, influencing the processes.

The problematic and routine actions, have close conceptual relations to the more informal distinction between implicit and explicit articulation (Strauss, 1988). When people are assigned to routine actions, they are doing explicit articulation. One actor is assigned to be a project leader, an other is assigned to take minutes, etc. In contrast, the invisible, unforeseen and often problematic actions imply implicit articulation. The explicit articulation may thus be connected to the planning and decisions regarding "Who should do what, how, when and where", while implicit articulation is invaluable in order to handle

contingencies. Star (1991) points to the unanticipated contingencies and breakdowns as central for articulation work, in order to "get things back 'on track' again in the face of the unexpected" (p. 272).

The strength of the concepts of articulation, viewed within an interactionist theory on action, is that collaboration is regarded as a whole consisting of actions, actors, and internal and external factors. By applying the salient dimensions of who-, what, where and how, we interpret the interwoven relationship between actions, actors and computer system in the following way: The *who*-dimension is related to the students in the collaboration process, and their roles in relation to the project as work form and in relation to the didactic principles in problem-oriented project pedagogy. The *what*-dimension is related to the actions that the students in their capacity of their roles must perform in various phases of the project. The where- and how-dimensions are related to the interaction between the applied computer system and problem-oriented projects. The *where*-dimension represents the context in which the collaboration takes place, i.e., in a distributed learning environment, created by actors who are separated geographically. The *how*-dimension is related to the functionality of the computer system in performing problematic and routine actions. In the next section, the empirical findings are discussed and analyzed by using this interpretation.

4 Students, actions and the distributed learning environment

Aalborg University (AAU) has since the middle 80s offered CSdCL based on project pedagogy. Seen in relation to the core of project pedagogy distributed collaborative learning communities constitute a contradiction: The academic or technical profit, derived from active participation in distributed collaboration, is to lesser extent than what one might has expected come up to the principles of project pedagogy (Dirckinck-Holmfeld and Lorentsen, 1990; Lorentsen, 1988; Georgsen, 1995).

To acquire a deeper understanding of problem-oriented distributed collaboration, and how the technology and other factors affect it, earlier experiences and research have been *focused* through an exploratory experiment carried out at AAU.

4.1 The exploratory experiment

The participants in the exploratory experiment were a group of teachers with a wide experience of being tutors in distributed collaborative learning situations, and a group of students belonging to the distance education program (at AAU), respectively. The students were first year students of humanistic informatics. So they were novices in relation to the subject of humanistic informatics, just as they were novices in relation to the form of work with problem-oriented projects. In additional, they were also novices as far as the use of technology was concerned and also on the whole the participation in a learning community that is distributed in time and space. The reason why we anyhow chose them to take part in the experiment was partly that they in their project actually studied their own collaboration process in a distributed collaborative learning community. Their general problem formulation was: *What conditions are needed for exploring each other's understanding in CMC* (See Løth and Køhler, 1995). In this way they became very conscious during the project of how collaboration functions distributedly. Furthermore, as novices they were interesting for our purpose because novices must very easily be able to point out what they experience as problems. The students were adults with responsibility for their daily work practice as well as for family and child care. The computer system—the widely applied FirstClass in CSdCL situations—has a central position in the students' collaboration as they lived and worked at geographically different places. As such, each of them represented a traditional distance education student.

The experiment was conducted as two group sessions, organized as reflective discussions. To structure the discussions we were to some extent inspired by Soft Dialectics (Bratteteig and Øgrim, 1994). Soft Dialectics is a method to understand and deal with problematic situations in the system development process. In line with the Scandinavian tradition of system development it is at the same time a method that takes its starting point in the participants' experience of practice, and which regards the participants as 'equal partners' in identifying and organizing the fields of problems.

In agreement with the techniques of Soft Dialectics (see Bratteteig and Øgrim (1994) for details), the participants collaboratively draw so-called 'rich pictures' (with a free syntax) of their experience and interpretation of CSdCL, and subsequently in line with simple schematic dialectics try to identify contradictions characterizing their situation. A contradiction is, in Soft Dialectics, understood as

a relationship where two aspects are interdependent, and which may simultaneously constitute a conflict and exclude each other[33]. The main idea is not that the contradiction must be solved, but that it must be the object of critical reflection and discussion in order to achieve a deeper insight in the problem area (in our case distributed collaborative learning).

In the following, the results from the discussions—supplemented with the results presented in the students' project report (Løth and Køhler, 1995)—are presented and discussed by using the analytical approach.

4.2 Who, What, Where and How in CSdCL

4.2.1 The Who-dimension

The *who*-dimension is related to the student's explicit role and her responsibility to the collaborative process in terms of experiences, knowledge and skills.

In connection with our discussion with the teachers, *mutual commitment* was identified as a decisive aspect concerning the student's role in distributed projects. Mutual commitment implies tolerance and trust in relation to the peer-students, and their knowledge and contributions. This also implies a sense of responsibility towards the project as a whole, both on the part of the teacher and among the students. Finally, it implies involvement in relation to the concrete problem and special aim of the projects. In this way mutual commitment implies continuous explicit and implicit articulation. The general requirements made on a student with regard to mutual commitment are that she must;

- have an ability to understand and reflect on others' contributions, ideas and knowledge.
- have the ability and capacity to negotiate about his or her *own* contributions, ideas and knowledge.
- be able to cope with and contribute to the solving of personal and social problems.
- be able to cope with contingencies, and work constructively according to this, together with the other actors in the project.

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[33] The concept contradiction includes the concept conflict, but is richer. This is because the unity - the interdependence - of the aspects is just as important (Øgrim, 1993).

The following questions are examples of what a student has to consider during the collaborative learning processes:

- What role will I take in the project?
- What roles will my peer students assume?
- What responsibility should I take?
- What do I know about this problem?
- What do my peer-students know about this problem?
- How does this topic fit into what I already know?
- What should I expect from my peer-students?
- How will I interact with my peer-students?

The discussion carried out with the students indicates that mutual commitment contributes to a contradiction in CSdCL. Mutual commitment, and the articulation belonging to it, implies *extra work* for the students. In some cases this overshadows the individual perception of belonging to a learning community and the pedagogical strength of collaboration. Based on problem-oriented project pedagogy, CSdCL was characterized as a contradiction about commitment.

This will be discussed further through the what-, how- and where-dimensions.

4.2.2 The What-dimension

The what-dimension is related to the actions characterizing the 'phases' of problem-oriented projects (see section 2.2). The questions below are examples of what a student has to consider in relation to the actions:

- What is the general aim of the project?
- What is the expected outcome?
- How much time is available?
- What steps must I take to dig deeply into the problem?
- What are the sub-problems and tasks?
- What literature is needed?
- What else do we need to find out about this topic, problem or task?
- How shall I present my ideas and knowledge for peer-students?
- How will the others react on my ideas?
- Do I need to revise my prior ideas and knowledge in light of her/his perspective?

As presented in section 2.2. each phase has special conditions and meaning in relation to the problematic actions and interactional processes. In the following, the students' experience on each of them is presented.

Problem formulation phase

Distributed collaborative learning arrangements are dependent on clear and explicit articulation (Harasim, 1990). This implies metacognitive skills, i.e., the student must be able to make explicitly to herself thoughts, ideas and knowledge to be able to communicate them to peer students.

The students felt that this was complicated in such an early phase of the project. The lack of sufficient individual knowledge related to the project field (CSdCL in a wide sense) and to the CMC system itself was their main reason. The articulation of individual ideas, knowledge and consensus about this through interactional processes became a practical problem. The students did not manage to achieve a common understanding and consensus about the problem formulation. Commitment and responsibility in relation to definition and formulation of the problem were regarded as extra work rather than a learning promoting activity for the individual student.

The students recognized this as a problem early in their project, and thus chose to explore this problem during an experiment lasting a fortnight. The aim of this activity, was to actively challenge each other's understanding against a background of common reading of literature. They did not use any other communication channels than the CMC system. In the light of this experiment the students concluded:

> We did not make a good job of the ideals of digging deeply to our studies, it only became superficial digging, where we did not succeed in getting to grips with the subject. Possibly because our basic knowledge is not certain enough, but also because the mutual challenge did not come off in CMC (...) Then it later appears in the project work that the fact that we have not been able to discuss our way to a conclusion about a common understanding of what it is to challenge each other's understanding creates a lot of problems in the project organization. (Løth and Køhler, 1995, p. 34, our translation).

According to the students the computer system was not very suitable for performing the problematic actions, which are necessary to be able to achieve deep discussions and common understanding. The interactional processes more or less turned off as rather simple two-way communication and presentation of information.

The problems that were identified in connection with the problem formulation phase have importance to the project as a whole, to its concrete result. In this phase articulation related to;

- individual ideas, experiences, knowledge and concepts,
- defining and clarifying the general aim of the project,
- reaching agreement about work schedule and plan,
- problems related to the subject, and the course of action and work forms,

were essential but problematic in practice.

The research phase

In this phase, the individual actions such as writing and presenting contributions are dominant. During the course of the project, contingencies related to presentation of individual thoughts arose. Two of the students were using a Macintosh version of the CMC system, and the third had a PC version available. "It was hell!" one of the students exclaimed during our discussion. Technical problems connected to incompatibility between the software programs, one group member had no computer for a time, the lack of sufficient technical knowledge and skills, all contributed to the fact that individual commitment and responsibility became extra work for the individual student. For instance one of the students preferred to use drawings as a technique of organizing her own structure of knowledge and of generating ideas. Because of incompatibility between the students' drawing programs, this became a problem. The student had to formulate her thoughts in written contributions, which had the consequence that she did not visualize her own thought sufficiently to herself and to her peer students.

In this phase, articulation related to problematic actions of individual nature was a problem of practice.

The production phase

The demands that the project pedagogy made on the student's role concerning commitment and involvement became particularly apparent in this phase of CSdCL.

The students claimed that they had gotten too far in their own process of knowledge construction before they got feedback on ideas and thoughts. A major effect of this is a reduced sense of responsibility as it appears to be no one to commit oneself to. The students stressed that the CMC system itself supports this

feeling and also competition and authority, rather than being a means for creating a common learning environment. The students only caught a glimpse of the interdependence that this implies.

If feedback from peers represented a contradiction to prior knowledge and interpretation, the students often did not have the capacity to follow it up and to negotiate about their own thoughts. It was easier to accept negative criticism, even when they did not agree about it, in order to get the job done in time. Negotiation calls for involvement, motivation and time. The students expressed this in the following way:

> "(...) Involvement and motivation require understanding of the subject and time to study unfamiliar knowledge carefully and time to work up this knowledge, partly by oneself and partly by the 'surroundings'. The time it requires is not a question of 'taking' the time, but a question of a development, a process of cognition, where one realizes that one is looking at a part of the world, with quite a new approach. (...) One must grow so strong in one's knowledge and attitudes that the possibility and foundation of knowledge will arise so that one can negotiate and re-negotiate quite naturally, that is without having to look anything up in the textbook." (Løth and Køhler, 1995, p. 15, our translation).

The lack of surplus energy was a threat against the necessary involvement and feeling of responsibility that the project implies:

> "In some cases it is difficult to solve problems and if this happens too often, or that we come to a standstill or do not understand each other, then the energy disappears" (Løth and Køhler, 1995, p. 41, our translation).

In this phase, the articulation needs related to;

- negotiations on individual ideas, interpretations and knowledge,
- negotiations on individual contributions to the project,
- feedback on individual contribution,
- responsibility and commitment,
- points of disagreement and interpersonal conflicts,

are particular important in distributed projects, but demanding and problematic in practice.

The project that was the object of our experiment had its distinctive features that separate it from many other CSdCL situations based on problem-oriented collaboration. The project had the general aim of critically reflecting on distributed collaboration situations, and of acquiring knowledge about this. This was a special motivating factor for collaborating through the computer system. Furthermore, according to this their situation was special as it was their own interactional processes that were the objects of research. In itself this was a source of personal, latent conflicts as the critical analysis in some situations became criticism directed against individual members:

> "It appears that actually more times than one would expect one is running the risk of 'smoldering conflicts', which may be of a personal or a scientific nature" (Løth and Køhler, 1995, p. 41, our translation).

In some situations the students did not trust each other's knowledge, which appeared in discussions connected to the individual student's contributions to the project. The lack of mutual confidence in each other's knowledge and a lack of will to acquaint themselves with the others' thoughts became an expression of manipulation. The students did not have the capacity to carry out the necessary articulation in order to cope with interpersonal problems. The result was that one of the students broke with the others in this phase. The students' conclusion related to CSdCL has its background in these problems:

> "Openness and tolerance, the will to reflect on others' opinions are far more important in CMC than in an oral discussion" (ibid., p. 42, our translation).

The collaboration has been full of conflicts and exacting on the students and as such they have won first-hand experiences with distributed collaborative learning. In accordance with the problem formulation the students have:

> "(...) recognized that understanding does not prosper in isolation, but from this to be able to challenge each other's understanding there is still a long way to go". (Løth and Køhler, 1995, p. 15, our translation).

In addition they have recognized that the use of the CMC system in accordance with the pedagogical and didactic principles of problem-oriented projects, is a

complicated phenomenon that imposes conditions on the individual student in respect of conscious and explicit articulation.

4.2.3 The Where-dimension

The where-dimension is related to the situation in which the collaboration takes place. The principles of problem-oriented project pedagogy have their roots in situations where both place and time are shared by the students. Traditionally collaborative learning has neither been distance-based nor technology-based. It is therefore crucial to explore what conditions the distributed environment imposes on actions *traditionally* found in problem-oriented projects, i.e., how the computer system contributes to the shaping of the actions. In section 4.2.2. we explored what fundamental articulation needs that were considered problematic in a distributed environment. Further, it is necessary to explore what *new* articulation needs the distributed environment contributes to in order to manage the meaning and aim of the collaboration.

A shared context in terms of time and place, contributes to an integration of the students in a learning community, with its infrastructure (the possibility of physically being together both formally and informally), communication facilities (such as face-to-face meetings), technical resources (photo copier, advanced software, advanced computers, scanners, etc.), academic resources (such as informal and formal guidance, technical assistance, library, etc.) and meeting facilities for the project sessions. Parts of the articulation can take place tacitly or implicitly. Implicit articulation takes place through actions that the students perform in order to be aware of the activities of the others. As Gutwin et. al. (1995) put it:

> "Collaborative learners maintain this awareness by tracking information such as other learners' locations in the shared workspace, their actions, the interaction history, and their intentions. Workspace awareness is necessary for effective collaborative work, but also plays an integral part of how well an environment creates opportunities for collaborative learning." (p. 147)

A shared physical presence and roots in a shared culture will make conscious coordination and adoption of actions possible. In the distributed learning environment, where the students are physically in different contexts as well as

being part-time students, the students have far weaker shared cultural roots. Compared to institutional situations, it seems that *explicit* articulation—like planning, coordination and meta-communication—is certainly more fundamental, and there is a greater need for making implicit articulation more explicit.

Additionally our exploratory experiment indicates that the distributed learning environment implies a sort of *extra* articulation in relation to certain aspects. It is for instance far more laborious to carry on a dialogue about essential open questions in writing than orally. Written communication more easily results in misinterpretations and misunderstandings, and problems of giving feedback on contributions, etc. (Dirckinck-Holmfeld, 1990). On the other hand the CMC systems give the opportunity to reduce explicit articulation work, because the students of the project can implicitly follow each other's actions through the contributions to the common database.

At AAU's distance education program the students are most likely adults who work. Those commitments that are made on the distance student are not only related to peer students and their collaborative processes. In addition she must attend to her commitments to family and the everyday work situation. The interdependence that problem-oriented projects implies may be regarded as demanding in respect to time, and thus active participation in respect of involvement and commitment implies personal articulation processes related to time.

Compared to traditional institution based collaborative learning situations, distributed situations may imply;

- a greater need for making implicit articulation more explicit.
- explicit articulation of responsibility and commitment to various contexts (home, work, shared learning community).
- explicit articulation in terms of time.

Compared to traditional learning situations, the distributed collaborative learning processes imply *new articulation needs* that in turn require new roles that the students must fulfill in order to create a collaborative environment. But distributed projects also imply new roles for the teachers. The students in our exploratory experiment asserted that some of their problems could have been reduced or avoided if the instructors had committed themselves more to the project. This is particularly obvious in situations where the students have problems with reaching common decisions, and in situations where interpersonal

problems became a threat to the cooperative work. At the same time the role of the teacher becomes more ‘distributed’ as the students appear only as names on a screen, and not visiting and ‘live’ at the teacher’s office. By the teacher this was seen as a threat to their involvement and also that too little time had been set aside (on the part of the educational institution) for the teacher's role. Corresponding to the fact that mutual commitment meant a contradiction in the distributed collaboration among the students the commitment from the teacher to the students implied a contradiction. This contradiction does nor necessarily have its origin in the teacher's intentions, but in the readiness of the educational institution to allocate resources, and to rethink the pedagogical approach to new learning situations.

4.2.4 The How-dimension

The How-dimension is particularly related to the conditions of the computer system to put the actions into operation. The objective of planned actions is theoretically the same independent of artifacts. How the actions are put into operation and the realization of the actions is to a great extent determined by the conditions that implicitly characterize the applied artifact. Audio, video, text and 3D images exhibit very different conditions and these conditions strongly influence the outcome of the actions and the participation in distributed environments.

Asynchronous and text-based communication systems are representations or models of social environments perceived as production and exchange of written contributions. The operational functionality of most CMC systems is determined by the conditions, set by the written language, and presentation and communication of text segments. Thus actions that are performed are controlled by the premises of the written language and the asynchronity of the system. A CMC system may offer also rigid and narrow conditions for performing problematic actions.

Earlier experiences from AAU and the exploratory experiment indicate that such communication forms seem to harmonize more with the research process than with the problem formulation phase and the production phase. In these phases, critical reflection through problematic interactional processes is crucial to learning, just as discussion and 'the better argument' are the means to the construction of (scientific) knowledge. Related to the how-dimension; communicative competence in CSdCL that integrates metacommunicative

competence, and skills related to the operational use of the system (Dirckinck-Holmfeld and Nielsen, 1992), are essential for effective articulation of actions.

5 Final discussion

The objective of our study has been to analyze distributed collaborative learning situations in which certain actions and interactional processes are aimed at being the core to active construction of knowledge. The analysis has been carried out by applying Anselm Strauss' concepts of articulation and actions, interpreted in terms of the interdependent relation between 'Who is doing what, how and where'. This approach has given us an opportunity to explore the interwoven circumstances that affect the distributed collaborative processes.

The who- and what-dimensions are connected to the actors, their roles and corresponding actions in relation to problem-oriented project pedagogy. The where- and how-dimensions constitute the intersection between the technology and the basic learning developing actions. The where-dimension is related to the context in which the collaboration takes place, i.e., a distributed environment where the actors are separated geographically and often in time. The how-dimension is related to the conditions the computer system sets in the process of performing actions.

The study shows that aspects connected to student's explicit role—mutual obligation and tolerance to peer students and their actions—may constitute a contradiction in distributed problem-oriented projects. This lack of commitment can have its origin in the composition of the project itself and the actors' social relations. Anyway, responsibility and tolerance are prerequisites for the development and progression of the collaborative environment, but they become more apparent in distributed collaboration. At the same time commitment implies extra work for the students. The students claimed that extra work was mainly caused by the computer system's weak conditions related to problematic actions and corresponding articulation. The asynchronous and text-based communication form was not sufficient to perform fundamental problematic actions, which contributed to the fact that individual involvement and commitment to the collaborative processes demanded too considerable resources in respect to time.

Distributed collaborative environments are basically created by the actors, through their actions and common understandings. The meaning of distributed

collaboration is created through the common practice of the collaborative arrangement. As Harrison and Dourish (1996) put it:

> "Placeness can be designed *for*, but it can't be designed *in*.. (...)The best that designers can do is to put the tools into their hands [the actors]. Trying to do more—trying to build places—is not our [the systems developers'] job." (p. 74).

The roles of pedagogical and technological designers, are to *organize for* qualitatively good learning environments, concerning both the computer system and the pedagogical approach. Research on CSCL (Gutwin et. al., 1995) and on CSCW (Dourish and Bellotti, 1992; Bellotti and Bly, 1996; Palfreyman and Rodden, 1996; Roseman and Greenberg, 1996) has contributed to design and implementation of computer systems supporting awareness. Awareness has clearly impacts on commitment and involvement, as it is the

> "understanding of the activities of the others, which provides context for your own activity." (Dourish and Bellotti, 1992, p. 107).

The student's awareness of the peers' actions, perspectives and progression, is fundamental to ensure that individual course of action is relevant to the collaborative processes and mutual commitment. Others have contributed to systems design aimed at reducing the complexity of articulation work (See e.g., Schmidt and Bannon, 1992; Schmidt, 1994; Simone et. al., 1995; Divitini and Tuikka, 1996), and are using concepts of articulation to link the study of how people work and systems design (Fitzpatrick et. al., 1995; Fitzpatrick et. al., 1996). This research has to be creatively integrated in design of computer systems that are *available* for the target group, adults studying from homes. Multimedia systems allow a plurality of codes in the interactional processes, which imply the possibilities of awareness and implicit articulation so that the participants of the project can adjust their contributions "in response to signals of understanding or misunderstanding, questions, or interruptions." (Kraut et. al., 1992, p. 378). Such systems have become more available, and in the future we can expect *sufficient* availability so that distributed collaborative learning situations can be offered to a broad spectrum of distance learners, also from their homes. The needs for additional and explicit articulation may still be present (Dirckinck-Holmfeld, 1995), but it will certainly reduce some of the collaboration problems that have been identified in our analysis.

In the nearest future Internet services, including the World Wide Web, constitute a promising point of departure for systems design and development. First of all, the World Wide Web seems to offer huge potential to integration of external applications across Macintosh, PC and UNIX platforms. Secondly, it has a low cost to usage. But, as Palfreyman and Rodden (1996) state, the World Wide Web is in contrast to the literature emphasizing the importance of awareness. Its growth in availability makes World Wide Web an open arena of various activities of millions of users. The socio-emotional factors of learning, including engagement and motivation, may be even more reduced than our study shows because of this overflow of actors and activities. Add to this, the traditional usage of the World Wide Web has been searching, browsing and retrieving information as well as making information available for others. This approach does not necessarily provide support for collaborative activities including joint authoring and social negotiation of knowledge. Further research, based on this study, is thus aimed at designing and developing computer based products that integrate available Internet services with appropriate collaborative approaches and awareness issues. The aim with such a product is not to be a collaborative system in its own right, but a medium and a tool that are sufficient for creating a common learning environment amongst geographically dispersed adult students.

Our study indicates that the computer system, in and of itself, does not support the collaboratively based processes of learning. A qualitatively good learning environment is dependent of far more complex factors. The actions that are fundamental to the students' interdependence, and the expected roles, ideally require mental and social presence at any time of all the actors. Compared to traditional collaborative learning situations, distributed environment requires *new* forms of articulation that contribute to the fact that the collaboration becomes demanding. This raises the question of a pedagogy that presupposes that mental and social 'distances' must be overcome, and not only the physical ones, may be a too *idealistic* approach to base on in designing collaborative distributed environments—no matter the technology applied. The principles of critical reflection and problem orientation, and the explicit roles of students and teachers, are needed to be reconsidered in respect of the new learning situation.

Problem-oriented projects can in itself imply a contradiction in relation to mutual commitment. First of all, to many adult students this approach is an unknown form in a *learning situation*. This can in itself imply extra work as the

students must learn to collaborate according to the principles that are implicit in project pedagogy. Secondly, project pedagogy itself in *practice* implies a fundamental contradiction, both in a distributed situation and in an institutional situation. In line with the fundamental philosophy of project pedagogy the collaborative process itself is stressed and the final outcome (the project report) is stressed less. The processes are not evaluated (at the examination) but the project report and the knowledge of the individual. This means that the incentive for the collaboration in practice can turn out to be a totally different one than the intended philosophy, namely to get good marks for the final report of the project and for the individual student's performance. This may indicate that the students do not attach importance to the collaborative processes—when it becomes too costly—which becomes more apparent in a distributed situation, and which may appear as a reduced sense of responsibility and mutual commitment.

In conclusion, our study of distributed collaborative learning shows that the who-, what-, how-, and where-dimensions should be seen in mutual interaction in which the dimensions determine and exclude each other in practice. First of all this makes demands on the design of good pedagogical models *adapted* to distributed environments. This does not mean that the established principles must be rejected, but function as a frame of understanding or guide to innovative and new thinking in the pedagogical design. Furthermore it makes demands on the design of computer systems—available from homes—supporting awareness and reducing the new articulation needs. These demands are fundamental to offer and deliver qualitatively good learning situations for adults in the lifelong process of learning alongside work.

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The Computer's Incorporated Role in Work

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Abstract

Networked computers are increasingly being used in cooperative work settings, seriously impacting the way we work together. An understanding of the relationship between networked computers and collaborative human work is necessary. Further, systems developers need frameworks that address both social and technical issues in order to be able to analyze work with computers and design of computer systems. Some theoretical accounts of this relationship exits, but in terms of usefulness for systems design and how the role of the computer in work is regarded, they have shortcomings. - This paper develops a conceptual framework for understanding computers as *incorporated* into work, focusing the computer as a tool and as a sign in the aspects of work, production, exchange and distribution. The framework is based on activity theory, further enriched by interaction theory.

1 Introduction

Since the 80ies, text processing programs, drawing and painting programs, spreadsheet applications and the like, have been valuable personal tools to articulate thought and knowledge into writings, drawings and schemes. In the late 90ies these tools have become much more than a value neutral instrument

supporting individual actions (Dahlbom, 1996). They shape the goals and courses of actions, increasingly taken place in collaboratively based work arrangements free from time and place constraints. The increasing dissemination of networks (including the Internet) support organizations to divide their labor force geographically (Greenbaum, 1995) and employees to take part in further education programs alongside work (Harasim et. al., 1995).

These new learning- and working environments cause a situation in which writings, drawings and schemes are exchanged and articulated by the personal tools of the individuals. A computer-based instrument (together with other mediating instruments like e.g., paper and pencils) should ideally mediate the actions, without hampering the alternation between them. Schmidt (1994) illustrates this in the following way:

> "(...) the user should not be required to shift to a special editor and leave the world processor normally used for composing letter, writing report, etc. The same applies to CSCW facilities supporting cooperative authoring, conferencing, etc. " (Schmidt, 1994, p. 68)

The operational conditions of the personal tools may hamper the mediation of individual and collective actions taking place in collaborative arrangements.

These new and emerging situations of computer applications, cannot be based on a tool- making perspective (Ehn, 1988) of systems development. Rather, the challenge is to view the computer as an incorporated part of human activity, merging the dichotomy of non-technological and technological aspects in a unified whole (Dahlbom, 1996). The computer is occupying the role as an instrument mediating both the operational and the communicative aspect of human actions, so that the application of an computer-based instrument to one operation does not hamper the operation of others. As systems developers we need powerful theories to study the close integration of human action and computer-based instruments, with particular attention on the interdependencies and interactions of technological and non-technological aspects in a unified whole.

There are some theoretical frameworks that can offer particular insight on this. Actor-network theory (Latour, 1991) explores the roles of human and non-human elements as equals in an interactional network. Hanseth (1996) uses this theory to analyze information infrastructure development and use practices. Interactionist theory of action (Strauss, 1993)—originated as a critical approach to the mainline

sociological literature—offers a rich understanding of the structural conditions of technology (among other factors) to actions embedded in collaboratively based work arrangements. Fitzpatrick et. al. (1995) use this rather incomplete theory as a bridging link between the social and the technical to provide insight into how to design computer systems. An activity-oriented approach of psychology, widely known as activity theory (Vygotsky, 1978; Leontjev, 1983; Engeström, 1987), offers a rich understanding of socially based human development in which artifacts have an essential meaning to actions. Kuutti (1994) uses the theory to classify the types of work support by information technology.

In this paper we add a framework theoretically based on the key features of activity theory and enriched with an interactionist theory on action. It is developed to guide systems developers through an understanding of a current work situation and to guide them through creative systems design.

The structure of the paper is the following: In section 2, the problem area is addressed in an activity theoretical perspective. To our point of view, the present approaches can not provide ready-made frameworks for understanding and designing computer-mediation of action embedded in collaborative settings. In section 3, we present the interactionist theory of actions to enrich the collective aspect of human activity. In section 4, we sum up and discuss the corresponding and different issues of the presented concepts, and are ending up with the features that form the foundation of the framework. In section 5 the theoretical outlook is operationalized in the form of a framework for understanding the computers role in collaborative work.

2 An Activity Theoretical Account of 'Incorporation'

The scope of activity theory as formulated by Vygotsky, and later by A. N. Leontjev, is a psychological theory for understanding the development of human activity, consciousness and personality. As such, it is not in the first place a theory of work (Christiansen, 1990). However, Vygotsky recognized the inseparable aspects of work and human development and the societal dimension of the educative process. He thus sought to define those aspects of social engagement that concern the development of mental processing (McMahon and O'Neill, 1992). A key issue of his research was that internalization is social by its very nature, and that intellectual development takes place on two levels. First it appears

on a social level, through *interpersonal* processes. Then it appears on an individual level through *intrapersonal* processes. Mental processes and human development are derived from actions performed by a person in cooperation with others (The range of collective actions comprises the so-called zone of proximal development).

A basic feature of an activity-oriented approach is the instrument-mediation perspective. Herein, are the goal-oriented actions that are characterized as by having a communicative as well as an operational aspect (Christiansen, 1990). These features of human activity constitute a point of departure concerning the problem of incorporation, and will be presented and discussed in this section. Although Vygotsky based his theory on the societal dimension on human activity, activity theory has exclusively dealt with individual human beings (Kaptelinin, 1996a). In order to consider incorporation of computer-based instruments into collaboratively based work organisation, we will present and discuss the activity-oriented contributions that offer insight to the collective aspects of activity.

2.1 The hierarchical structure of activity

The levels of human activity were theoretically developed by Vygotsky's student A. Leontjev. Leontjev (1983) developed a, today well known, hierarchical structure of activity. This hierarchical structure has inner dynamics, transformations and its own development (Leontjev, 1983). The driving force behind activity, action and operation is different, as can be seen in figure 1:

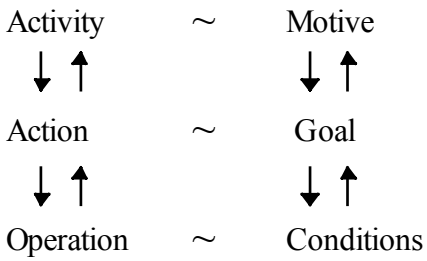

Figure 1: The internal side of an activity, along with corresponding driving forces (ibid.).

An activity is realized through goal-oriented processes, termed actions. An action can realize different activities as the given action may fulfill different motives. Before an action is performed, it is planned consciously. Actions are realized through operations, that face conditions in the external world. Operations

are typically initiated unconsciously—often even the collection of operations that accomplish the action is selected without explicit decision. The 'automatic' choice and routinesed performance are possible only for a knowledgeable and experienced person (subject). But once acquired, this ability appears as a competence for situated action. Human development is thus a process moving actions to operations, and operations into actions (e.g., instances of breakdowns). As the degree of routinisation increases, the action is moving towards operation.

According to Leont'ev (1978), actions are usually polymotivated; two or more activities can temporarily merge, motivating the same action.

2.2 Instrument-mediated action

Central to Vygotsky's activity-oriented approach is the instrument-mediated action, and which enrich the issue of integrating computers and human action. Any instrument can be understood only within the context of human activity by identifying the ways people use the instrument, the needs it serves and the history of its development (Kaptelinin, 1996b). Vygotsky distinguished between two interrelated types of instruments; tools and signs. According to Vygotsky, the function of a tool

> "(...) is to serve as the conductor of human influence on the object of activity; it is *external* oriented; it must lead to changes in objects." (Vygotsky, 1978, p. 55).

Examples of tools are text processing programs, drawing and painting programs, paper and pencil, description techniques, etc. The signs have a different character and are means of thought, and reflective and conscious actions. A sign

> "(...) is a means of internal activity aimed at mastering oneself; the sign is *internally* oriented." (Vygotsky, 1978, p. 55).

Examples of signs are language, writing, drawings, schemes, diagrams, all sets of conventional signs, etc. The essence of signs is that they are basic instruments for intrapersonal processes that necessarily has a communicative form. However, it is the internalization of social dialogues into an inner dialogue that allows one to plan and monitor cognitive progress and further actions in interpersonal and communicative processes. The communicative aspect of an action is the way knowledge is constructed about the phenomenon of question, while the operational aspect of the same action is mediated by the chosen tools (e.g., paper

and pencil). The outcome of the action is framed by the embedded conditions of the tools.

All signs reflect the tools and aid available for use in carrying out action. Following the instrument-mediation perspective of human activity, we can point out two interrelated roles of a computer-based instrument:

- The mediator of the communicative aspect of action (sign).
- The mediator of the operational aspect of action (tool).

To develop computer-based instruments mediating actions within activity, systems design has to be aimed at understanding the communicative aspect of action (the sign-part) in order to offer good solutions for the operational aspect (Christiansen, 1990).

2.3 Operationalizing collective aspects

Although activity theory almost exclusively has dealt with individuals, approaches have been developed to expand and operationalize the concept of activity to socially organized arrangements.

The concept of *collective subject* has been introduced to account collaboration amongst individuals, dealing with a joint activity. The collective subject can then be considered as a 'total subject' of the joint activity, and

> "the interrelations with the individual subjects can be comprehended through a psychological analysis of the joint activity" (A. A. Leontjev, cited in Engeström (1987, p. 70)).

Such an interpretation may be problematic if the various subjects have different motives for their actions, but also with respect to analyzing interpersonal processes (such as negotiations, consensus seeking, common problem solving, etc.)

An essential problem with Leontjev's general structure of activity is that the instrumental and communicative aspect of activity were not brought into a unified model (Engeström, 1987). These features have certain importance to the topic of incorporating computers into the total arc of collaboratively based work arrangements. Engeström (1987) has taken these features into consideration, and as such we will apply Engeström's interpretation as a theoretical foundation for understanding the problem area.

Engeström's interpretation has been widely adopted in the IS field. Bødker (1996)—who introduced activity theory to the HCI-field (Bødker, 1991)—uses

Engeström's interpretation to study computer-based instruments in use. Bellamy (1996) uses the interpretation as a framework to study the relationship between technology and educational change. And finally, Kuutti (1994)—who introduced activity theory to the CSCW community—applies the structure of activity to classify the types of (cooperative) work supported by information technology. Kuutti (1994) recognizes the incorporated role of the computer. He is rather engaged in considering the different aspects of cooperative work separately, and to identify the capabilities of computer applications to support pre-defined aspects of collaborative arrangements.

2.3.1 Production, exchange and distribution

The objective of Engeström's model is to consider the socially based nature of human activity by including rules of communication and division of labor. The model is illustrated in figure 2. The upper triangle of the model illustrates Leontjev's basic interpretation of human activity. The two others represent the collective aspects of human activity.

In the model, human activity is interpreted as a dynamic interrelation between the three aspects. The model shows that an individual is not isolated but is a part of a community, and the activity is affected by the individual's participation within this community.

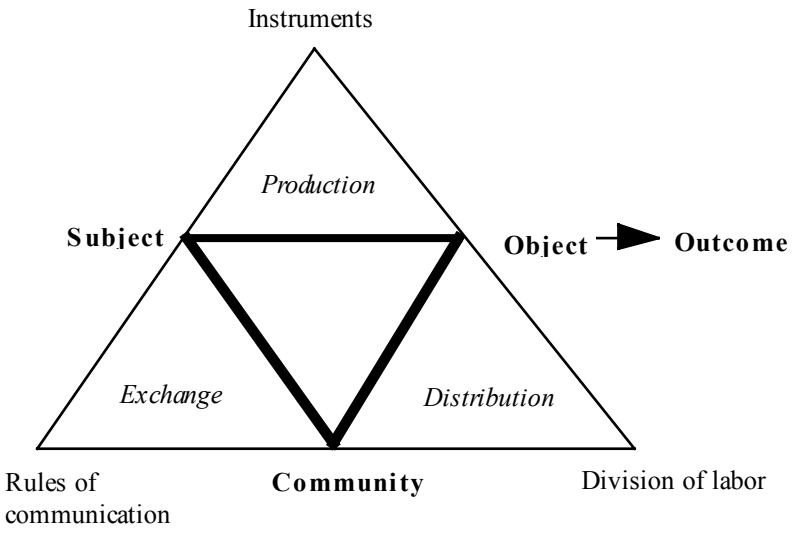

Figure 2: The aspects of collective activity

The individual's action toward the object of the activity is affected by three factors: The instruments applied (signs and tools), the community a person belongs to in terms of the embedded rules of that community (laws, practice and tradition, etc.) and the division of labor in that community (roles, communication and coordination procedures, etc.). The individual's relationship to the community is mediated by rules. The community's relationship to the object of the activity is mediated by the division of labor.

2.4 The Problem of computer-mediated collective action

In order to analyze the incorporated nature of information technology and actions, we find some problems by applying Engeström's model as an analytical approach.

The first problem is connected to a weak recognition of the dynamic structure of activity presented by Leontjev (1983). Leontjev's structure is to some extent presented through the concept of inner contradictions. An activity itself is not only mediated by, but also develops rules, instruments and division of labor. However, the processes by which a community of individuals articulates actions and operations, and handle and develop them in the face of situated actions and contingencies, are not clearly elaborated. The evolution of collaboratively based arrangements involves actions to negotiate on perspectives and beliefs, and to handle contingencies and situated actions (Cf. Suchman, 1987).

The second problem is related to the instrument-mediation, that is, to the duality between sign and tool. Collaboratively based communities are created and maintained by activities conducted through actions of individuals (Bødker, 1996). A such, the duality of sign- and tool-mediation has to be present in the computer-based instrument. However, the model is exclusively focusing on this duality. 'Rules of communication' and 'division of labor' may be viewed as structures of the communicative aspect of action. However, the duality of sign- and tool has also to be considered with respect to the two collective aspects of human activity.

Let us for a moment use simple and asynchronous text-based e-mail systems as an example to illustrate this. These systems are well known for being obstacles for negotiations and consensus seeking (Eklundh, 1986; Feenberg, 1989; Sorensen, 1994). The lack of immediate feedback, the written communication style and the dominating non-verbal situations, make these types of actions both time-consuming and problematic to fulfill especially when deadlines are near. Also, the practical problem of distributing a written document attached to an e-mail

message may cause problems unless the collaborative actors have compatible text-processing programs. The role of an e-mail system is thus not limited to transmission of operational aspects of communication. The e-mail system also shapes the goals of the people using it, as well as the style of communication and communication rules.

Although Engeström recognizes the collective aspect of human activity, the model can not provide a ready-made solution to understanding the dynamic and situated nature of collective work. Thus, other theories are needed to enrich this understanding. In the next section we will present an interactionist theory of action with this purpose.

3 An Interactionist Theory on Action

The interactionist theory of action, presented in Strauss (1993), traces the human actions and embraces the interaction of multiple actors, contingencies and course of action.

Strauss' conceptual frameworks, and particularly his concept of articulation work, have been complemented and evolved by current CSCW work. Schmidt and Bannon (1992) use articulation work as a basis for understanding the complex and distributed nature of cooperative work. Simone et. al. (1995) explore the role of protocols as mechanisms to reduce the complexity and extra work that cooperative work often entails. Fitzpatrick et. al. (1995) use Strauss' 'continual permutation of action' to bridge the social and technical dimension of CSCW. However, they seem not to consider the nature of incorporation as interpreted in this paper. Fitzpatrick et. al. (1996) very interestingly use Strauss' as a framework to discuss the concept of 'space' with respect to design of computer systems as well as to analyze computer mediated collective actions.

3.1.1 Action and interaction

The fundamental unit of analysis in activity theory is an activity that exists in a material context. For Strauss, the fundamental unit of analysis is the interwoven nature of action and interaction, and its structural conditions.

> "Actions are embedded in interactions—past, present and imagined future. Thus, actions also carry meanings and are located within systems of meanings. Actions may generate further meanings, both with regard to further actions and the interactions in which they are embedded." (Strauss, 1993, p. 24).

The interactional processes are the strategic means by which the actions are maintained, strengthened and supported. Actors and meaning (e.g. beliefs, attitudes, perspectives, etc.), tasks, responsibility (obligation, commitment, division of labor, etc.) and external factors (of technological, cultural, organizational, physiological and economical features) are parts of action as they influence and change the course of action.

Strauss (1993) distinguishes between two levels of actions; the routine and the problematic:

> "Problematic interactions involve 'thought', or when more than one interactant is involved then also 'discussion'. An important aspect of problematic action can also be 'debate'—disagreement over issues or resolutions" (ibid., p. 43).

However, most interactions are routinesed:

> "Actions and counteractions are expectable; often repeated; governed or guided by rules, regulations, standardized procedures, agreements, or understandings." (ibid., p. 43).

Complicated and complex actions cannot take place without the routine actions, and the usually taken for granted skills and abilities. Moreover, routines may be changed, and turn over to complicated actions caused by contingencies.

Strauss does not explicitly distinguish between actions embedded in interpersonal and intrapersonal processes. There is an interwoven and dynamic relationship between individually and collectively oriented actions. This is in line with the dynamic relationship between production, exchange and distribution in Engeström's model.

3.1.2 Social worlds and effective communication

Strauss' notion on social worlds can be compared with Engeström's notion on community. A social world is the 'recognizable form of collective action' (Strauss, 1993, p. 223). Central to Strauss' is that membership of social worlds is

not determined by geography or organizational boundaries, however constrained by the limits of effective communication. Following this line of interpretation, the instruments used to mediate human actions, thus need to maintain effective communication.

4 Application of the Interactionist Theory Within an Activity-Oriented Approach

Since activity theory has no universal accepted notion of collective activity (Kaptelinin, 1996a), we feel free to interpret activity theory in a way that is useful for our problem area. We enrich the key features of activity theory with Strauss' (1993) theory on action/interaction. In this section we will discuss the relationship between these two theories.

The theories differ when it comes to the context of action. In an activity theoretical perspective this is defined as the activity itself. The interactionist theory on action addresses the membership of actors in social worlds as the condition for actions. The dynamic relationship between routinezed and problematic actions corresponds well with Leontjev's concepts of activity. Problematic action may be viewed in terms of Leontjev activity-action level. This level will inherit many aspects from the activity it is realizing, which is likely to add the coherence between the single actions that belong to one activity. Routine action corresponds with Leontjev's action-operation level. The choice and performance of operations are often well habitualised and less conscious. It is, however, fruitful to regard this seamless flow of collaboratively based work situations as the outcome of articulation. Before the choices we can imagine a brief moment of articulation (this coincides well with Strauss' (1988) implicit articulation), which even a tiny breakdown brings to the surface. We can even evaluate the performance; the goal(s) of the actual action gives the criteria to such evaluation.

We interpret Engeström's notion of a community as a social world with actors that share the same object of their individual activities. In activity theory this is known as object orientation, i.e., the object is what determine the activities and hence its boundaries. This notion of collective activity also agrees with Leontjev's (1983) notion of polymotivation, i.e., a collective action may realize different activities.

Concerning collective action, Engeström's model is a valuable basis. The model constitutes a systemic approach with respect to understanding human activity. By enriching Engeström's model with Strauss' concepts of routine and problematic action, a systems developer is allowed to explore the interwoven relationship between instruments and actions: The computer application's conditional meaning for problematic and routinezed action and *how* it influence the course of action. The instrument's role (the computer applications together with other instruments) is to mediate actions embedded in production, exchange and distribution however without hampering the alternation between them. A framework developed on this basis is presented in the next section.

5 A Conceptual Framework for The Computer's Incorporated Role in Work

This section presents a framework for understanding the computer's incorporated role into work.

5.1 Incorporation

The framework is aimed at supporting systems development. The particular interest is to regard a computer application as an instrument. The framework focuses on the role of the computer application, and does not regard other important issues that should be taken into consideration during systems development.

We regard incorporation as quality. It may thus be improved or worsened due to changes regarding the computer applications or the work arrangements. If a computer application hampers the web of human action, the level of incorporation is low and thus quality.

An operationalized model of incorporation is shown in Figure 2. The model is based on Vygotsky's idea of an instrument being either a tool or a sign, and on the aspects of an activity that Engeström proposes. The pyramid in Figure 2 is a conceptualization of the instrument's role in the web of human actions embedded in production, exchange and distribution.

Engeström (1987) regards contradictions as the driving force in any human activity. We have adopted this view on human development, and analyze the quality of incorporation with respect to various *contradictions*. That is,

contradictions concerning the instruments' incorporated role into production, exchange and distribution. In addition we address the contradictions due to the duality of instruments.

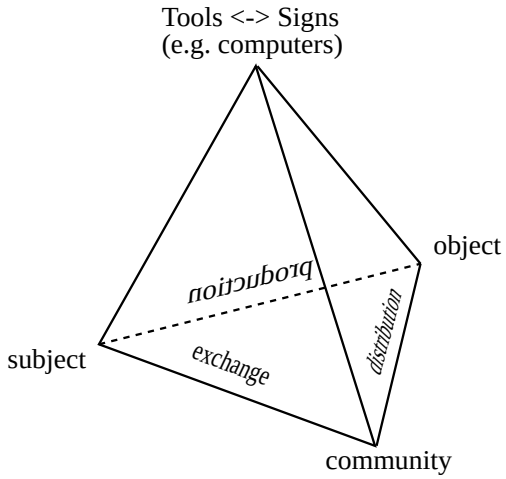

Figure 2: Computer applications as instruments in cooperative work

Instead of giving an explicit definition of incorporation, we explain it in the following:

The dialectics between the three aspects are crucial in understanding collective work. In any collective work arrangement, neither of these aspects can be considered separately, because they all influence each other continuously. Rules mediated interpersonal interactions influence the course of individual and collective actions. Moreover, individual and collective actions may influence and change the whole work organisation, and the work organization influences these actions. The work organisation also influence what kind of instruments that is used in the web of actions, and the instruments may in turn influence the work organisation and division of labor.

5.2 The Main Categories

In this section, we will give an operationalization of the concept of incorporation.

Although many instruments may act both as a tool and sign, we regard this an essential property of computer applications. The framework consists of two categories or contradictions:

1. The tools and sign duality in the levels of action.
2. The role of computers in collective action.

We distinguish between the tool and sign duality within the levels of actions. Hence, the following categories should be considered:

The Tool and Sign Duality in the Levels of Actions

	Activity <-> Action	**Action <-> Operation**
Tools	Use of tools involves thought and is targeted toward the object of the activity. The involvement of thought may stem from problems of using the tool, due to breakdowns, or due to unfamiliarity with the tool.	Use of tools is conducted automatic, due to internalization of the tool's properties and behavior. It is argued that this is an ideal use situation, because the tool is transparent in work, and hence not hampers the focus on the object of work.
Signs	Signs are an aid for thought and reflection. They are targeted toward the activity itself.	Signs are unconsciously guiding the course of actions.

It may be difficult, even impossible or unnatural, to make a clear distinction between tool and sign related to a given action. This is however not the main clue of the framework. Rather, focus should be put on the duality within the instrument.

We have presented Engeström's (1987) three aspects of a collective activity. The computer applications' incorporated role into a collective context is related to the tool - sign duality. Hence, the following categories should be considered:

	The Role of Computers in Collective Action
Production	Tools and signs are targeted toward the object of the activity. Tools are means of changes upon the object, while signs are aiding thought and reflection upon the object. *Examples:* *Tools: Applications for: text processing, spreadsheets, calendars. Database management systems.* *Signs: Texts, spreadsheets, paintings, databases, calendars.*
Exchange	Signs mediate thought, knowledge and perspectives among subjects in the community. Tools are means of changes upon the object, but the interpersonal aspects involved are also focused. *Examples:* *Signs: e-mails, shared databases, group decisions.* *Tools: e-mail applications, video conferencing systems, workflow systems.*
Distribution	Signs mediate the division of labor in the activity, like common decisions, commitments, and work arrangements. Shared tools are means for a community to collectively make changes upon the object. *Examples:* *Signs: Group decision, plans, access rights, calendars* *Tools: Information systems*

5.3 What to look for?

The present version of the framework is neutral to whether it is a current work practice, or an imagined future work situation that is analyzed. Thus, we believe the framework can be used both in analysis activities and design activities, and this is an issue for further research. We put emphasis on the role of contradictions as the core of understanding the computers incorporated role in work. We have outlined some categories of contradictions that may guide the analysis.

5.3.1 Contradictions due to the duality of instruments

These categories of contradictions relate to the duality within instruments (Vygotsky, 1978), i.e., the double function of computers as tools and signs. We have observed that the tool function may hamper the sign function, and vice versa.

An example is: A multiple user database may be designed so that the individual users can not know of, and can not interfere with, each other's actions. (This is common, and is enforced by serialisability protocols in shared databases.) The problem occurs due to the missing mediation of the other users' actions. Hence, situations where cooperation would be appropriate are hidden by the computer system (Sørgaard, 1988).

5.3.2 Contradictions between different instruments

These categories of contradictions relate to the instruments used in a work situation. A large number of computer based and non-computer based instruments are present in any work situation. These may be designed with different modes, paces, heuristics, etc. in mind. Hence, there may be tensions between the various roles of instruments in work. An example is: Cf. the quote in the introduction (Schmidt, 1994).

5.3.3 Contradictions due to the levels of action

These categories of contradictions relate to the hierarchical structure of activity (Leontjev, 1983). We have observed that computer applications have been designed with one particular level in mind, not taking into consideration the dynamic interplay between them. An example is: A MOO/MUD application is fundamentally based on a room metaphor, and may as such help novice users to engage in interaction with limited training. However, this can be an obstacle for an experienced user. An other example is: Using a text processor is shortly routinezed. However, once a special function is to be used, e.g., integrating a picture in the text, thoughts are directed towards the tool itself.

5.3.4 Contradictions between the aspects of collective actions

These categories of contradictions relate to the dynamic relationship between production, exchange and distribution (Engeström, 1987). We have observed that individual computer applications hamper the actions directed towards exchanging materials in collective work. An example is: Co-writing of a scientific paper, using text processors with different formats. An other is: Consider a video conferencing system with a shared worked space. Seeing the collaborators' facial- and bodily expression may be used to control access to the shared work space. However, bad image quality may hamper this important aspect of awareness of the others' intentions and views (Kuzuoka et. al., 1995).

5.3.5 Contradictions between multiple activities

These categories of contradictions relate to Leont'ev's (1978) view on polimotivated actions, i.e., two or more activities can temporarily merge, motivating the same action, thus creating a contradiction between the involved activities. An example is: A secretary is involved in different activities. The mediating instruments in these activities may be different (Framemaker, Word and LaTex/UNIX, Mac, PC), and thus constituting a hamper in work because of the weak incompatibility between the instruments.

6 Summary

This paper has proposed a framework for system developers in their process of structuring their understanding and analysis of a problem situation, in which computer-based instruments are incorporated into work. This summary will present the key features of the framework.

An essential feature of the framework is the duality between the computer as a tool and as a sign. This two-sided role differs from situation to situation, and what role a computer application occupies has to be considered with the situation at hand. However, viewing computer applications as signs has been emphasized since

> "they are originally instruments for co-operative, communicative and self-conscious shaping and controlling of the procedures of using and making technical tools." (Engeström, 1987, p. 60-61).

The computer's role as a sign has thus a fundamental meaning to a collaboratively based work arrangements in which mediation of thought, perspectives and common decisions have a central and shared position. The computer occupies the role as a personal tool and aid for carrying out actions related to the collaborative process. However—as mentioned in the introduction—the computer shall not hamper the alternation between these tool-related aspects.

The computer-based instrument occupies the interrelated roles as a sign for thought and reflection and as a tool for Operationalizing the same action. This feature is developed from activity theory and Vygotsky's (1978) fundamental concepts of instrument-mediated human action.

The levels of action are understood as the dynamic relationship between planned and situated action (Cf. Suchman, 1987). This feature is developed from activity theory and Leonjev's (1983) hierarchical but dynamic structure of activity.

Although activity theory views interpersonal processes and cooperative activities as the foundation for human development, the concept of collective action is not thoroughly developed. The interrelation between individual and collective oriented action is important when it comes to understand and analyze the complexity of (collaboratively based) work. With basis in Engeström (1987) model of collective activity, we enrich the concept of collective action with Strauss' (1993) theory on action and interaction.

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Drama as a Metaphor for Design of Situated, Collaborative Distributed Learning

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Abstract

This paper deals with the complexity of designing distributed collaborative learning (CSdCL). The complexity is found in the integration of those pedagogical,- organizational- and technological aspects that influence a collaborative learning process. From a basic understanding of this complex triadic feature of CSdCL, a metaphor from theatre is suggested as a framework for understanding and approaching design of CSdCL situations. Three CSdCL-examples from practice are analyzed and critical aspects of CSdCL are explored from the perspective of this new framework to demonstrate the benefits of using a holistic metaphor to comprehend and capture the challenge of CSdCL design.

Keywords − Collaborative learning, CMC, design, metaphor, drama.

1 Introduction

Computer support for collaborative learning (CSCL) is a new research field including a focused study of the use and development of computer-based artifacts to support collaborative learning (Koschmann, 1994). There is no clear conceptualization of the field, but all approaches distinguish themselves from the traditional, 'transmissive' model of learning in which the instructor is assumed to

be the sole source of knowledge and skills (Harasim, 1990). Unlike the teacher-centered models, pedagogical approaches to collaborative learning treat the learner as an active and reflective participant of a collaborative community. There are, however, important differences among the various theoretical understandings and practical pedagogical approaches, in the sense that they seem to emphasize interactive and collaborative processes differently.

Focused studies within CSCL research deal with computer support for distributed collaborative learning (CSdCL)[34]. Such approaches build on the communicative potential of communication technology for designing and organizing collaborative learning communities among geographically dispersed students. Asynchronous computer-mediated communication (CMC) systems—computer conferencing systems being the far most applied (Bates, 1995)—have been considered promising in the mediation of learning activities involved in distributed collaborative learning communities (Harasim et. al., 1995; Mason and Kaye, 1990; Harasim, 1990; Garrison, 1989). Harasim et. al. (1995) explain the educational potential of CMC-technology in the following way:

> "Any course that emphasizes in-depth coverage and discussion of materials can be effectively conducted entirely online, as can any course with extensive writing assignments. The sharing of ideas and collaborative tasks, such as seminars or joint writing, are particularly effective online. Generally these activities use discussions, brainstorming, problem solving, group work, and reflective or analytical contributions based on special projects or research." (Harasim et. al., 1995, p. 25)

Several experiences with CSdCL, however, have indicated that the deployment of CMC-systems to collaborative learning situations is a complex challenge, in design as well as delivery (Georgsen, 1995; Fjuk and Dirckinck-Holmfeld, 1996 a, b; Sorensen, 1996a). This complexity is positioned in the interplay between organizational, pedagogical and technological aspects (Sorensen, 1996a; Fjuk, 1993). The three elements are connected with one another in a dynamic interplay; therefore, a change for instance in the mediating artifact (including CMC-

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[34] We use the term 'CSdCL' to underline the distributed or distance nature of collaborative learning in which telecommunication technology is applied to mediate collaborative and individual activities.

systems), will also influence and challenge the pedagogical as well as the organizational aspects.

This paper describes and discusses the nature of this complexity and its challenges to design of CSdCL-situations. The empirical basis consists of three CSdCL examples, all of which are claimed to depart from the idea of collaborative learning, but with different emphasis on the interactive processes amongst the peers. The situated complexity of each of the cases is explored and identified using Aristotle's fundamental idea of *drama as the representation of a complete whole action*. A CSdCL phenomenon is considered as a whole complete action with several incidents closely connected. The analysis of the examples, reveals a clear diversity in the design products and the delivery processes. The varying gap between *theoretical collaborative intentions* in the pedagogical design and the *expected effects* in the actual delivery and learning processes is interpreted to be a problem related to the attempted integration of technological, pedagogical, and organizational aspects in the CSdCL designs.

This paper is a plead for the use of the holistic perspective of theater as a conceptual framework for establishing more successful CSdCL processes, and the various concepts within 'the whole action' are suggested and applied as tools to explore some critical aspects of designing CSdCL.

Section 2 deals with the problem of the very fundamental theoretical perspective of the designer of CSdCL and stresses the importance of a conscious theoretical approach. In section 3 the empirical cases of CSdCL are introduced, and their individual theoretical basis is touched upon. Section 4 forms the forum for the introduction to drama and theater as the point of departure for understanding and approaching CSdCL design. Finally, section 5 provides an account of concluding remarks on some important principles for design of CSdCL.

2 Theoretical Perspectives

In this section we turn to the perspectives behind design, and we explain in what way these are related to learning theory.

All theories about learning imply fundamental assumptions about humans and about the world, and about the nature of the relationship between the two. Such

latent perspectives influence and form our pedagogical choices and initiatives (Sorensen, 1996b). Diana Laurillard puts it this way (Laurillard 1993):

> "Every teacher plays a part in nurturing their students' epistemological values - their conception of how we come to know - and hence their conception of what learning is, and how it should be done. None of these features very much in course syllabuses, because they tend to be concerned with the content to be learned, rather than its epistemological status. It is often implicit, (...)" (Laurillard, 1993)

Before engaging into learning designs it is therefore important to reconsider and to make explicit where, "geographically", in the epistemological and learning-theoretical universe one is positioned, so that it becomes possible to make conscious and critical pedagogical choices of high quality.

2.1 Interaction: The Basis of Human Existence

Generally, we may speak about two different types of basic philosophical assumptions that underlie today's pedagogical approaches (Collin and Koeppe, 1995): The rationalistic assumption and the existential-phenomenological assumption. The rationalistic assumption builds on a dualistic ontology or view of the world in which reality (and its objects) and the acquisition of knowledge, are separated. Humans are viewed as existing in an outer world constructed by objects and properties, and our actions are carried out in this world. All reasoning takes place through observation and detached reflection (in an inner world of mind) in an attempt to find 'the truth' about a thing or a relation. The dualistic ontology implies the idea that there are 'objective facts' about the world which are not dependent on interpretation or on the presence of a person. It is also viewed to be possible to make objective models of the world; models that maintain and, objectively, mirror the relations of the real world.

In the dualistic approach perception is seen as a process through which facts in the outer world are registered (not always correctly) in our thoughts and feelings. In the dualistic perspective subjectivity and practice are invisible, and the social construction of the world is hidden in the background.

In contrast, the existential-phenomenological approach builds on a view of the world as being fundamentally social. Humans are viewed to be fundamentally social creatures, and subjectivity is essential. In opposition to the dualistic view

this approach has the social aspect in focus, and social linguistic activity is viewed to be the ultimate foundation for intelligibility, existence, and language:

> "Language is a form of human social action, directed towards (...) mutual orientation. This orientation is not grounded in a correspondence between language and the world, but exists as a consensual domain—as interlinked patterns of activity." (Winograd and Flores, 1986)

The theory of collaborative learning is a general theory that is viewed to meet limitations in inappropriate features of 'direct transfer' models and in many ways, more rationalistically based theories of learning. These models and theories reflect the view that the teacher is the sole source of knowledge and skills. The learner is a passive recipient of information, and knowledge is further transformed through individual studies. In contrast, collaborative learning models treat the learner as an active participant in a collaborative community, and see active participation as a key element in the individual development of cognition. Derycke and Kaye put the close relationship between the social and individual nature of collaborative learning this way:

> "(...) Learning is inherently an individual, not a collective process, which is influenced by a variety of external factors, including group and inter-personal interactions. (...) Group and inter-personal interactions involve the use of language (a social process) in the re-organisation and modification of one's personal understanding and knowledge structures, so learning is simultaneously a private and a social phenomenon." (Derycke and Kaye, 1993, p. 194).

At a broad level it may be stated that collaborative learning in a certain sense captures and connects the two—often contrastingly described —worlds of learning modes: Learning through individual detached reflection and learning through dynamic interaction in a social community.

With an ontology that rejects dualism, and an epistemological view of the world that fundamentally gives priority to social behavior and social interaction in the acquisition of knowledge, it also clearly follows that it is necessary first to review the *conditions of inter-personal interactions* before a discussion of learning and principles of learning is initiated (Sorensen, 1996b). Especially, this is crucial in situations where one is about to investigate and define *new*, *virtual* learning

spaces and environments in which inter-human interaction has a significant status in the learning process.

2.2 Perspectives Behind Distributed Collaborative Learning

There are numerous studies reporting computer support for collaborative learning (CSCL). These studies differ widely in terms of theoretical approaches, time and place for learning, target groups, computer-based technology, etc. In this section, we focus on two major traditions of learning, each of which has influenced the design of CSdCL. These are the tradition of collaborative learning and the tradition of distance learning.

There are two major theoretical perspectives that have dominated research in the tradition of collaborative learning: Socio-cognitive theory represented by Piaget, and socio-cultural theory represented by Vygotsky.

In his later work, Piaget was largely concerned with individual development. Earlier, however, he emphasized the importance of social interaction on individual development and saw differences in perspectives and confrontations of these as the driving force for human development.

The focus of Vygotsky's theory is that all human development has its origins in social processes. His key concept is the idea of the zone of proximal development in which learning occurs. The zone is defined as:

> "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

In the Vygotskian understanding, social interactions are not only catalysts for change; they are also themselves internalized by the individuals involved. The Vygotskian view is consistent with the value of social interactions, since social-based dialogues are the foundation for 'inner dialogues' which reflect thought and action. In essence, there is a causal—or dialectical—relationship between social and the individual processes.

In comparing these two major theoretical understandings, one may say that the Vygotskian approach is focused on the goal and the outcome of human activity, while Piaget is concerned with the methods of active cognition through interactions, e.g., in order to provoke cognitive conflicts cognition (Mellin-Olsen,

1993). In practice, these two views may be interpreted as mutually interdependent in terms of how learning takes place.

Research on CSCL that is inspired by Vygotsky tends to focus on computer support for collaborative actions amongst peers with different intellectual or knowledge abilities (e.g., between student and teacher), whereas the research inspired by Piaget emphasizes computer support for social interactions amongst collaborative actors with an equivalent level of knowledge. In past research around CSdCL, however, these two views are often combined and exist harmoniously as one perspective behind design.

In focusing on computer support for distributed collaborative learning, the tradition of *distance education* must be added. Such tradition does not exist in Denmark (a, geographically, small country with no need for bridging distances), but in other Scandinavian countries - in particular Norway - the correspondence institutions has for many years formed an important alternative model of learning; - a result of democratic ideals in terms of everyone's right to education, regardless of geographical conditions. In contrast to the tradition of collaborative learning, this tradition rests on the understanding of learning as an individual and independent process, and of written assignments as something to be sent to a tutor for comments and guidelines for further progress. Organizationally, the correspondence model provides the same learning flexibility with respect to time and space as CSdCL. CMC-systems have been considered promising in terms of adding a social component to the individualistic learning process.

The next section presents and reflects upon three different CSdCL examples. The examples are all resting on theoretical intentions that include the concept of collaborative learning and a wish for learner flexibility in terms of time and space, but they diverge in terms of how these concepts are applied to practice.

3 Distributed Collaborative Learning: Three Cases

In this section we present the three empirical cases. We will focus on the perspectives behind design with respect to interactive and collaborative nature of the applied pedagogical approach, and briefly illuminate how the cases took place in practice. This will be further discussed and explored within the framework of theater (section 4).

The examples have certain features and conditions in common. They were all run by educational institutions with several years of practice in offering computer supported distributed collaborative learning. The organizational expectation to the three distributed, collaborative learning situations was flexibility in terms of time and place. CMC-applications were applied to support this organization. During the delivery process of the three courses, virtual communities (computer conferences) were created for discussions. The target group was adults in various work-situations, and their participation in the courses was a part of their further development related to daily work practice.

There were significant distinctions between the cases. The most outspoken of which were the interpretation of collaborative learning, and the educational and learning perspectives embedded in the tradition of the delivering institutions.

In agreement with the phenomenological paradigm, the intention with the investigation has been to understand and examine CSdCL as a *complete whole phenomenon*, and not to achieve brief knowledge of separated fragments. *Discussions* with the participants, in order to get insight in the subjective views and experiences, as well as *observations* and *analysis* of the collective actions taking place in virtual environments, were the main research method applied. In addition, we have both been involved occupying different roles[35] in relation to design, delivery, and evaluation. This, we think, provides a solid ground for a nuanced investigation of the interconnected nature of the phenomenon of CSdCL.

3.1 Case 1: Pedagogical Online Seminar

Pedagogical On-line Seminar (POS) was arranged and run by NKS Distance Education (partly in cooperation with the University of Oslo) as a part of the EC-project COSTEL (Course Systems for Telecommunicated Training of Trainees and Innovation Management). Since 1914, the variety of distance education courses offered by the NKS - designed with a basis in the correspondence tradition - have made lifelong learning possible, long before this became an

35 Both authors have been involved in the design, delivery and evaluation of the cases investigated. Elsebeth K. Sorensen was a guest lecturer, observator and evaluator of the OET case. She was also a participant, observator and evaluator of the POS case. Annita Fjuk was designer, organisator and evaluator of the POS case. Both authors have been supervisors at (distributed) collaborative projects at the University of Aalborg, and are currently involved in research activities within this area.

desired objective of the modern society. Since the second half of the 1980's, several courses and studies have been offered through distributed, collaborative learning environments.

The principal aim of POS was to give future consultants, teachers and educational administrators an appreciation of the strengths and weakness of the use of CMC-application in distributed collaborative learning environments (Fjuk and Jenssen, 1993). The actual number of participants was 26, mainly college and university teachers from the Scandinavian countries.

The foundation for design was the pedagogical and didactic principles of pedagogical seminars, taking place within an academic community. Seminars represent an active learning environment with the overall aim of creating discussions on scientific topics under professor- or expert guidance. Presentation of individual contributions or ideas connected to the overall topic, as well as discussing theory in relation to situations of practice, are activities usually found in seminars. Although the pedagogic principles of inter-personal interactions were considered important in POS, confrontations of perspectives and inter-human conflicts (Piaget), were not viewed to be fundamental to learning. It was more the Vygotskian view on collaboration between tutor and students as well as presentation of individual thoughts and reflections that dominated in the perspective behind design.

The inter-personal interactions took place in one virtual conference shared by the tutors, (POS) designers and the participants. The collective and individual activities of POS were planned and structured by the organizers and teachers in the design process. This was transformed to practice, in such a way that the two tutors (experts on distance education and CSdCL) had a central position in the virtual conference. In the beginning of each week, the tutors presented a summary of parts of the seminar literature (selected articles on distance education and CSdCL) associated with the planned theme. In addition, some issues from the articles were selected for discussion. The tutors' role was to follow up on the discussions with comments and further discussion topics.

In order to acquire experience and knowledge on the topic of using CMC-systems for collaborative learning situations, the participants were expected to take actively part in the discussions. The discussions were pulled off by contributions of good quality, in the sense that they expressed the results of serious, preceding reflections in relation to the readings. Each contribution to the

dialogue was often of considerable length. The dialogues, however, did not develop into interactive, dynamic discussions among the participants, and the general style of most of the contributions was one of written assignments (Sorensen, 1996).

The computer application was applied to mediate the communicative aspects of seminars. This approach on distributed collaborative learning understands the computer as a medium for some kind of joint activities, although it does not necessarily support collaborative activities much more than being a means for transmitting information.

The POS used the text-based conferencing system, PortaCOM, as the mediator of the interactional activities. The underlying metaphor behind the design of the interface is one of text and transfer of text, and of the processes of writing, sending and receiving texts (Sorensen, 1992).

3.2 Case 2: Online Education and Training

Online Education and Training (OET) was run in parallel to the POS course by the Open University and the University of London in collaboration. The Open University is a full time distance education based institution, established in 1967 by the British government. It is a nationwide university system with no resident students. It is large, well funded, and employs the fullest range of communications technologies to teach a full university undergraduate curriculum to adults (Moore and Kearsly, 1996). The principal aim of the OET course was to give students an appreciation of the strengths and weaknesses of the use of CMC-applications as teaching and learning media. The main emphasis in the course was on the potential of the virtual conferences for supporting inter-personal interaction and learning. During the course, students experienced a variety of different styles and ways of using CMC, including teacher-led, tightly moderated, conferences, online small-group work, inter-personal networking, peer review, and online guest lectures and seminars. By the end of the course, participants should be able to decide whether CMC presents an effective solution for some of their own training and education problems, and be able to apply concepts from the course to their own context (Sorensen and Kaye, 1992).

The course attracted 47 participants, from the UK, Australia, Iceland, Israel, Russia, Spain, and the USA, including university and polytechnic lecturers, school teachers, educational advisors, nursing trainers, a prison training officer, and

information technology and computing advisors. The course was divided into five modules, each lasting three weeks, and each with a different tutor/moderator responsible. The tutor set up and moderated the discussion environment on the CMC system for his or her module. One major conference was set up for the course, with one or more topics for each module of the course, and topics for socializing, practicing the system commands, project outlines, queries, and so on. Topics and conferences were added as and when the need arose.

The theoretical perspective behind the design of the course was centered around Vygotsky's view on the importance of peer learning and entailed 3 related assumptions with implications for the collaborative learning process (Sorensen and Kaye, 1992): 1) Meaning is social. A view on social activity as the ultimate foundation for intelligibility, existence and language (Winograd and Flores, 1986). The very fundamental concept of meaning is social and cannot be reduced to the meaning-giving activity of individual subjects. 2) The acquisition of knowledge does not take place in distant reflection within the inner world of a person, but in a fundamentally dynamic and social reality, where it is constructed through interactions with other people, and where individuals have primary access to the world through pragmatic, involved action (ibid.). Acquisition of knowledge can never be reduced to a question of transfer from one person to another, just as language cannot be understood as merely a system of symbols for transporting thoughts and information. 3) Linguistic interaction is fundamentally related to human existence. Humans are, fundamentally, linguistic creatures. Through language we act in a world constructed and constituted by language (ibid.).

As a consequence of this theoretical position, the potential of the CMC-application was viewed to be associated with at least three central aspects of the collaborative learning process: 1) learning through interaction with a group, 2) helping the learner to structure knowledge, and 3) making possible a certain level and type of social interaction among the participants (Sorensen and Kaye, 1992).

The OET experience was very dynamic and interactive. One of the key problems in managing the asynchronous conference environment is the maintenance of a satisfactory balance between too little activity and too much. In the case of the OET course, many participants felt obliged to spend far more than the estimated 100 hours on the course that the tutor team had planned. The interactive atmosphere was conducive to discussion and collaboration and seemed to stimulate a feeling of presence and debate. Often a very speech-like style of

language was used in the contributions. But, the course suffered from the problem of overload. This problem may, though, also have been associated with the size of the group.

The diverse structure of the virtual environment seemed to help the orientation and perception of the participants in terms of overviewing and separating the various parts of the content. Also, the occasional division of people into smaller groups seemed to have a positive effect with respect to the establishment of group identity and confidence in submitting entries. Also, the social forum was widely used and seemed to play an important role for the separated learners (Sorensen, 1994).

The conferencing system used was CoSy. A text-based and command-based system that, conceptually, in its interface metaphors, attempts to mirror to the user an already familiar world of communication as interaction.

3.3 Case 3: Problem-oriented Project Pedagogy

Problem-oriented project pedagogy (POPP) (Illeris, 1974; Illeris, 1981; Borgnakke, 1983; Adolfsen, 1985; Dirckinck-Holmfeld, 1990; Olsen, 1993) is the theoretical and practical foundation for institutional based collaborative learning environments at the Aalborg University (AAU).

Problem-oriented project pedagogy may to some degree be compared with problem-based learning and case-based learning. These approaches to collaborative learning are found appropriate because they provide contextual relevance of learning experience, and immerse the learner in the situation requiring her to acquire skills or knowledge in order to solve a problem or manipulate a situation (Jonassen et. al., 1993). In contrast to problem-based and case-based learning, problem-oriented project pedagogy views *critical reflections* on problems of practice —rather than *solving* tasks or problems pre-defined by an academic community—as a conditional principle of development of cognition. This builds upon the didactic principle of *problem orientation*. Critical reflection on problems does not, however, in itself form the foundation for learning and human development. Creativity, engagement and motivation are as important as problem orientation. In this respect, Illeris (1981) underlines *participant's control*. This means that the students should *own* the problem, *formulate* it, and *define* it. Critical reflections, creativity, engagement and motivation are necessary processes in order to penetrate the problem. The project is the organizational frame for

collaboration amongst peer-students. This builds upon the Piagetian view that learning most effectively takes place through interactive processes in which ideas and perspectives of the individuals are confronted, built upon and partly integrated in a common understanding. In agreement with the Vygotskian view, the individual student makes a contribution to the social development and thus indirectly to her own individual development. Learning is a result of full participation and involved actions in a collaborative arrangement. The final outcome of the collaborative process is a common project report. Each student project has a supervisor. Compared with the required engagement of the student, the role of the tutor is relatively passive.

From the second half of the 1980's, problem-oriented project pedagogy has been applied as foundation for CSdCL-design at AAU. An objective in these CSdCL situations, is that the computer should be the mediator in the peers' creation of a common collaborative environment, in order to achieve learning and producing a common final project report. This means that the computer application is not only supposed to occupy the mediating role in the transmission of information, but also a role in the coordination of individual contributions, the coordination of tasks and responsibility, and the role as a means for discussing, negotiating and reflecting on knowledge and individual experiences.

The application of this pedagogical method to distributed collaborative learning environments, has been identified as complicated (Dirckinck-Holmfeld, 1990; Dirckinck-Holmfeld and Lorentsen, 1990; Lorentsen, 1988; Georgsen, 1995). The empirical foundation of our investigation consists of ten years of practice and research conducted at the AAU, however focused and explored, for the present context, through one distributed project (Fjuk and Dirckinck-Holmfeld, 1996 a, b). The students were three women, with family and full time work. The overall aim of their project was *critical reflections on CSdCL*, based on problem-oriented project pedagogy. In other words, this student project studied their own learning situation critically, and through their critical analysis as well as through discussions with one of the authors (of this paper) they helped exploring some of the problems identified in earlier research (Dirckinck-Holmfeld, 1990; Dirckinck-Holmfeld and Lorentsen, 1990; Lorentsen, 1988; Georgsen, 1995).

Critical reflections and intensive cooperative work are demanding processes where engagement and commitment are critical factors. It was experienced that these critical factors meant extra work (instead of being experienced as a means

for developing cognition and learning) when taking place in a learning process realized through CSdCL. In a virtual collaborative environment, commitment and responsibility are manifested through the actors' written contributions. Discussions took place, but they did not end with a common consensus, because the students did not manage—or did not give priority—to negotiate and confront their individual perspectives and contributions. Although presented perspectives and thoughts from peers represented a cognitive conflict to the individual, it was much easier to accept them rather than using time and energy on critical open reflections, confrontations and cognitive restructuring (Fjuk and Dirckinck-Holmfeld, 1996 a, b). These features of the collaboration process had consequences for the project in general, but were most critical in the problem formulation phase. This phase forms the basis and the discussion platform for the entire common work.

In practice, the collaboration processes demonstrated a low level of dynamic, interactive processes. Also, the interaction was more like transmission and presentations of ideas and contributions.

The distributed problem-oriented projects used the conferencing system FirstClass as the mediator of the collaborative activities. Similar to PortaCOM, the information transmission paradigm of communication, seems to have been the focus behind the design of the technology, only in FirstClass it is not a general text metaphor, but a general mail metaphor that constitutes the point of departure for the design of the interface (Sorensen, 1991).

4 Theater: A Metaphor for Understanding and Design

In section three, we presented the collaborative learning approaches that frame the design of the three cases of CSdCL, and we illuminated the basic features of the interactive and collaborative activities that took place in each of the CSdCL cases. The cases indicate a varying degree of conflict between theoretical intentions in the CSdCL design, and the expected effects in the actual delivering process. The conflict is present in Pedagogical On-line Seminar (POS), but it appears to be even more outspoken and critical in the case of problem-oriented project pedagogy (POPP).

As we see it, this complexity of design and practice of CSdCL may be due to a weak integration of pedagogical, organizational, and technological aspects. The interpretation of *integration* is illustrated in figure 1.

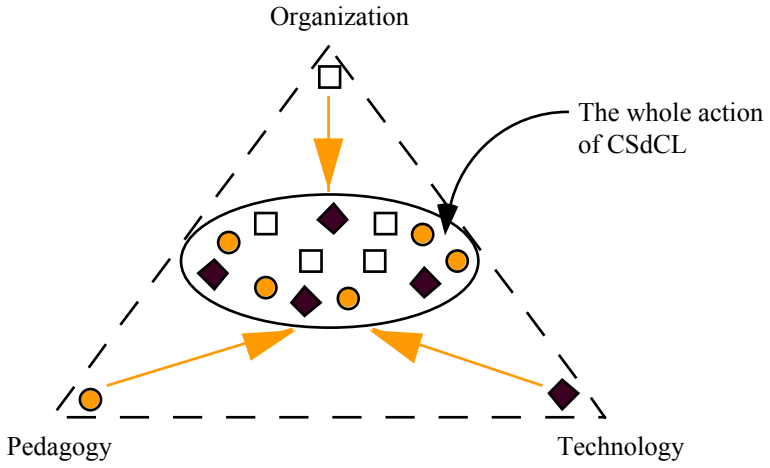

Figure 1: The integration of pedagogical, technological and organizational aspects

The corners of the triangle represent aspects of, respectively, organizational, pedagogical and technological features. *Organizational aspects* are related to the educational tradition embedded in the perspective of the delivering institution. In the POS example the tradition of the delivering institution was distance education, rooted in established methodologies of correspondence education. In the POPP example the tradition was problem-oriented project pedagogy, with confrontations of perspectives and a certain degree of peer interdependency as two fundamental principles. In the OET example, the tradition was built on a view to "employ the fullest range of communication technologies to teach a full university undergraduate curriculum to any adult who wanted such education" (Moore and Kearsley, 1996, p. 26). *Pedagogical aspects* are connected to theories and practice of collaborative learning, and to the roles which students and tutors are expected to fulfill due to the pedagogical approach. In the POS example, the pedagogical approach was academic seminar, and its interactive nature. In the POPP example, the pedagogical foundation was built on critical reflections and problem orientation, and the meaning of inter-human interaction to these didactic principles. And in the OET example, the approach was focused upon interaction through communication technologies. *The technological aspects* are connected to conditions and limitations of available technology.

In ‘Collins English Dictionary’, “to integrate” is defined as “to make or to be made into a whole”, and “integration” is defined as “the act of combining or adding parts to make a unified whole”. The concept of integration is analogues to a *holistic view* on a phenomenon, which means that the aspects of each corner are not static. Rather, they constitute a dynamic interrelationship with the aspects of the two other corners. Any change that happens in one part of the triangle, has an effect and consequence to other aspects of the same part of the triangle, and to aspects connected to the other parts. A holistic view on a phenomenon (such as CSdCL) starts with a complete wholeness of a situation, and seeks to explore those aspects (and interconnected aspects) that are *most critical* to the phenomenon.

The difference in the extent to which practice of the three cases actually reflects their individual theoretical basis, may indicate that a ‘holistic view’ on CSdCL as a phenomenon of its own has not been applied in design. Although a new mediating artifact has been brought into the picture, it seems that this - only to a limited extent - has spawned changes in the two other categories of aspects. It seems that most of the designs that dominate the computer-systems literature (e.g., DeMarco, 1978; Yourdon, 1986), are based on this kind of “bottom-up” approach. A typical bottom-up approach is to break “large complex problems into smaller less complex problems and then decomposes each of these smaller problems into even smaller problems, until the original problem has been expressed as some combination of many small solvable problems.” (Yourdon, 1986, p. 61). From viewing CSdCL designs in terms of these kinds of ‘separated fragments’, most designs do not address the interwoven, and complex nature of distributed collaborative learning.

In the following, we adopt the perspective that to design CSdCL situations which can be characterized by “quality” and “success” with respect to learning, we do not need fragmented metaphors to help the understanding of this challenge. We need metaphors that eliminate the borders between them. Such a metaphor, “the metaphor of drama”, for a holistic comprehension of the challenge of CSdCL design, will be presented in the following pages.

4.1 The Role of Metaphor

As a background for understanding the effect of the use of metaphors, this section deals with the role and function of metaphors in communication, the way it is interpreted within the existential-phenomenological tradition.

In the rationalistic tradition metaphors are viewed to function mostly as poetics, finery or rhetoric (Sorensen, 1991), quite in harmony with the view on the role of language as merely a means of description (without any social significance).

Within the existential-phenomenological understanding of the world the view on language is more fundamental, as language is viewed to be a dynamic, social and interactive phenomenon; - in other words, language is interpreted as a means of action (Sorensen, 1994). Adopting this understanding, metaphors and metaphorical concepts are not only a phenomenon of language alone, - they are also a part of the human cognitive system (Lakoff and Johnson, 1980). Human ways of thinking are for a large part metaphorical, as the human cognitive system is structured and defined metaphorically. The power of metaphor is centered around the fact that they structure how we perceive, how we think, and what we do. Metaphors permeate not only our entire language, but also our thoughts and actions; - metaphors move structures of consciousness (Sorensen, 1991).

There is no doubt, that the use of metaphors is one of the strongest communicative and transcending mechanisms of our language. It is so profound that it seems a relevant mechanism also to import into the virtual world. So far, however, it is mostly the area of systems design - in particular, interface design (Sorensen, 1991) - which has shown special interest in this unique communicative mechanism. When it comes to CSdCL design - designs that distend in the space defined by pedagogy, technology, and organization - it seems that we have not found (or have not tried to find) too many helpful and transcending metaphors. On the contrary, we seem to still be accepting to depart from the metaphors of the single pieces of fragments of which the CSdCL challenge is put together; - in other words, the partial metaphors of the pedagogy, the technology, and the organization. This is one principle matter of metaphorical thinking that may have constituted - and may still constitute - a serious obstacle for the creation of fruitful virtual learning environments.

In conclusion, the problem we are facing in design of CSdCL is not a loss in terms of decreased power and effect of metaphors, but rather a problem of *choosing the right metaphor*. A metaphor that allows us in CSdCL design to

depart from an understanding of CSdCL as a coherent and holistic phenomenon, instead of splitting it up and just keeping track of the various partial entities of which it consists.

4.2 The Idea of Theater

One of Aristotle's[36] many works, the 'Poetics', is a theory of drama which includes careful analysis of human action, speech and thought, as well as aspects of his wider philosophy. Aristotle described how drama is a representation (mimesis) of life, similarly to how language represents ideas. He argued that we can learn about reality from these representations in the way that we identify what is represented.

One of Aristotle's fundamental ideas is that drama is the representation of a complete whole action; - a holistic phenomenon with several incidents closely connected. This 'whole' has similarities to an organic whole:

> " An imitation of an action must represent one action, a complete whole, with its several incidents so closely connected that the transposal or withdrawal of any one of them will disjoin and dislocate the whole. For that which makes no perceptible differences or absence is no part of the whole". (Poetics)

Many theorists have amended Aristotle's Poetics on certain points. One of them, is Bertolt Brecht (Brecht, 1957), one of his epoch's most considerable dramatists. Another is Brenda Laurel (Laurel, 1991) who has brought the concepts of 'the whole action' into her alternative view on human-computer interaction. Brecht's view on the role of theater in society and life on the one hand, and Laurel's theatrical view on interface-design on the other, are significant points of departure for applying theater as metaphor for capturing the complexity of CSdCL design.

Brecht's basic view is that a play (which is a representation of reality) and reality stand in a particular and necessary relation to one another. For Brecht, theater is not only a place in which we can leave the world for a moment. It is also a place for reflection and cognition. Brecht wants to entertain the audience, but at the same time force them to independent thinking. He posited that a play is not completed until the spectator's reflection on the play has been integrated to her

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[36] Aristotle (384-322 B.C) was a student and the successor of the philosopher Plato, and he was the tutor to Alexander the Great.

social life (Brecht, 1957). The representation is not the same as real life, but may have effects and consequences for life and society.

Both theatrical design and CSdCL design, are aimed at creating representations of worlds that are like reality, only different. In our culture theories and practices of collaborative learning have neither been technologically, nor distance based. Collaboration and inter-human interaction are not, traditionally, phenomena born in the virtual worlds, but within institutionally based learning traditions in which the learners share time and place. The overall aim of CSdCL is to make use of the communicative potential of communication technologies, to design virtual collaborative learning situations, which - as we will see - differ from institutional based collaborative learning.

In agreement with Brecht's view on theater, participation in a distributed collaborative learning community has effects and consequences to reality. In a learning situation in which the learners are adult workers, their daily role is one of an employee. Once they engage into a CSdCL situation, their role changes. However, the employee- and the learner roles are interconnected, as actions and outcomes in the learning processes are brought into their daily situations, and vise versa.

According to Laurel (1991) design of the representation (in her case, the graphical interface) has to be based on the wholeness in which both human-, computer-generated- and other elements of the representational context, are interconnected. Using Laurel's interpretation, CSdCL design has to be considered in terms of a whole interconnected action, consisting of those pedagogical, technological and organizational aspects that influence and may have consequences for the collaboration process and the process of learning.

In order to structure the design of a play, Aristotle suggested six qualitative elements that have a certain relationship to each other. These elements are, in the following order*: action, character, thought, language, melody and spectacle*. The structure of these elements may be considered in terms of a hierarchy, with a certain relationship between them. Each element has a causal or material (technological) relationship to the elements above or below. Even though Aristotle emphasizes such a hierarchical structure as a tool for design of a play, design, additionally, has to explore the interwoven, non-hierarchical relationship between the elements.

In the following pages we explore the interwoven relationship using the three different cases of our investigation. In agreement with Aristotle, we will apply the hierarchical structure of the elements as a tool for approaching the challenge of design.

4.2.1 Character

> "Good characters are those who successfully fulfill their function—that is, those who successfully formulate thought into action". (Laurel, 1991, p. 50)

In a CSdCL situation, 'character' is related to roles of the actors (the learners, the tutors, etc.), and the mediating role of the computer-applications in the activities of the actors. This means that the concept of “good actors” must be connected with the expectations of the actors found in the theoretical basis and the pedagogical model.

The computer-application is ideally the mediator of those activities that are found important for building and maintaining the collaborative environment. If a computer application has the potential of fulfilling its role as mediator for the intended human activities, it may be characterized as “a good” application for the current model.

In collaborative learning theories the learner is viewed as the real actor of the situation. The roles are different in different collaborative learning models. In collaborative learning situations, based on problem-oriented project pedagogy, the learners are objectively interdependent on each other in the collaboration process (Fjuk and Dirckinck-Holmfeld, 1996 a, b). During the learners' common process of producing a final product, certain coordination and interactive activities are necessary. The didactic principles of problem-orientation, critical reflection and engagement, are the keys for learning and for developing a common learning environment. In such collaborative learning situations, commitment and mutual responsibility towards the peers, the collaborative processes, and the collaborative products, are pertinent requirements in order to fulfill the role as learner.

These requirements constituted a contradiction with practice in the POPP case (Fjuk and Dirckinck-Holmfeld, 1996b). The requirements implied extra work for the students, rather than forming a means for creating a common environment of learning. The typical 'non-knowledge-transfer' model of learning implies that the learners need to have collaborative skills, as well as appropriate technological

skills in order to take part in the collaboration process. Lack of such skills may appear as lack of engagement (i.e., they are not seen in the virtual environment). Collaboration is a time consuming and demanding process in itself, and even more so in an asynchronous, text-based environment (Fjuk and Dirckinck-Holmfeld, 1996b). The lack of immediate feedback (Eklundh, 1986), the written communication style and the dominating non-verbal situations (Sorensen, 1994), are well known for being obstacles for collaboration in such environments.

On the other hand, it is widely accepted that there is a clear learning value in the request of having to express thoughts into writing (Harasim, 1990). The text-based learning environment is essentially dependent on a clear and explicit articulation which involves meta-cognitive skills (expressing a thinking process by which a decision or conclusion is reached, or the strategy for accomplishing some tasks), and it is often through such process of explication that we become aware of what we think (Harasim, 1990; Sorensen, 1994). This request to operate at two cognitive levels may sometimes be considered as too demanding (Fjuk and Dirckinck-Holmfeld, 1996b).

So, fulfilling the role as collaborative actors, may indicate extra work for the learners. This experience of extra work may, though, have its roots in other aspects of the whole action, such as the technology applied or the pedagogical foundation (this will be illuminated through the elements of 'thought', 'melody' and 'spectacle'). It may also be related to the role of the supervisor, who - in problem-oriented project pedagogy - has a certain degree of responsibility for the project of the students (especially in the problem formulation phase). Fulfilling the role in terms of guiding and tutoring the collaborative process of problem formulation may also imply a contraction for the tutor, as the time and resources allocated (by the educational institution) for the fulfillment of this role is not sufficient to cover the extensive process of tutoring in distributed collaborative environments (Fjuk and Dirckinck-Holmfeld, 1996b).

Nonetheless, guiding, planning and structuring seems to be a must in fulfilling the tutor-role. This was taken into consideration in the design of the POS case. In agreement the tradition and practice of the delivering institution (distance education), the instructional aspect of the tutor's role was more outspoken (Fjuk, 1992), but at the same time the tutor was expected to fulfill also the role of a discussion partner. In practice the tutor presented summaries of the seminar-material, and initiated discussions on the basis of the summary. The tutors did not

fulfill the role as active discussion partners, their roles in practice were those of initiators and presenters. The participants did, though, contribute with extensive textual ideas, but collaborative discussions remained absent. Both the roles of tutors and learners were in practice more similar to their roles as they were practiced in the traditional correspondence education: The role of the student is to mail assignments to the tutor, and the role of the tutor is to give comments and guidelines for further studying.

In the OET example, the situation was different. It seems that a basic awareness in the design, of human existence as fundamentally social, and the importance of this as a basis in a learning process, were more outspoken. At any rate, the pedagogical integration of the communicative potential of the technology into the collaborative learning process was done at a more basic level, and with a strong focus on the *creation of interaction* as a basis for learning. This shared ambition of the course designers also penetrated the traditional roles of both the learners and the tutors. The tutors recognized the learners as equal participants in a shared activity and communicated this accordingly to them. Also, the tutors themselves moved from the role of being facilitators of knowledge in a distance education tradition to a new role of 'weaving' (Feenberg, 1989).

4.2.2 Thought

> "Inferred internal processes leading to choice: cognition, emotion, and reason". (Laurel, 1991, p. 50)

In a CSdCL-situation, 'thought' refers to conscious actions towards an immediate, defined goal. The actions may be collective and individual. Typical collective actions are; brainstorming, negotiations, consensus seeking, administrative coordination of tasks and responsibilities, technical coordination of individual contribution, etc. Individual actions are e.g., authoring, acquisition of knowledge through readings, mediation of ideas thoughts and perspectives, etc. The goals of the actions are e.g., a solution on a problem, a problem formulation, a common decision, a project report or parts to this, etc.

The actions, and their goals, are from a theoretical point of view the same in any artifact-mediated activity. However, the *methods* for carrying out the actions, and the concrete outcomes, are dominated by the conditions and the limitations embedded in the mediating artifact. Different technologies have (or lack) different varieties of operational functions to support these actions. Indirectly, thought

refers to the *conceptual link* between the potential in terms of action of the technology, and the pedagogical and didactic principles of the pedagogical approach.

We may say that CMC applications technologically are built from a general concept of information transfer. This functional view may be rather obvious in the design of the interface, or it may be replaced by more user-oriented concepts. In any case, CMC applications represent an interactive and collaborative view, defined upon and constrained by the concept of the interface, and the actions embedded in interaction- and collaboration will then have to submit to this frame of understanding.

The correspondence between the understanding of the functionality of the technology and the pedagogical understanding (i.e., the conceptual link), was strongest in the POS case, in the sense that both understandings more or less focused on collaboration as a phenomenon of 'transfer'. Even though more dynamic interactive processes than information transfer, were parts of the design focus, concrete, written contributions 'discussions' were the expected objectives of the collaboration process.

The conceptual correspondence between the technological design of the system and the understanding of collaboration was less outspoken in the case of distributed problem-oriented projects. The CMC system may be seen as placed in a collaboration situation beyond the boundaries of the underlying model of learning, as the students did not succeed in challenging each other's experience and knowledge (Dirckinck-Holmfeld, 1990; Georgsen, 1995; Fjuk and Dirckinck-Holmfeld, 1996a). In other words, the critical reflection, through confrontations leading to inner conflicts, did not appear. According to the students, 'groping and trying' can not be done through the written language, and they considered the quality of the decisions poorer due to interactive inertia caused by the asynchronous conditions of the interaction. Although a contribution, perspective or idea represented an inner conflict, the students did not resolve this, but overlooked it in order to speed up progression and get the work done. If they finally got a feedback that - again - brought up inner conflicts, they did not have the engagement and overview to carry out the necessary negotiations and discussions. As one of the students said: " It is very difficult to fly on each others chains of thoughts, and at the same time draw the lines and see the project as a whole". Also, overviewing the connection between the various contributions, and

distributing the work tasks and individual responsibilities appeared problematic, as the students did not manage to carry out in-depth discussions. Interpreted within the dramatic concept of ‘thought’, this indicate that the CMC application did not fulfill the role as a 'good character' in the way it was integrated in this model of learning. One explanation may be, that the POPP case did not consciously recognize—and design for—the important role of language and interaction in the electronic environment.

In the OET case the technical functionality did not induce an understanding of interaction and collaboration as a transmissive question. On the contrary, the concept clearly emphasized the idea of collaboration and interaction as shared experimental challenges. In contrast to the other two cases, the *integration* of pedagogical model and technological conditions, was considered at a more fundamental level, recognizing the social role of language and interactive learning, and the CMC application seemed to fulfill the role as a ‘good character’ in the OET case.

4.2.3 Language

> "The selection and arrangement of words; the use of language."
> (Laurel, 1991, p. 50)

In CSdCL, ‘language’ refers to the visible and hidden signs and language anchored in the learning environment, and how these have meanings for course material, roles and actions.

Language and the use of language are not neutral (Sorensen 1992). It reveals the understanding and interpretation of the views of the designer, and as we act in a world constructed and constituted by language, we influence— through the metaphors and the language we use— the views of the people with whom we interact (Lakoff and Johnson, 1980).

The course guides of POS and OET mirror the implicit understanding on the role that the technology is expected to occupy in practice (Sorensen, 1996). In other words, it mirrors the envisaged nature of the communicative acts that the system is expected to facilitate in the pedagogical process. This is shown in at least three ways (Sorensen, 1996):

First, it is reflected in the choice of language used to describe the expected roles and actions of the learners. In POS, the course guide described the expected collective actions of the participants as ‘reading’ and ‘writing’ activities, whereas

the OET course guide implied the idea of collective exploration through discussion.

Second, the form or composition of the linguistic description of human activity within a certain subject indicated which activities were viewed to be primary. In the descriptions of the OET course guide the readings appeared as ‘PS' which was assigned the role of providing inspiration for the main discussions. In POS however, the descriptions of the expected interaction were mirrored as secondary to the readings. This was further emphasized by the resumes which were entered at the beginning of every new subject and which attracted the focus of the participants (a factor which is likely to stimulate comments as responses directly on the reading and the resume).

Finally, the introductory descriptions of the aims of the courses indirectly indicated a corresponding difference in the expected level of collectively and interactively (and experimental character), as well as the views of the importance of this in relation to the acquisition of learning.

These features indicate that the language applied in the course materials might have influenced the actual actions of practice. Although the idea behind the design of POS, was collaboration and interaction, the language applied mirrors a perspective on learning more similarly to a correspondence model (Sorensen, 1996). The language applied indirectly invited the learner to engage in certain kinds of activities.

In the example of POPP, the pedagogical view is anchored in the delivering institution, and exists independently of the organization of learning. The language games of this pedagogical tradition dominate the whole learning context and educational environment. The institution’s usage of a CMC application to organize courses based on the idea of collaborative learning, logically creates an expectation in the learner that the application posses an operational functionality that can support the actions of the pedagogical form. If this is not the case, it clearly constitutes an obstacle for the participant in terms of fulfilling their role of an active participant in ‘the drama of learning’.

In the OET case the more fundamental level of the integration of technology and pedagogy also produced, linguistically, a more holistic and unified CSdCL situation. A situation where there seemed to be a higher degree of harmony between the fragments of which the CSdCL situation was composed.

4.2.4 Melody

> "Everything that is heard, but especially the melody of speech."
> (Laurel, 1991, 50)

The varying contrast between theory and practice in the three cases is explored through the roles of the actors and their expected actions, through the way in which the technology seems to have fulfilled the role as mediator of the actions, and through the way in which the language of design has influenced the actions in practice. In this section, we further explore how the *institutional tradition* has influenced design and practice of CSdCL.

In CSdCL, 'melody' refers to the perspectives embedded in the institutional tradition. 'Spectacle' (section 4. 2. 5) refers to the understandings and assumptions that form the perspective of the individual designer. There is, however, a close relationship between 'melody' and 'spectacle' in CSdCL design: The institutional tradition may impose frames for design in terms of specific pedagogical and didactic conditions, and in terms of economy and technological requirements. It is important to bear in mind, though, that CSdCL design contains a principle potential for changing factors embedded in the tradition.

In the case of POS, practice did not fulfill the intention of pedagogical seminars, and the participants did not feel a dependency on computer-mediated interaction. In fact, POS could have been run without the electronic possibility of interaction, with the exception of that part of the course which aimed at gaining hands-on experience with the system as a tool. A dependency on the system (without an alternative possibility for self study) may constitute one important factor in terms of establishing an interactive atmosphere (Sorensen, 1996). Both design and practice of POS were activities born within the boundaries of the correspondence tradition. Although this was not a conscious factor behind the design (Fjuk and Jenssen, 1993), this tradition probably, unintendedly, influenced the actual design product.

When it comes to the POPP case, the design perspective was - in contrast to both POS and OET—identical to the institutionally based tradition of collaborative learning. In the design, the special form of pedagogy has not spawned any rethinking directed towards the creation of a fertile, technological ground for the specific communicative needs of this pedagogy. The model of the established, institutional based modes has more or less directly, been transferred

to the virtual environment, without the necessary reflections on integration of the pedagogical and technological aspects. Although problem-oriented project pedagogy may be seen to have clear roots within the existential-phenomenological paradigm (section 2), the design of CSdCL— within this same pedagogy— does not seem to have dealt explicitly with this aspect. On the contrary, practice seems to have been based more on a rationalistic approach (i.e., an approach that accepts making 'objective' models of the world). To what extent this, relatively attractive, form of pedagogy, in practice— on a basis of more thorough and insightful integration— may prove to be suited for CSdCL, we shall leave as a challenge to pursue in the future.

Again, the experience from the OET case seems to differ from the other two cases. In OET there does not seem to be a major conflict between design theories and practices.

4.2.5 Spectacle

> "Everything that is seen." (Laurel, 1991, p. 50)

In design of CSdCL, 'spectacle' is centered around the designer's perspective, whilst 'melody' is concerned with the perspectives embedded in the institutional traditions.

Departing from an existential-phenomenological view, it clearly follows that a basis for design is an understanding of the meaning and aims of inter-personal interactions and collaboration with respect to learning. Additionally, it demonstrates the importance of knowing the conditions and limitations of available technology to the pedagogical approach, and how the computer application affects the interactive and collaborative processes.

The cases of our analysis, indicate a difference in the extent to which the designers consciously approached this challenge of design.

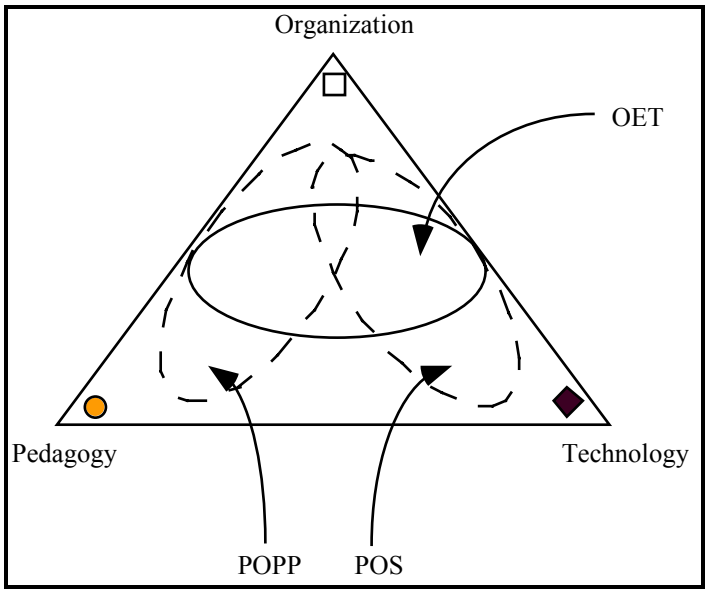

Figure 2: The dominating aspects in the design of the three cases.

Figure 2 illustrates the dominating aspects in the CSdCL design of the three cases. In the POPP case, the pedagogical- and organizational aspects dominated, e.g., the delivering institution's tradition of collaborative learning was directly applied as pedagogical model to new collaborative learning situations, without serious reflections on the technology's 'distance-based' nature and conditions for collective actions. In this case, CSdCL was interpreted as a much more demanding alternative compared to institutionally based collaborative learning situations. The general problems found in this pedagogical form when carried out in traditional modes, became *more visible* when carried out as CSdCL.

In the POS case, the CSdCL design seemed to be dominated by technological- and organizational aspects. Similarly to the POPP case, the delivering institution's tradition unconsciously dominated design. The communicative nature of the CMC-applications has much in common with letter-writing, and as such, the technological aspects was in harmony with the correspondence thinking. We may say that the design and practice of POS as a case of CSdCL did not mirror a qualitative change in the experience of learning at a distance.

Compared to the other cases, the design of OET seemed to be more placed within a holistic perspective on design (as suggested in the introduction of this section, and illustrated in figure 1). It is obvious that this case represented a

stronger relation between the theoretical foundations for design and the practice of CSdCL, than the other two cases. The more collective emphasis of the course as an experiment everybody (both teachers and learners) could learn from, together with the more consistently transcended roles of the characters (student, learners, the environment) and the high degree of willingness of the institution to support a new experiment, seemed, in many ways, to produce a more holistic and unified CSdCL process. Such a design perspective is probably a direct consequence of the fundamental philosophy of the delivering institution, namely to apply modern communication technology to various pedagogical approaches. The institution has nicely integrated aspects traditionally found in distance education and aspects from collaborative learning—such as inter-human interaction—with the limitations and possibility of the available technology.

Design is a demanding process in which a certain extent of *transcendence* is necessary. Critical reflections, creativity, engagement and motivation are conditional activities, in order to explore and identify the interwoven relationship between character, thought, language, melody and spectacle. There is no doubt that this transcendence should be considered within principles of established traditions modified and rethought to new situations. Rethinking pedagogical and didactic principles and applying them *into completely new situations*, is a cooperative process in which practitioners from different disciplines need to take actively part. In order to explore and structure the complexity of CSdCL as an interdisciplinary, collective activity, Fjuk and Øgrim (1997) suggest *dialectical analysis*. Dialectical analysis is used to describe and understand the wholeness of complex phenomena in terms of identifying the most critical aspects of a CSdCL situation. The identified aspects are further interpreted as dialectical contradictions, and discussed amongst the participants taking part in CSdCL-design. Activities and attitudes that earlier were taken for granted, are illuminated and the designers (the participants) become aware of aspects that may be hidden due to simplicity or familiarity (ibid.).

At any case, this is a resource demanding activity in terms of both money and people. The available (allocated) resources at the delivering organization are vital, as they may impose obstacles for the challenge of CSdCL design. In other words, we need new and *transcending visions* and *support* from the institutions engaging into the process of CSdCL design and delivery.

5 Concluding Remarks

Today—and in the future—the challenges of educational designs will be framed by the conditions imposed by a society based on lifelong learning. Especially, this need is found within the area of continuing education and competence development for adults, with limited possibility to follow institutional-based learning due to commitments, both in relation to work and social life. The communicative potential of different communication technologies in combination with the increasing emphasis on collaborative learning approaches, has during the last years been considered as promising with respect to design and organization of flexible learning. Especially, asynchronous computer-mediated communication (CMC)-applications have been considered promising with respect to providing flexibility in terms of both time and space. Traditionally, in our culture, theories and practices of collaborative learning have not unfolded on a technological basis or in an educational organization, independent of time and space, but is rooted in situations in which the learners and tutors are sharing both time and place. Nonetheless, it seems beyond any doubt, that a *distributed* collaborative learning situation established through communication technology (CSdCL) represents a promising educational potential precisely in terms of the societal need for flexibility,—now and in the future.

Many experiences of CSdCL, however, clearly demonstrate, that the 'transfer' of collaborative learning processes from being traditional, institutional based phenomena to becoming virtual, distributed phenomena mediated by communication technology, has been far too simplified. Compared to traditional collaborative learning situations, distributed collaborative learning situations have become even more blurred because of a weak correspondence between interpretations of collaborative learning in design, and the resulting CSdCL situation. This may be a result of a weak consciousness of the designer in terms of her fundamental perspective and understanding of the underlying theoretical assumptions and their related human roles and actions. A conscious approach is vital in order to make the process of design, delivery and evaluation a qualitatively progressive and fruitful activity, that will continuously spawn improved CSdCL designs.

The weak correlation between theory and practice appear to be most outspoken in CSdCL situations that emphasize critical reflections through dynamic and

confronting interactive processes together with a high degree of commitment and mutual responsibilities amongst peers.

Design of CSdCL has been carried out under the implicit assumption that the learning environment and framework are invariable factors in CSdCL design. What we need, is to review and analyze not only our implicit theoretical assumptions, but also the new educational environment and its communicative potential, in order to understand and define *new conditions* into which we are integrating our learning situations. Finally, as pleaded for here, we need, in this new approach, to understand CSdCL, not as a learning situation established from fragments of entities of technology, organization and pedagogy, but as a holistic phenomenon, requiring a new perspective that is able to capture its holistic nature.

The metaphor of drama offers such a perspective. Like theatrical design, CSdCL design aims at creating representations of situations that are like reality, only different, and similar to the Aristotelian concept, 'the whole action,' CSdCL—despite its fragmented material—should be considered a holistic phenomenon. The interwoven nature of 'the whole action' is analogues to a view on CSdCL design as an integrated activity manipulating the wholeness of those pedagogical, organizational and technological aspects that influence the collaborative learning process.

In applying theater as metaphor, we have explored and put into focus some critical aspects of CSdCL design:

- CSdCL design is not a 'left-hand' activity. It cannot be easily applied as an 'add-on' phenomenon in a traditional educational institution. It requires resources at several levels (money, time and people).
- CSdCL design has to depart from a fundamental theoretical understanding and awareness around the interactive conditions in an asynchronous and text-based environment, and from a conscious view on the roles of interaction and collaboration in collaborative learning.
- CSdCL design needs to find a balance between tradition (experiences of practice) and transcendence.
- CSdCL design has to depart from a holistic perspective, capturing the entire *expected* and *new* roles and actions on behalf of the actors (students, teachers).

- The language of CSdCL design needs to submit to the rules of the language games of ‘the play’—the pedagogical approach of distributed collaborative learning.

Understanding CSdCL in terms of an integrated wholeness, does not make the actual practical challenge appear too much simpler. So far, we know that the need for reflective considerations on past practices is essential, and that it is only through analysis of actual delivering processes spawning continuos re-designs that good CSdCL situations are born. There are also clear indications that these analysis and evaluations must go hand in hand with a basic theoretical understanding of design perspective as well as a clear and conscious view on how learning takes place. What, in addition to this, we plead for here, as a pertinent and transcending factor in terms of guiding CSdCL designs towards success, is a holistic view on the whole action of learning as it may unfold, synchronously, on a stage in the theater of lifelong learning.

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The Dichotomy of Distributed Collaborative Learning - Approached through Dialectical Analysis

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Abstract

Designing distributed collaborative learning situations of good quality is a complicated problem. The problem is identified into a dichotomy of aspects, historically found in the traditions of distance education and collaborative learning respectively. In order to improve good conditions for learning, we suggest that the contradictory aspects of these traditions need to be considered more thoroughly than up till now.

Keywords — Computer-mediated communication (CMC), collaborative learning, contradictions, dialectical analysis.

1 Introduction

Computer support for distributed collaborative learning (CSdCL) represents a complex problem area of educational practice and research. CSdCL aims at designing good pedagogical conditions for learning, through collaboration among geographically dispersed peer-students.

In this paper, CSdCL is interpreted into a dichotomy. This dichotomy contains aspects that historically have been characterized by two significant different traditions of education: distance education and collaborative learning. In contrast to distance education, the approaches to collaborative learning are all built on inter-personal interactions as critical means to active development of cognition. The approaches all assume co-presence of the students and teachers, and a certain degree of peer-interdependence in order to participate in joint activities. Also, collaborative learning has historically been neither distance- nor telecommunication-based.

Pairs of aspects, such as peer-interdependence/independence, shared place/flexibility with respects to place, pacing/unpacing, social learning process/individual learning process, represent a challenge for CSdCL-design aimed at delivering educational programs of good quality.

In this paper, we seek to identify the fundamental aspects of this dichotomy, and further examine them in terms of dialectical contradictions. Dialectical contradictions are appropriate means to explore the mutual interdependence between the central aspects, which also may constitute conflicts.

Our investigation is empirically based on a study conducted at two educational institutions. The process of identifying the critical aspects, interpreting them as contradictions, is carried out through structured discussions arranged at the both sites. Both institutions use text-based and asynchronous computer-mediated communication applications as means for collaborative learning activities at the distance. The institutions differ significantly with respect to the dichotomy as the one represents the distance education tradition and the other represents a socio-constructivist approach to collaborative learning. The different pedagogical traditions, as well as their different motives of CSdCL activity, guide their interpretations on the problems of CSdCL.

The structure of the paper is: In section 2 we illuminate the problem area, and present the research approach applied in the study. In section 3 we present and discuss the contradictions of the two CSdCL situations.

2 Making collaborative learning distributed

Distance education is an old tradition of designing and delivering educational programs based on physical distance between students and teacher. Thus,

communication mediating artifacts have a central role in the information exchange and communication between the involved actors (Moore and Kearsley, 1996). In order to organize learning situations of good quality, design is aimed at developing guided, often rigorous, study programs and tasks for individual reflection and problem solving. The pacing[37] is in the end left to the individual student.

When it comes to the other tradition of the dichotomy, the socio-constructivist perspectives of psychology—with its roots in Vygotsky's ideas of human development (Vygotsky, 1978)—have received renewed interests (Bruffee, 1993; Koshmann, 1994). 'Situated learning' (Lave and Wenger, 1991), 'problem-oriented project pedagogy' (Illeris, 1981; Dirckinck-Holmfeld, 1995), 'learning by expanding' (Engeström, 1987), 'problem-based learning' (Koschmann et. al., 1994), 'case-based learning' (Jonassen et. al., 1993), are all inspired by the socio-constructivist approach to active development of cognition. Central to these approaches is that the personal process of learning and the social processes of collaboration are mutually constitutive. Active development of cognition is achieved through social negotiations and confrontations of the individuals' creation of meaning. The individual makes a contribution to the social development and thus indirectly to her own individual development (Engeström, 1987). As a result of this practice, the students are viewed as the true sources of learning, rather than considered as passive recipients of information.

In agreement with a socio-constructivist perspective, the basis for CSdCL-design is an understanding of the *meaning* and *aims* of inter-personal interactions and collaboration with respect to the development of cognition. In making collaborative learning distributed, the communication mediating artifacts play an important role both in individual and collective activities at distance. The tendency of practice seems however to focus too much on the features of the technology per se, and not on cognition developing activities, and how the artifacts influence them (Bannon, 1995). Thus, we will argue, design should also be based on an understanding and identification of how external factors, such as the artifacts, affect the collaborative processes.

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[37] Pacing implies meeting deadlines for starting course, assignments and exmainations. These deadlines can be flexible or rigid (Paulsen, 1992, p. 61)

2.1 Research Approach

We rely on a socio-contructionist (phenomenological) research approach in order to explore the critical aspects of the dichotomy. Such approaches aim at understanding and explaining complexity, instability, uniqueness and socially constructed factors, such as human beliefs and attitudes, behaviors, perceptions and values (Schön 1983; Easterby-Smith et. al., 1991). This contrasts the more traditional scientific approach of positivism. In agreement with the socio-contructionist research approach, CSdCL-designers' tasks are to filter the critical aspects out of a problematic and complex situation, not necessarily to solve the problems of the situation.

In this respect, dialectical analysis is promising as it aims at describing and understanding the totality of complex situations and phenomena in terms of contradictions. In our investigation, we have applied a technique–Soft Dialectics (Bratteteig and Øgrim, 1994)–that combines the analytical strength of dialectical analysis (Øgrim, 1993) with the creativity and spontaneity of drawing 'rich pictures' (Checkland, 1981; Checkland and Scholes, 1990). The technique was used in cooperation with involved actors at both sites of study—teachers, educational practitioners and researchers, computer scientists, students and management.

In this paper, we present the results of the analysis—the identified dialectical contradictions.

3 The identified contradictions

In this section we explore and discuss the aspects identified as critical at two different CSdCL sites. NKS Distance Education (NKS) has historically aimed at designing courses based on techniques and principles from the correspondence tradition. Aalborg University (AAU) is based on the political and philosophical ideals of problem-oriented project pedagogy. Pedagogical design has traditionally been aimed at organizing good conditions for collaboration with respect to the central principles of the pedagogical foundation.

3.1 CSdCL at Aalborg University

Problem-oriented project pedagogy is fundamentally aimed at educating the students to critically reflect on problems of society (Illeris, 1974; Illeris, 1981; Adolfsen, 1985; Borgnakke, 1983; Dirckinck-Holmfeld, 1990; Olsen, 1993). The focused problem to be reflected upon is not defined in terms of academic disciplines. Rather the problem is defined and formulated through collaboration amongst the peers. Learning through critical reflective activities is a demanding process in which creativity, engagement and motivation are fundamental properties that must be held by the participants (Illeris, 1974; Illeris, 1981). The learning process is organized as collaborative arrangements in projects, also aimed at producing a final project report.

Since the second half of the 1980s, this pedagogical foundation is the basis for research and delivery of CSdCL. The computer application holds the mediating role in the process of articulating individual contributions, tasks and responsibility, as well as being a means for discussions, negotiations and reflections on knowledge and individual experiences. Thus, the rationale of this institution is to apply the central principles of problem-oriented projects in making collaborative learning distributed.

Compared to the pedagogical and didactic principles and to the expected outcome of the CSdCL activity, CSdCL has been identified as a complex problem area (Dirckinck-Holmfeld, 1990; Georgsen, 1995). In order to organize good conditions for learning through distributed problem-oriented projects, there was a need to explore the most critical aspects of this relative new practice.

3.1.1 The critical aspects

Commitment was identified as a fundamental human property in the students' common process of creating a collaborative arrangement (Fjuk and Dirckinck-Holmfeld, 1996a). Commitment implies tolerance and trust to the peer actors, to their knowledge and contributions. It implies responsibility to the project—both from the adviser and among the peer learners. And further, it implies engagement toward the problem and objective of the project.

In the distributed collaborative processes commitment challenges the socio-constructivist ideal of problem-oriented projects. The fundamental contradiction identified was: The relation between *development of cognition* and *distributed collaboration.*

This relation implies that the distributed collaborative arrangement (a computer conference) is the organizational frame for cognition developing activities at the distance. The expected roles as responsible and engaged participants seemed not to be fulfilled by the students (Fjuk and Dirckinck-Holmfeld, 1996a), as the collaborative arrangements are characterized by a lack of visible contributions and dialogues.

The students experienced that their processes of fulfilling their roles implied extra work—rather than a means for developing cognition (Fjuk and Dirckinck-Holmfeld, 1996b). Even if a contribution, perspective or idea represented an inner conflict, the students tended not to resolve this, but instead to overlook it for the sake of progression. They also considered the quality of their decisions too weak with respect to a clear definition on the problem, and so was their process of coordinating tasks and responsibility.

Critical reflection on problems is a time consuming and demanding process in itself, and even more so in an asynchronous, text-based environment. The lack of immediate feedback (Eklundh, 1986), the written communication style and the dominating non-verbal situations (Sorensen, 1994), are well known as obstacles for collaboration in such environments. Also, the students need collaborative and meta-cognitive skills in order to articulate thoughts and knowledge precisely for peers. When applying text-based and asynchronous communication applications, these skills are even more important (Harasim, 1990).

Our investigation indicates that the ideals of problem orientation and critical reflections implied a cumbersome situation for the students. The necessary and expected roles of commitment are fundamental to create a common arrangement, to develop cognition and to the mental perception of belonging to a wider university community. This fundamental problem, has created an educational research question whether problem-oriented project pedagogy is a too idealistic philosophy as foundation for CSdCL design and practice (Fjuk and Dirckinck-Holmfeld, 1996 a,b; Fjuk and Sorensen, 1996)—no matter what kind of distance based technology applied.

3.2 CSdCL at the NKS

NKS Distance Education has offered a variety of distance education courses since 1914. A challenge of course design has historically been to integrate

correspondence based methodologies with available media such as video and audio cassettes, television and radio programs, telex, telephone meetings, etc.

Since the second half of the 1980's, university level programs within finance, management and administrative computer processing, have been offered through distributed collaborative learning environments. The overall motive with the CSdCL activity is to deliver learning situations combining the socio-emotional aspects of collaborative learning with the key concept of flexibility. Earlier research has shown that the practice of CSdCL clearly has the socio-emotional benefits of motivation (Fjuk and Jenssen, 1993; Fjuk, 1992), but has not resulted in fundamental and qualitative new learning situations (cf. Sorensen, 1996). Methodologies and principles developed through more traditional forms of distance education—such as planned programs and individual studies—have heavily influenced the practice of CSdCL (cf. Fjuk and Sorensen, 1996), and joint activities are not considered as basic features in design. Compared to earlier design practice, CSdCL has lacked a serious integration of new artifacts with good pedagogical models. The CMC-applications have been considered as 'add-on' to an established tradition of correspondence.

An exploration of the most critical aspects connected to a 'non-add-on-perspective' was considered important in order to meet the new challenges in developing CSdCL situations of good quality.

3.2.1 The critical aspects

At AAU, commitment was identified as a central concept to describe the problematic situation. At the NKS, integration—or the lack of integration—was considered as a challenge for design. Integration was interpreted in terms a unified whole, in which the communication mediated artifact will imply changes in work tasks, pedagogical principles, roles, etc.

Internet services, such as the World Wide Web, e-mail and newsgroups, were emphasized as the appropriate technological means for CSdCL. This was mainly based on their opportunities for flexible communications with respect to time and place, but also their considerable meaning with respect to marketing.

Two dialectical contradictions were identified as critical with respect to the integration of Internet services and pedagogical thinking:

- The relation between the *distance education and collaborative learning*.
- The relation between *entertainment* and *development of cognition*.

The first contradiction is a fundamental one, and is directly related to the dichotomy of CSdCL. The CSdCL situation at Aalborg University clearly demonstrates this contradiction. The central principles of problem-oriented projects imply certain properties of the involved actors that are demanding and complicated to fulfill at distance. Problems identified at NKS were of a different nature from those at the AAU. AAU is aimed at designing CSdCL situations based on the pedagogical tradition. NKS is aimed at integrating available communication technology with good pedagogical models, with the fundamental rationale of creating income. These different motives heavily influence the institutions' interpretations of the problem area.

An early pilot study identified some of the problems of combining the approaches of collaborative learning and distance education (Søby, 1990; Fjuk and Jenssen, 1993). The students were fascinated by the communicative opportunities of the conferencing system—in terms of question-and-answers—free from time- and place constraints. On the other hand, joint activities and peer-interdependence implied conflicts with the individual progression in the study and the students' expectations of their roles (Fjuk and Jenssen, 1993). (Fjuk 1992) shows that the design of well-planned studying programs—designed for independent students—make participation in computer conferences superfluous, because the programs are sufficient guides and resources for the individual development of cognition. This constitutes a contradiction, both with respect to the idea of making distance education more social and with respect to the income. The earlier studies also demonstrate that the students should be made aware of their roles early in the educational program.

The second contradiction was directly connected to the Internet, and to the mental imaginations and interpretations that people have to the Internet and its application to learning. First, this contradiction explores the cognitive benefits that playing and entertainment have to learning. Bertolt Brecht (Brecht, 1957)—one of his epoch’s most considerable dramatists—has much to offer in this respect. Brecht's basic view is that a theater is not only a place in which we can leave the world for a moment—to have fun. It is also a place for reflection and cognition. Brecht wants to entertain the audience, but at the same time force them to independent thinking. He posited that a play is not completed until the spectator's reflection on the play has been integrated to her social life.

Entertainment and development of cognition are close connected—learning is both a funny and a serious matter.

Designing CSdCL situations of good pedagogical quality—based on Internet services—implies a conflict. To some people, Internet has become a cyberspace in which young boys are surfing around, or a place for distributing pornographic or nazi propaganda. Thus, Internet has created a mental picture that has little in common with serious organized forms of learning and education—at the one hand as a medium for entertainment and leisure activities, and on the other a medium for criminal activities. Audio- and video cassettes as well as television- and radio programs, may very well be associated with the same features. In contrast to Internet these more established media have been integrated as pedagogical means since the late 1960's (Nipper, 1989). And according to Bates (1993) several years pass from the introduction of a technology until it is positively integrated in distance educational models.

Also, the new media may imply new contradictory roles—both with respect to learners and teachers. The Internet services are based on information transmission and -presentation. This may create an illusion analogues to the 'direct transfer' models of learning, in which the teacher is assumed to be the sole source of knowledge and skills, and the learners are considered as passive recipients of information (Harasim, 1990)—similar to a performance and movie. Such an interpretation of the learners' and teachers' role is fundamentally in conflict with the socio-constructivist psychology of human development and collaborative learning.

On the other hand, compared to traditional correspondence, Internet has the potential of 'immediate response', which in turn may create an illusion of the teacher as an 'on-line resource'—available on the net 24 hours (c.f. Fjuk, 1992). Such an expected role, may conflict with one of the NKS' major objectives of Internet—to create income. The teacher's role, as an active and participating contributor, implies more fees.

In relation to the fundamental concept of integration and the motive of creating income, CSdCL has to be aimed at creating collaborative arrangements allowing the learners to reflect on problems related to *their daily work* situations. From a pedagogical point of view, the philosophy of problem-oriented projects is appropriate in this respect, both in terms of project as a work method and in terms of the problem orientation. However, learning from research and practice from

AAU, the central principles of this pedagogical view have to be seriously reconsidered in terms of the limitations and conditions of the Internet services.

Such an approach to collaborative learning is less appropriate in learning situations aimed at educating students on an undergraduate level. Such a target group does not have the sufficient common background in order to critically reflect upon a relative unknown problem area. Also, the students in such distance educational situations seldom know each other before collaborating. The approach is, however, more appropriate to learning situations based on 'on-the-job-training.'

4 Concluding Discussion

In this paper we have sought to explore the fundamental contradictions of making collaborative learning distributed. Two fundamental contradictions were identified as critical with respect to approaching and designing CSdCL of good quality:

- The relation between cognitive development and distributed collaboration.
- The relation between the distance education and collaborative learning.

The contradictions were identified on basis of two different motives and traditions of CSdCL. The first contradiction was identified as fundamental when approaching problem-oriented projects at a distance. The other was identified with the motive of fully integrating available technology with appropriate pedagogical models, fundamentally with the purpose of generating income.

Both contradictions are characterizing CSdCL as a phenomenon in terms of the dichotomy. But, the different motives and traditions of the delivering institutions guided the interpretation of them differently.

The first contradiction, may challenge the applications of socio-constructivist views on learning in a distributed situation, as it focuses the pedagogical benefits of distributed collaboration. Socio-constructivist approaches fundamentally relying on peer-interdependence and dynamic interactional processes, seem to be cumbersome foundations for good CSdCL practice. The required expectations of individuals' responsibility to create and maintain a collaborative arrangement is too demanding and complicated at distance. The pair of the dichotomy focusing on shared place/flexibility with respect to place, represents an unsolved problem for CSdCL and is thus a challenge for new pedagogical designs.

The other identified contradiction, is close related to the first one. The other pairs of the dichotomy, peer-interdependence/independence and pacing/unpacing were the basis for this one. In order to organize good collaborative learning situations, these pairs clearly challenge the ideal of distance education, i.e., to offer the adult work force opportunities for further education and competence development. This target group needs flexible educational programs—independent of peers and collective progression in the study—allowing them to combine job, family and education (Paulsen, 1992).

The overall motive of generating income was emphasized by one of the institutions. Lack of income as well as lack of resources with respect of money and people, might be a hindrance of designing new learning situations of good quality. Pedagogical design, aimed at creative reconsideration of pedagogical principles, of the teachers' and students' roles, as well as carefully examinations of technological conditions, is a resource demanding activity. Both institutions have missed creative and reflective thinking with respect to the new technology. They have both been influenced by their own tradition of the dichotomy, and not taken aspects of the other into serious consideration (Cf. Fjuk and Øgrim, 1997). The practice of CSdCL seems to be characterized by an unreflective transmission of established models and techniques into a new virtual learning environment. As we have seen, such design practice may have consequences for the students' benefits of collaboration at the distance. In the NKS case, participation in the virtual environment has been considered superfluous, caused by the well prepared studying programs—ironically developed for individual studies. In the Aalborg case, participation in the distributed collaborative learning community is even more demanding compared to the traditional modes.

In interpreting the aspects of the dichotomy in terms of dialectical contradictions, it seems that the distance-based nature of the communication mediated artifacts and the fundamental aspect of physical co-presence in collaborative learning approaches, is the most critical unsolved problem of CSdCL. In making collaborative learning distributed, the following principles has to be thoroughly considered:

1. With respect to problem-oriented project pedagogy, the principle of critical reflections on problems has to be considered less ambitiously.

2. The collaborative actors should initially have a certain degree of experience on the focused problem area, and have a professional motive of examining the problem.
3. New problem formulations must be elaborated in a shared context in terms of time and place.
4. The collaborative actors should know each other.
5. The learners' and the adviser's role should be clarified by the designers, and informed to the actors.
6. The principles of students' control should be seriously combined with special guiding and tutoring techniques.

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Towards transcendent thinking in design of distributed collaborative learning environments

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Abstract

Studies conducted at two educational institutions—each rooted in the traditions of distance education and collaborative learning—indicate that principles and methods from these traditions have been directly transformed and adjusted to distributed collaborative learning situations. Based on the Scandinavian critical tradition on system development, we argue for another position: Pedagogical design and systems design should explicitly seek to view the tension between tradition and transcendence. This is applied in a prototyping process discussed: The process was aimed at building on and transcending perspectives related both to distance education and collaborative learning.

1 Introduction

Computer Supported distributed Collaborative Learning (CSdCL) is a new phenomenon of learning and education (Mason and Kaye, 1990; Harasim, 1990; Kaye, 1992; Harasim et. al., 1995; Schnase and Cunnius, 1995; O´Malley, 1995; CSCL Bibliography). CSdCL aims at improving good pedagogical conditions for

learning, through collaboration among geographically dispersed peer-students. CSdCL has its theoretical and practical foundation in the intersection between distance education and collaborative learning (Fjuk and Dirckinck-Holmfeld, 1997).

CSdCL has clear educational potentials with respect to the international political strategies on life-long learning (European Commission, 1994). It gives adults opportunities to take part in further educational programs—independent of where they live and work, and with collaborative work methods analogous to daily work practice.

Studies conducted at two Scandinavian educational institutions, and undertaken by the first author, indicate that design and practice of distributed collaborative learning environments is a complex challenge. The two institutions—the Norwegian NKS Distance Education and the Danish Aalborg University—each has ten years of practice in designing and delivering courses based on CSdCL. Both institutions have applied asynchronous and text-based computer-mediated communication (CMC) systems as technological means. The two institutions differ significantly with respect to their organizational frames of learning, as they represent two different traditions of education and learning: Distance education and collaborative learning.

Based on these studies, we discuss the problem of creative and innovative design of CSdCL environments. We build on the understanding of the Scandinavian critical tradition of system development. In this tradition, dialectical analysis has played a central role (Ehn, 1988; Stage, 1989; Bjerknes, 1989; Øgrim, 1993). Especially, the dialectical contradiction—or the tension—between tradition and transcendence is emphasized in systems design. As system developers, it is our duty to think new, and to creative innovative solutions. Still, the new solutions have to relate to the organizational practice if they are to be used. Thus, the tension of transcending traditions can be interpreted as the core of our work as system developers.

With basis in this tradition, we argue that the tension between tradition and transcendence is fundamental also for the design of distributed collaborative learning environments of good quality. Both pedagogical design and systems design have to consider the possible interaction between traditional perspectives and the new opportunities and conditions of available technology. Only through

comprehension of traditional perspectives and existing methods is it possible to extend and apply them effectively in new situations.

Based on this view, a project was undertaken by the University of Oslo and the Norwegian NKS Distance Education in cooperation. The systems design process of the project built on principles from; 1) distance education. Flexibility in terms of where and when to study constitute the core. The computer system's availability from homes at a minor cost is an approach to flexibility. 2) a social-constructivist view on learning which underlines socially based negotiation and knowledge construction. In this context, we argue that systems design is more than transforming the understanding of physical co-presence. Rather it is about to offer means for social memberships and committed actions.

The paper is structured as follows: In section 2 we introduce the theoretical positions behind distributed collaborative learning. In section 3 the main findings from our studies are presented, especially with respect to their short comings. In section 4 we introduce the theory on tradition and transcendence. In section 5, we discuss—with basis in the studies—the tension between tradition and transcendence in the process of designing a CSdCL system based on Internet-services.

2 Theoretical positions behind distributed collaborative learning

> "[D]istance education offers students opportunities to study entirely individually what, when and where it suits them, to start and finish when they want to, to submit assignments and communicate with the distance teaching organisation at any time, and generally to adapt their study to the conditions of adult life, including job, family and social commitments. In such cases the courses and the tuition address the individual, not a group. The student may have chosen a unique combination of courses and may work at a speed that is quicker or slower than that any other student. " (Holmberg, 1993, p. 333)

Historically, distance education has emphasized the situations of individual adults and flexibility in terms of when, where and what to study. Designs of courses have thus been aimed at creating planned learning programs in order to guide the

students through a learning process geographically separated from the teacher. Special instructional techniques are required, and also special organizational and administrative arrangements (Moore and Kearsley, 1996). Although distance education has its basis in correspondence thinking, it represents an evolutionary approach that is historically linked and influenced by the development and availability of other communication technologies (Ljoså, 1993; Nipper, 1989). In contrast, collaborative learning has historically neither been distance based nor technology based. The fundamental assumption is physical co-presence of peer-learners and teachers. Collaborative learning is particularly appropriate for adult learners in the process of life-long learning, as it applies to the practice of work (Bruffee, 1993; Dirckinck-Holmfeld, 1995; Engeström, 1987). Problem solving and problem orientation in projects are work methods that have become more appropriate in a continuos changing society. Collaborative learning approaches which are built on projects and cases, are especially interesting in this respect. Such approaches immerse the learner in a situation where knowledge is acquired not for its own sake, but in order to reflect on a problem or a phenomenon, to solve it or to manipulate the situation (Jonassen et. al., 1993). Reflective actions are necessary especially in exceptional situations of work (Engeström, 1987).

The understanding of computer support for distributed collaborative learning (CSdCL) applied in this paper, is placed in the intersection between these two traditions; distance education and collaborative learning. CSdCL has aspects in common with both involved traditions (see e.g., the argumentation made by Harasim (1990)). The key concept of flexibility in terms of when and where to study, is inherited from the tradition of distance education. The role of mediating communication has certain aspects in common with both distance education and approaches to collaborative learning: text-based communication with distance education and interaction processes between students with the collaborative learning approaches.

In the next section we will describe briefly the theoretical position of collaborative learning taken in this paper.

2.1 The social-constructivistic approach to collaborative learning

Our understanding of collaborative learning, is based on the Russian psychologist Lev. S. Vygotsky's fundamental view on human development (Vygotsky, 1978). Central to Vygotsky's, and later Leontjev's (1983) work, is that artefacts—such as

language, writings, diagrams, maps, mechanical drawings, and now computer systems—have inseparable roles in action as they serve as means to acquire, construct and retrieve different kinds of knowledge and performance. According to Leontjev (1983), whose work is commonly accepted as in the core of activity theory, every action is consciously related to a goal. How the actions are performed and realized is however conditioned by the applied artifact. Leont'ev (1978) puts it in this way:

> "Obviously, a tool is a material object in which are crystallized methods and operations, and not actions or goals. For example, a material object may be physically taken apart by means of various tools each of which determines the method of carrying out the given action." (p. 65).

Related to CSdCL situations, pure text-based e-mail systems and high band-width multimedia systems, clearly have different impacts on how the actions are carried out, and the results of the operation.

The artefact of language has a critical meaning to learning as it mediates dialogues between individuals. The dialogues between individuals are the key to social construction of meaning, and thus to learning and human development:

> "[I]t is the internalization of social speech into inner speech, that is, the ability to engage in a socially appropriate dialogue with oneself, that allows one to plan and monitor cognitive progress. Inner speech, Vygotsky maintains, is developed by participating in social dialogue." (Knuth and Cunningham, 1993, p. 171-172).

The core of this matter is found in the zone of proximal development, which is about effective knowledge construction

> "determined through problem solving under adult guidance or in collaboration with more capable peers." (Vygotsky, 1978, p. 86).

The individualistic constructive process takes place by interpreting new information and experience in terms of prior knowledge, existing beliefs and perspectives. Learning is a result of deeper analyses, rather than 'surface analyses' (Jonassen, et. al., 1993). According to Jonassen et. al. (1993),

> "the most effective learning contexts are those which are problem- or case-based, that immerse the learner in the situation requiring him or her to acquire skills or knowledge in order to solve the problem or manipulate the situation." (p. 235).

The most effective learning, that which is most meaningful and creates motivation, involves real-world tasks and problems. A common understanding between the actors is a result of social negotiation of meaning. This allows the learner to alternative viewpoints and interpretations that challenge her initial understanding. This in turn may result in deeper analyses of prior knowledge and experience. Learning is thus a process in which the individualistic knowledge construction and the social negotiation of meaning, are mutually constitutive. The individual learner makes a contribution to the socially created collaborative environment—such as a project—and thus indirectly to her own construction of knowledge.

A rather common interpretation takes the zone of proximal development as a rationale for creating situations in which instructional support is given to the child (Engeström, 1987). The notion of 'scaffolding' is a result of such an interpretation. Vygotsky may be interpreted in a broader context, i.e., collaboration with more competent peers. Thus, collaborative knowledge construction environments enable members of groups and projects to contribute their interpretations, and to reconcile multiple perspectives, beliefs and experience in order to solve or reflect upon problems and tasks. The socially based confrontations and negotiations are thus centered around the collaborative processes taken place between learners, with different competence areas and knowledge. This interpretation of the zone, forms the basis for the theoretical positions of this paper.

3 Design and practice of CSdCL environments

In this section we present two examples of collaborative knowledge constructive environments, developed by geographically dispersed students by the application of text-based CMC-systems. The two examples are designed and delivered by two educational institutions, with their roots in distance education and collaborative learning, respectively. Both institutions were aimed at using CMC-systems as the mediating artefact, in order to support individual flexibility in terms of when and

where to take part in the collaborative environment. In both focused cases, the students were novices or low experienced users of CMC. Also, CMC was used to discuss CMC as such to distributed learning and education.

3.1 Distributed Problem-oriented Projects (dPOP)

Problem-oriented project pedagogy (Illeris, 1981; Borgnakke, 1983; Adolfsen, 1985) has its basis in a social-constructivistic view, but integrates approaches of experiential learning (Kolb, 1984; Olesen, 1985). Problem-oriented project pedagogy is the institutional profile of Aalborg University (AAU) and Roskilde University in Denmark.

Critical reflection on a (scientific) problem or a phenomenon in society is the didactic, basic principle. At the same time critical reflection contributes to problem-oriented project pedagogy arguably being a more demanding form of learning than the approaches focusing on the solving of a given problem. This means that the students are the true owners of the problem. Thus, the students are collaboratively responsible for a problem formulation defined through social negotiation.

Creativity and engagement are fundamental human properties in order to create a common, clear and realistic problem formulation and to be able to critically reflect upon it during the collaborative processes. In order to produce a common product—a project report—and to create a common collaborative environment, commitment among the peers is fundamental. Since the middle of the 1980s, this collaborative method has been the basis of CSdCL at the AAU. The pedagogical design has been aimed at applying the concepts of social negotiation and collaborative knowledge construction to distributed situations. An objective is that CMC-systems should be the mediator in the peers' creation of a common collaborative environment, as well as their process of producing a project report. The CMC-system is supposed to hold the mediating role in coordination of contributions and responsibility, as well as being a means for discussions, negotiations and reflections on knowledge and experience. The practice of distributed problem-oriented projects (dPOP) has been identified as complicated. A considerable problem, compared to the individual students' benefits and to a social-constructivistic perspective, is that the students do not succeed in challenging each other's experience and knowledge (Dirckinck-Holmfeld, 1990; Georgsen, 1995; Fjuk and Dirckinck-Holmfeld, 1997). In this paper we will

briefly focus upon this problem area through an exploratory experiment undertaken by the first author (see Fjuk and Dirckinck-Holmfeld, 1997).

In the experiment, engagement, creativity and commitment are viewed as extra work, rather than as means for collaborative construction of knowledge (Fjuk and Dirckinck-Holmfeld, 1997). In contrast to the pedagogical philosophy, collaboratively based critical reflections through confrontation and negotiation, seem not to appear. If exchange of contributions, thoughts and ideas, brings up inner contradictions the students do not have the engagement and overview to carry out the necessary negotiations and deeper analyses. This can be seen in the distributed environment by a lack of individual written contributions, which in turn may be interpreted as a lack of engagement and commitment.

The students that participated in the exploratory experiment used drawings as a thinking tool to structure knowledge and interpretation, as well as to generate ideas. The processes of presenting them for the peers, became a problem because of incompatibility between drawing programs. The students then had to formulate thoughts in terms of the written language, which in some situations make the process of idea- and knowledge construction demanding.

Also, overviewing the connection between contributions, and distributing the work tasks and individual responsibilities appeared as problematic, since the students did not manage to reach common decisions (Fjuk and Dirckinck-Holmfeld, 1997).

The CMC-system applied is the widely applied FirstClass. The focus behind the design of the technology, seems to be that of a information transmission paradigm of communication. A general mail metaphor constitutes the point of departure for the design of the interface (Sorensen, 1991).

The CMC-system may be seen as placed in a collaboration situation beyond the boundaries of the underlying model of learning. The distance- and text-based nature of the CMC-system does not in any strong sense support the dynamic and interactive processes of social negotiation. To this is added, the mutual constitutive processes between individual knowledge construction and social negotiation of meaning, seem to be a problem of practice due to problems of software incompatibility.

3.2 Distributed Pedagogical Seminar (dPS)

Since 1914, a variety of distance education courses have been offered by the Norwegian NKS Distance Education (NKS). Pedagogical design has been dominated by correspondence thinking, influenced by the historic development of a variety of media (audio and video cassettes, television and radio, telex, telephone, etc.). Since the second half of the 1980's, several courses and studies have been offered through distributed, collaborative learning situations. In this paper, we highlight the design and practice of distributed pedagogical seminars (dPS) (Fjuk and Jenssen, 1993; Sorensen, 1996; Fjuk and Sorensen, 1997). The actual number of participants was 26, mainly college and university teachers from the Scandinavian countries.

Pedagogical seminars represent an active learning environment with the overall aim of creating discussions on scientific topics under professor- or expert guidance. Presentation of individual contributions or ideas connected to the overall topic, as well as the application of theory on situations of practice, are activities usually found in seminars. Although the learning benefits of interaction processes were considered important in dPS, social negotiations were not considered as so fundamental to learning as in the dPOP example. Rather, dialogues between tutor and students as well as presentation of individual thoughts and reflections, were dominating perspectives in the pedagogical design.

The two tutors (experts on distance education and CSdCL) had a central position in the distributed environment. In the beginning of each week of the seminar (the total duration was 11 weeks), the tutor's role was to make summary of parts of the literature associated with the planned theme. Also, some issues from the articles were selected for discussion. The tutors' role was to follow up on the discussions with comments and further discussion topics.

Seen from a distance education perspective, dPS was considered a success (Fjuk and Jenssen, 1993). But, seen from a collaborative learning perspective, the tradition of correspondence education seems to have strongly influenced the pedagogical design (Sorensen, 1996; Fjuk and Sorensen, 1997). The course guide described the expected collective activities of the participants as 'reading' and 'writing,' and not directly in terms of joint activities (Sorensen, 1996). Joint activities involving social negotiation, were by the designers mirrored secondarily to the readings. This unconsciously mirrored the collective activities that took place (Sorensen, 1996; Fjuk and Sorensen, 1997). The dialogues that took place

did not develop into dynamic discussions among the participants. The contributions represented seriously, preceding reflections on the selected articles. The general style of the contributions was written assignments—a feature in common with the tradition of distance education (Sorensen, 1996).

The learners used the text-based conferencing system PortaCOM, as the mediator of individual and collaborative activities. The underlying metaphor behind the design of the interface is one of text and transfer of text, and of the processes of writing, sending and receiving texts (Sorensen, 1991). Thus, the correspondence between the CMC-system and the pedagogical understanding, was quite strong in the sense that both focused on collaboration as a phenomenon of 'information transfer and presentation.'

The learners participated in the dPS experienced analogous practical problems as the students at AAU, i.e., problems related to software incompatibility. When a learner was to contribute to the discussions, she was often required to shift to a special editor and leave the word processor normally used for composing letter, writing reports, etc. This means that the computer system did not support in any sufficient way the fluent meshing between the individual activity of articulating her own thought to writings, and the social based activity of presenting and negotiating on them for peers.

4 Understanding change: The tension between tradition and transcendence

Mathiassen (1981) distinguishes between three different types of change, which may illustrate the practice of CSdCL: adjustment, transformation and transcendence. Adjustment is the simplest form, and denotes the replacement of elements in a situation with new elements of the same type. An example is the substitution of traditional correspondence with electronic mail in distance education. The communicative nature of electronic mail (and text-based CMC-systems in general) has much in common with letter-writing, both with respect to the process of writing itself, and to some extent the mechanical process of transfer (Sorensen, 1996). If electronic mail represents a function similar to what letters do in the pedagogical thinking, the new situation does not necessarily imply a qualitatively new learning situation with respect to the tradition of distance education.

We interpret dPS as an adjustment of distance education. Compared to the tradition of distance education the seminar represented a change, as collaboration amongst students was introduced. But, the delivering institution's tradition unconsciously dominated pedagogical design. The dPS design process seems to be highly influenced by the tradition of distance education, and lacked the necessary reflective and creative activities of how to interpret the useful aspects of this tradition into distributed collaborative learning situations. Compared to distance education, dPS did not represent a qualitatively new phenomenon of learning. In practice, the CMC-system did only occupy a role as an electronic post office and as such dPS represents adjustment to the tradition of distance education. Transformation means replacement of elements with new ones, but with other properties. An example might be to enhance a text-based computer conferencing system with multimedia elements in order to simulate collaborative situations with physically present actors. An other example may be to introduce a computer conferencing system in collaborative learning situations traditionally taking place on campus. The introduction and enhancement of the technology do not in any strong sense influence the other elements. The traditional elements and their relation are still present, and the new artefact represents a role as an 'add-on' to these.

We interpret dPOP as a transformation of POP. Compared to institutional based POP, dPOP represents a change as a new artefact was introduced to mediate the individually and collaboratively based actions. Quite contrary, the collaborative method seems to have been directly transformed to distributed environments. The pedagogical design seems to have missed considerable reflections on the new properties and limitations with respect to POP, resulting in more complicated collaborative situations. The general problems found in POP become more visible and obvious in dPOP situations as the students do not manage to establish a common understanding through social negotiation. This is especially critical in the problem formulation process, aimed at creating a common understanding of a focused approach to a problem. Transcendence is the most complicated and challenging type of change. Change of this type means that the relation between the elements of a situation is changed, so that the organisation of it is abolished. An example is to fully integrate a new artefact in a learning situation, in such a way that routines, work tasks and roles of the teachers, students and administrative staff are changed. The relation between the elements of the

established situation is changed, and a totally new situation is created. Transcendence thus means to create something new, something extraordinary or exceptional. Creativity (thinking new) and innovation (acting new) are both parts of transcendence. Design of CSdCL environments entirely based on transcendence, might lead to creative use of new technology, but without the fundamental reflection on the educational context and pedagogical approaches.

Stating that transcendence is related to change, tradition must be related to the opposite. Tradition can be defined as a domain of perspectives and attitudes shared by a community or group, evolved over time.

In design related to CSdCL three different sets of traditions are involved:

1. The result of design is going to be used in an educational institution. The tradition of the institution is often articulated in didactic and pedagogical principles, administrative routines, economic frames, etc. The pedagogical designers and systems designers are responsible to these aspects and for seriously considering them with respect to new situations.
2. The actors of the collaborative learning environment, the students, have needs and attitudes with respect to their own learning. The designers have to analyze the present and future student groups in order to tailor the product to their work practice, general needs and styles of learning. Pedagogical methods with similarities to work practice—such as project work—have benefits to adult learning (Bruffee, 1993). When it comes to styles of learning, however, Fjuk (1993) concludes that CSdCL may suffer from the fact that the adults are used to other learning styles than collaboration.
3. Knowledge and skills established within the tradition of information systems research and development, need to be taken fully into account in CSdCL design. In this paper, we will rest our understanding on systems design and development on the Scandinavian, critical tradition in academic system development.

The Scandinavian, critical tradition in academic system development is characterized by multi-perspective reflection, user participation and situated design (Bansler, 1989; Bjerknes and Bratteteig, 1987; Bødker et. al., 1987; Greenbaum and Kyng, 1991). These three major elements of the tradition are tied together. Perspectives owned by the future users and perspectives owned by the systems designers are negotiated in order to design qualitatively good media and

tools for the work practice. The practitioners of the systems development tradition and the practitioners of the work practice develop systems solutions through collaboration. The belief in situated design is based in the understanding of system development as an uncertain and complex process, a process that can only partly be granulated and planned in details (Andersen et. al., 1990). Dialectical theory has a strong position within this tradition, since dialectics can support both multi perspective thinking and the understanding of change (cf. Mathiassen, 1981; Ehn, 1988; Stage, 1989; Bjerknes, 1989; Øgrim, 1993). In addition, activity theory, also based on dialectics, has a strong position within this tradition (Christiansen, 1988; Bødker, 1991; Kuutti, 1994).

The tension—or dialectical relation—between tradition and transcendence is basic in every design situation (Stage, 1989; Øgrim, 1993; Ehn, 1988; 1993). Design is a creative and transcendent process, which is characterized as research and learning resulting in new insight, development and implementation of new ideas. Creative and new thinking, is fundamentally dependent on the knowledge, experiences and principles established within a tradition of practice. Technological imagination is impossible, or at least difficult, without knowledge of existing technology and its possibilities and limitations. Analogously, new thinking about CSdCL is fundamentally dependent on an understanding and insight of principles of both collaborative- and distance learning. But, creativity is more than knowing established principles. Creativity is also applying the principles in completely new situations. When the designers have achieved insight in the frames of a tradition, they will be able to move away from them and form new practices through creative activities. Creativity thus also transcends rationality. Creativity can be practiced, but the creative ideas in turn are caught and treated with logical thinking based on, and transcending the tradition (Øgrim, 93).

On the other hand, the frames evolved in a tradition may prevent creative activities. Established routines, human attitudes, economic frames, the availability of technology, the cost of technology, etc. are well known barriers for creative and transcendent thinking with respect of CSdCL (Bates, 1995).

5 Designing collaborative learning environments through the World Wide Web

With basis in the problem area of CSdCL, a pilot project was initiated by Department of Informatics (University of Oslo) and NKS Distance Education. The overall objective of the project was to contribute to a transcendent thinking towards integrating the principles lying at the root of distance education and a social-constructivistic view on learning. Flexibility in terms of where and when to study was seen as a fundamental criterion for good design. Delivery to homes has historically been the best way to support this flexibility (Bates, 1995). Also, accessibility with respect to cost and technology is an important condition to keep the democratic ideals of everyone's right to education and competence development.

In order to design a computer system supposed to be an appropriate means for distributed collaborative knowledge construction environments, the tension between tradition and transcendence was emphasized in both pedagogical design and systems design. The pedagogical design and systems design were conducted in parallel, because the design processes have impact on each other. In this paper we will exclusively discuss the systems design process. The design approach was prototyping, and the idea was to consider the most critical factors of both traditions into consideration. The process is more thoroughly described and discussed in Berge (1997).

User participation became a problem as potential students were cited geographically all over Norway. However, the various versions of the prototype were applied in different contexts: Earlier versions of the system were applied and evaluated by graduate students of informatics at the University of Oslo and students of informatics at the Polytechnical College (in Norway). The application of the system was a voluntary offer to the students' collective activities usually taken place on-campus. The students had, in terms of their study, a professional interest to evaluate the system for further design and implementation. Although these students did not represent the assumed target group of the system, their critical evaluation and re-design suggestions, were valuable for further systems developments. The version, which is presented in this paper, was applied in a different context that the two others: The users were employees at the NKS, but participating as students in a course, aimed at training project management.

In section 5. 1. we set the scene for the new challenges and opportunities with respect to creative design in which Internet-based services are the technological platform. In section 5. 2. we discuss the tension between metaphors currently applied in systems design, and strongly argue for an action-oriented approach. In section 5. 3. we present how the design process has been transformed to a prototype developed in the pilot project—Dynamix. Dynamix is an example of a computer system developed to support transcendence in systems design and CSdCL.

5.1 Challenges and opportunities for systems development

A basic assumption for institutional based collaborative environments, is the individual learner's awareness of the peers' interpretations and perspectives (see Dourish and Bellotti, 1992; Gutwin et. al., 1995). Awareness of the peer learners' activities and progress is essential for the learner's commitment and engagement, with respect to both course of action and social negotiations.

In institutional based learning situations, in which the learners have frequently opportunities to share place and time, they

> "(...) maintain this awareness by tracking information such as other learners' location in the shared workspace, their actions, the interaction history, and their intentions. Workspace awareness is necessary for effective collaborative work, but also plays an integral part in how well an environment creates opportunities for collaborative learning. " (Gutwin et. al., 1995, p. 147).

In CSdCL situations, however, this type of awareness must be consciously and explicitly sought, as the physical distance between the collaborating learners reduces the implicit awareness physical co-presence implies (Fjuk and Dirckinck-Holmfeld, 1997). The dPOP case is particularly an example of this. The learner’s explicit role as a responsible and engaged actor in the social negotiations, was by the learners viewed as time-consuming extra-work rather than a necessary aspect of the collaborative knowledge construction environment. Also, the cases indicate that the applied CMC-systems did not appear as means to support what Gutwin et. al. (1995) term concept awareness, i.e., awareness of how peer learners' interpretation and perspectives fit into the learner's prior knowledge. Because of software incompatibility, the processes of developing common understandings and a common learning environment, became a problem to concept awareness.

The cases thus indicate that the applied computer systems did not effectively support the learner's need for an individual thinking tool on the one side, (in terms of articulating inner thoughts to written words and drawings) and a means for social negotiation of meaning on the other. This leads us to an overall aim of offering the learners a computer system that (together with other artefacts) mediates actions related to both (individual) thought processes and the collaborative like processes, without hampering the alternation between them (Fjuk et. al., 1995).

Researchers within the CSCL community (Gutwin et. al., 1995) and the CSCW community (Dourish and Bellotti, 1992; Bellotti and Bly, 1996; Palfreyman and Rodden, 1996) have contributed to design and implementation of computer systems aimed at supporting awareness. But, an assumption for these suggested solutions seems to be a common availability of technologies, based on networks with higher bandwidth than accessible from most homes (examples are video-conferencing and multimedia applications). Thus, these categories of technology often constitute a strong discriminator for distributed learning situations in which homes are the work place.

In the nearest future Internet services, including the World Wide Web (WWW), seem to constitute a promising point of departure. Similar to computer conferencing systems, Internet offers flexibility with respect to when and where to connect a node in the net. The relatively low cost combined with increasing availability, seems to fulfill the criteria of access and cost.

The development and growth of WWW have during the last years widened people's access to Internet. We have seen its growth from an item of academic novelty to major international business and education. This has altered the way in which we think about learning situations (KUF, 1995), but also systems development (Palfreyman and Rodden, 1996). One common feature with the two presented cases, is that incompatibility of software caused problems for the processes of collaborative knowledge construction. In all its generality, this may be a problem, related to the students' lack of technical skills. Nevertheless, the software incompatibility has caused serious problems for system developers who must pay close attention to issues of heterogeneous machines, networks and software. One significant lesson learned from the WWW is that heterogeneity needs to be accepted as a norm (Palfreyman and Rodden, 1996) in the today's emphasis on groupware and 'virtual' organizations. The WWW seems to offer

huge potential to integration of external applications across Macintosh, PC and UNIX platforms and the students' practical problems of software incompatibility might be reduced compared to the former widely applied computer conferencing systems. It thus seems that WWW supports the technological and economic conditions found critical to organize distributed collaborative environments.

5.2 The tension between the two traditions

It seems that the Internet-services, accessed through the WWW, support the fundamental criteria of distance education. But what about the other end of the involved traditions, collaborative learning? In a social-constructivistic view on learning, how does the WWW support social awareness and social negotiation? In approaching these questions, we build on Vygotsky's (1978) and Leontjev's (1983) interpretation of artefact mediated action combined with the concept of "social worlds" developed in the interactionist school of sociology (Strauss, 1978; 1993, Clarke, 1991).

According to Clarke (1991) social worlds are "groups with shared commitments to certain activities, sharing resources of many kinds to achieve their goals, and building shared ideologies about how to go about their business" (p. 131, cited in Strauss (1993)). Any social world is an interactive arrangement that arises when a number of individuals strive to act in some collective way. Central to Strauss' interpretation of social worlds, is that membership of social world is not determined by geography or organizational boundaries, but constrained by the *limits* of effective communication (our emphasis). Following Strauss, this implies needs for means that appropriately mediate actions involved in social negotiations.

A relatively common interpretation is that WWW is a means for presenting and linking documents across the world. The traditional usage of the WWW has been searching, browsing and retrieving information as well as making information available for others. WWW offers a huge potential for presenting the individual student's thoughts and ideas. Also, Jonassen et. al. (1993) argue that hypertext and browsing are good examples of contructivistic learning environments, "because acquiring knowledge from hypertext requires the user to engage in constructivistic learning processes" (p. 237). Browsing represents a kind of thinking tool, as "it engages the learner in tasks that facilitate knowledge construction." (p. 237). But, this 'document-driven' approach does not necessarily

provide support for collaborative activities including joint authoring, common and annotate documents (Bentley et. al., 1995), social negotiation of knowledge including processes like consensus seeking and conflict resolution. Presenting thoughts written or graphically as well as browsing, are inherently individual actions and is only one part of the collaboratively constructed learning environment.

Quite contradictory to the document-driven metaphor dominating WWW, rather associated with institutional based collaboration, is that the WWW is presented as a '(cyber)space' and information is gathered by 'navigation in space'. This is particularly present by the Netscape Navigator browser, which has a rudder as an icon.

Our understanding of action and behavior related to the physical social worlds is transformed as basis for computer systems design. Many designers have used spatial coordinates or graphical renderings of rooms, doors, blackboards, shelves, etc. in systems design. One example is the desktop metaphor of single-user systems. These systems are aimed at simulating our understanding of work and work environments by facilitating the properties of the three-dimension world. Folders on a desktop are good examples. The folders are archives or containers of files and documents, but they have additional properties that are not drawn or transformed from our understanding of work. The folders allow us to sort their contents by name, date and other criteria and the same document can be put in the two folders at once. But, as Nelson (1990) argues, the 'desktop metaphor' "doesn't look like a desktop; we have to tell the beginners how it looks like a desktop (...)".

Other examples of application of spatial metaphors, are the MUDs and MOOs, which have gained an increased popularity in educational contexts (Cherny, 1995; Fanderclai, 1995; Lindeman, 1995) through the explosion on interests in Internet. The structures of the MUDs are dominated by locations or rooms in which the participants' actions and interactions take place. Participants are moving from location to location in text-based, supplemented with simple graphical, interactive environments. This simulation of co-presence in meetings, may be helpful in learning situations in which school teaching of pupils in classrooms is the overall objective (Fanderclai, 1995). Contradictory, project-based learning situations in which adult workers have the position of being learners, spatial metaphors do not necessarily have any strong impact for learning. Many of the actions performed in projects are conducted by individuals in other social worlds than the collaborative

environment as such—at home, at work, on the train, in the elevator, etc. Membership in one social world influences memberships in others (Strauss, 1993). And learning follwoing Leontjev (1983), the conditions of the artefact available in the social worlds influence how the actions are performed.

Although collaborative learning is a socially based learning approach, most actions are thus carried out isolated from peers. The actions are resources for and results from social negotiation in the social learning environment. The action and its immediate meaning are influenced by the collaborative learning environment the learner is committed to. A qualitatively good learning environment, aimed at educating adults, is rather about memberships and commitments to social worlds, and the actions carried out in this respect. Computational equivalents of physical domains—interpreted by spatial metaphors in systems design—are not rejected by Strauss' interpretation of social worlds (Fizpatrick et. al., 1995). The interpretation of social worlds combined with Leontjev's and Vygotsky's artefact-mediated actions, pleads for means allowing the users to carry out actions appropriately and effectively in order to collaboratively create a social world of learning.

The desktop metaphor and the room metaphors dominating MUDs and MOOs are aimed at simulating our understanding of non-computerized social worlds. The problem with the metaphors is that they are like the well-known social worlds only different. The strength of interface metaphors is their value in helping the users to learn how to use the system. Sooner or later this will break down. The systems are no longer regarded in terms of metaphors, but as a tool in its own right. Interactions with and through computer systems, are real actions carried out by real people. Computerized social worlds are not virtual worlds, but real worlds.

To make an analogy - watching sports on TV gives a totally different experience than being present at the arena. Physical presence gives the atmosphere, the feeling of belonging to a community of supporters, the possibility to shout, freeze and almost touch the athletes. TV watching gives something totally different: overview, comments, re-issues, studies of style, and so on. One can not say which of the two is best - they are different. Good TV programs do not necessarily simulate physical presence for the watchers. We believe learning and teaching can be seen as an analogy: physical presence is not necessarily the ideal. Space metaphors may not be especially useful as long as the systems are text based. The users have to *imagine* the rooms, doors and so on. Rather, the

conditions for carrying out the actions are critical. When virtual reality-like applications are more common on the WWW, spatial metaphors may become more useful.

5.3 Dynamix—an example

The design process of Dynamix is presented to highlight the tension of tradition and transcendence in practice. In the presentation, we will highlight the shortcomings and the challenges in the process. The Dynamix prototype was developed as an experiment to design computer support for collaborative learning situations over distance. In order to increase the learner's awareness in the interaction processes of knowledge confrontation and negotiation, each project or group of learners should be provided with;

- an own domain, rather than an open one characterizing the WWW
- a computer system (together with other artefacts) that mediates actions involved in the individual thinking process as well as actions involved in social confrontations and negotiations of meaning, without hampering the alternation between them.

Services available via Internet—such as e-mail, news groups, chat, Web-pages—were aimed at being offered through a common WWW interface, in such a way that the services together constitute an appropriate means for collaborative construction of knowledge organized as projects.

The resulting prototype, Dynamix, is an example of such an interface developed through the browser Netscape Navigator (at least version 2. 0). CGI (Common Gateway Interface) scripts were chosen for implementing the system (Berge, 1997). CGI-scripts were written in Perl (Practical Extraction and Report Language) as it enables quick (further) development of prototypes.

The overall approach to the design process was action-oriented. This means that the language applied in the user interface should indicate a mapping between actions related to collaboration in projects and the services offered to support them. Thus the interface was aimed at giving the learner an intuitive indication of how to perform what actions. What services applied should be dependent on the learner and her actions at time, and what services the individual learner felt confident with for performing the particular action. The interface was categorized into three aspects related to collaboration in projects: *Communication*,

Administration and *Distribution*, which may be viewed on the opening WWW-page (Username: anonymous, Password: guest).

By selecting *Communication* the learners are offered an opportunity to take part in interaction processes, either synchronously or synchronously with respect of time. Spoken interaction is highly interactive and dynamic. Social confrontation and negotiation involving brainstorming, consensus seeking, common problem solving, etc. have its best condition when the students are sharing time. Thus, priority was given to exploring this issue. With basis in the general principle on accessibility, a development effort based on video- or audio conferencing was disregarded and effort was instead given to develop a text-based solution. A chat-function seems appropriate as it allows the learner to take part in interaction processes in shared time. Compared with e-mail, a chat-function has shorter delays between contributions and is more like spoken conversations with greater reciprocity and feedback (McDaniel et. al., 1996).

Combining the synchronous nature of chat with the requirement on access from homes, implied however a practical problem to systems development (Berge, 1997). At first glance, the UNIX application YTalk seemed appropriate, but the approach requires that all learners have the YTalk software installed. This requirement is not fulfilled as most home computers do not run the UNIX operating system. An other approach is the Internet service IRC (Internet Relay Chat). IRC is a multi-user and multi-channel chatting network that allows people to communicate in shared time. Most 'channels' on IRC are public, with the possibility to create closed channels with access to invited participants. In order to support a certain degree of awareness among the learners, it was an aim to dedicate each project of learners a closed channel. This approach does however require special privileges on the IRC server, which was problematic in practice. In order to implement interaction processes in shared time, a chat application was developed from scratch. The interested reader, is welcome to read (Berge, 1997) for more details.

The chat sessions are stored in text-files with one file for each day a session has occurred. This archive of the discussions was implemented by providing a collection of hypertext links, with one link for each text file. The learners may view the transcripts through *Distribution*. Compared to oral interaction, the transcripts have extra learning benefits as they allow the learner to reflect on the dialogues after they have taken place. Contradictory, the dynamics and

spontaneity found in oral interaction, may be reduced as the contributions are stored (Lorentsen, 1988; Sorensen, 1996).

The two additional services included in *Communication*—E-mail and news groups—are intended for actions where time is considered less critical. Compared to the chat-function, composing of e-mail is closer to writing than oral conversation (McDaniel et. al., 1996). These services contribute to a second dimension of knowledge construction as they are allowing the learners to examine and reflect upon the ongoing discussion in a way that is precluded in oral dialogues and chats (Fjuk and Jenssen, 1990; McDaniel et. al. 1996).

The two other aspects of collaboration in projects—*Administration* and *Distribution*—are related to explicit division of actions and to the individual actions of thought, respectively. All the three aspects of collaboration are more or less interwoven and constitute a mutual dependency. The interaction process taken place through *Communication*, has meaning for activities taken place through *Administration* and *Distribution*, and vice versa.

When it comes to *Administration*, there are particularly two features that were assumed critical with respect to awareness. The functionality of the *Scheduler* is similar to physical objects used for scheduling meetings. In a CSdCL situation, coordination in terms of time is critical as the adult learner is committed to different social worlds; daily work-practice, family and the peer learners. A shared discussion—either taken place distributed (through the chat-function) or taken place physical—need to be carefully planned. The Scheduler may be found by selecting "Avtalekalender" (the Norwegian word for scheduler) from the opening WWW-page.

The other feature, a *Control-list*, is aimed at offering the learner awareness on the peer-learners' interaction history in Dynamix. In order to commit oneself to the collaborative constructive learning environment or to initiate a discussion (in shared time) a learner needs to know if the peers are present in the distributed environment. Also, when a learner presents a written contribution, a thought or an idea, it will help if she knows whether the peers have seen this or not. A service providing for this feature, is the UNIX program Finger, but not available for the target group. This constitutes a further challenge for system implementation, as today's servers do not provide a way of tracking the status of a message. A new mail protocol, IMAP (Internet Message Access Protocol), provides a solution for this (Berge, 1997). "Services that conform this protocol (...), can retrain

information about users and messages in standardized format, so e-mail clients can reliably learn when a message was retrieved." (Berge, 1997, p. 131).

The last aspect of collaboration, *Distribution*, is related to the outcome of actions mainly taken place individually, directed towards the social environment. By selecting *Distribution*, the learner is allowed to present individual thoughts and interpretations for the peers through Web-pages, and correspondingly to receive such from the others. Also the transcripts from the chat-function can be found by selecting this aspect.

Paper forms, such as charts of responsibilities and milestone planning are central for the division of actions in any collaborative projects. These forms were complicated to implement in WWW, illustrating important limitations of the technology with respect to collaboration in projects. Instead, a text based project directive was implemented. It is important that text can be modified after it is stored as the form constitutes a basis for discussion among the learners. The *Project Directive* can be found by selecting "Prosjektdirektiv" from the opening WWW-page.

6 Transcending traditions? A concluding discussion of the design process

The two cases presented—distributed problem-oriented project (dPOP) and distributed pedagogical seminar (dPS)—indicate that the CMC systems were applied within existing pedagogical and methodological thinking. Technology and pedagogy were not incorporated, and the employment of technology implied unexpected problems both of pedagogical and organizational characters. Both cases have given valuable experiences; to understand the possibilities of a new technology, it first has to be used in a traditional way. Based on these experiences ideas occur, and the technology can be used to transcend the traditions.

The experiment with the Dynamix prototype, based on Internet services, was an attempt to transcend the traditions both with respect to distance education and collaborative learning. From the tradition of distance education we wanted to maintain flexibility, accessibility and low costs. From the tradition of collaborative learning we wanted to maintain the idea of social confrontations and negotiations, and critical aspects related to the student's awareness of peers' action, progress and interpretations. On the other hand we wanted to transcend the

tradition of physical presence as the most important condition for building a collaborative knowledge contribution environment.

We approached this by using knowledge and principles achieved within the Scandinavian tradition of systems development. In addition to the dialectical analysis of the tension between tradition and transcendence, this tradition emphasizes situated design and user participation in the design of learning environments.

Did we succeed?

It can be argued that CMC systems are transcending the correspondence thinking rooted in distance education: mail is no longer the dominating medium for communication. Quite contrary, communication is conducted through different channels: e-mail, news groups, chat, Web-pages and their different applications in Dynamix. More important is however, the transcendence of the pedagogical approach: The learner-to-teacher interaction is completed with collaboration between geographically dispersed students.

Still, the flexibility is kept: the learners can study when they want to, except from the possibility to agree on certain meetings where students are participating. Also the accessibility is kept to a certain degree: more and more people have access to the Internet from their own homes.

The focused case on distributed problem-oriented project (dPOP) shows, that trying to use a text- and synchronously based CMC-system as means to build a collaborative knowledge construction environment, is not trivial. One reason might be that the students compared CSdCL with physical co-presence. One can argue that the use of metaphors in Dynamix transcends the idea of physical presence: spatial metaphors are consciously avoided. An action oriented approach is used instead of the space-oriented ones. This is used to avoid the idea of simulating physical presence. Also the idea of simultaneous presence is transcended: only exceptional meetings are arranged simultaneously. For further research, we argue that an analysis aimed at exploring the meaning of ‘space’ to (adult) learning, is crucial.

What about the ideas of situated design and user participation? These are related to the tradition of designing computer systems for organizations. In short, the argumentation goes like this: Every organisation is unique, every organizational situation is unique. Thus every system development project must be organized to design a unique computer based system, optimally adjusted to the

user organisation. And, following the line of argumentation: The user groups in the organisation may have different interests with respect to the new computer system. If the computer system is to be used as intended, the different user groups should experience it as a tool for conducting their work in a qualitatively good way. This can best be obtained through user participation. In addition, the users' organizational and technical knowledge is useful in the development process. User participation is also important with respect to democracy at the work place.

Today, these conditions are, also in Scandinavia, to some degree broken. Many computer systems are designed, as in the Dynamix case, for a broader audience consisting of heterogeneous user groups on the Internet. Then the ideal of situated design and user participation is problematic. The solution chosen is designing for flexibility. The Dynamix prototype is designed so that the technology should not form the organisation of collaboration: The students are allowed to use what services they feel confident with in the process of carrying out actions. This is an approach to support situated design. The new problem is then to handle the contradiction between flexibility and situatedness: Situated design may result in computer systems only usable for the specific user group, and flexible design may result in computer systems so general that they are not usable for anybody.

To conclude, we have succeeded in the process of moving towards transcendent thinking in design. But, there are still many problems left.....

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Appendix 1: Soft Dialectics

Soft Dialectics (Bratteteig and Ølgrim, 1994)[38] is a systems development technique emphasizing learning promoting activities corresponding with a socio-constructivist perspective on learning. The areas of application are in particular situations in which expanded learning is necessary. Corresponding to a socio constructivistic perspective, the focus is not on problem solving but on problem orientation. The foundations for problem orientation are dialectical contradictions and so-called 'rich pictures' (Checkland, 1981; Checkland and Scholes, 1990), combined with multi-perspective thinking (Nygaard and Sørgaard, 1987).

According to Soft Dialectics, a contradiction consists of two aspects, which are mutually dependent and fighting at the same time each other (Ølgrim, 1993). Dialectical theory recognizes the *situatedness*. Each phenomenon is always seen in the context of external contradictions. The understanding of a phenomenon is achieved through studies of internal contradictions. Expansion is understood to be result of changes in the relations between the internal contradictions of the phenomenon.

The idea behind Soft Dialectics is mediation of spontaneous activities in to order to quickly grasp and penetrate the essence of a problem. Soft Dialectics consists of four mutually dependent activities:

1. Drawings
2. Description of multiple perspectives
3. Description of contradictions
4. Discussion of the descriptions with the members of the actual situation.

The mutual dependency between the activities implies that the activities should be carried out with the others in mind.

Drawings

Drawings are one of the main activities in Soft Dialectics, and the ‘rich pictures’ are first and foremost mediators of spontaneous and creative activities. However, since the problem situation usually is quite complex, the drawings can also be a mediator in the process of initially structuring a complex phenomenon. The rich

[38] The references included in this appendix, are found in the original reference list.

pictures are mediators of active reflection, and not a result of a learning process. The benefit of drawing in relation to spontaneity is emphasized by Schön (1983):

> "The act of drawing can be rapid and spontaneous (...) there are no stoppages, breakdowns of equipment, or soil conditions which would make it impossible to sink a foundation." (Schön, 1983, pp. 157-158).

The rich pictures do not have any formal syntax. The drawings are not structured in terms of pre-defined world views of e.g., the designer of the technique or the method. Rather, they are structured after the actors' skills to draw, their world views and their creativity. In order to achieve spontaneous and creative activities, the pictures should be drawn by hand and not by e.g. computer-based drawing programs. When systematizing and refining the picture too much, easily done when applying computer based drawing programs, the idea and advantage of spontaneity is lost.

Rich pictures are also used by others, e.g., Mathiassen et al. (1993). They present two different ways of drawing: emphasizing either stability and structure, or change. The examples given (Mathiassen et. al., 1993) are drawn with the aid of a computer. Their technique is an attempt to solve a serious problem of analysis, the one of deciding what to model. In real life, you do not start with a requirement specification, though there is a problem of defining how to develop the requirement specification. Developing the requirement specification is a typical problem formulation and problem definition situation. Mathiassen et. al. (1993) try to combine the creative and unstructured technique of rich pictures with the structured and formal object oriented modeling. However, there is no smooth or obvious connection between the unstructured technique of drawing rich pictures and the structured technique of object oriented modeling.

Description of Multiple Perspectives

Traditional systems development methods and description techniques, structure the analysis in terms of aspects like functional roles of people (customer, owner, etc.), information flow, transformation from input to output, etc. Soft Dialectics pays attention to aspects that are often left out of the formal specifications, like tacit knowledge, interests, attitudes and power of the individuals. These aspects influence various perspectives on a problem. To structure the actors' views, as well as the problem situation, the different perspectives are textually formulated.

Description of Contradictions

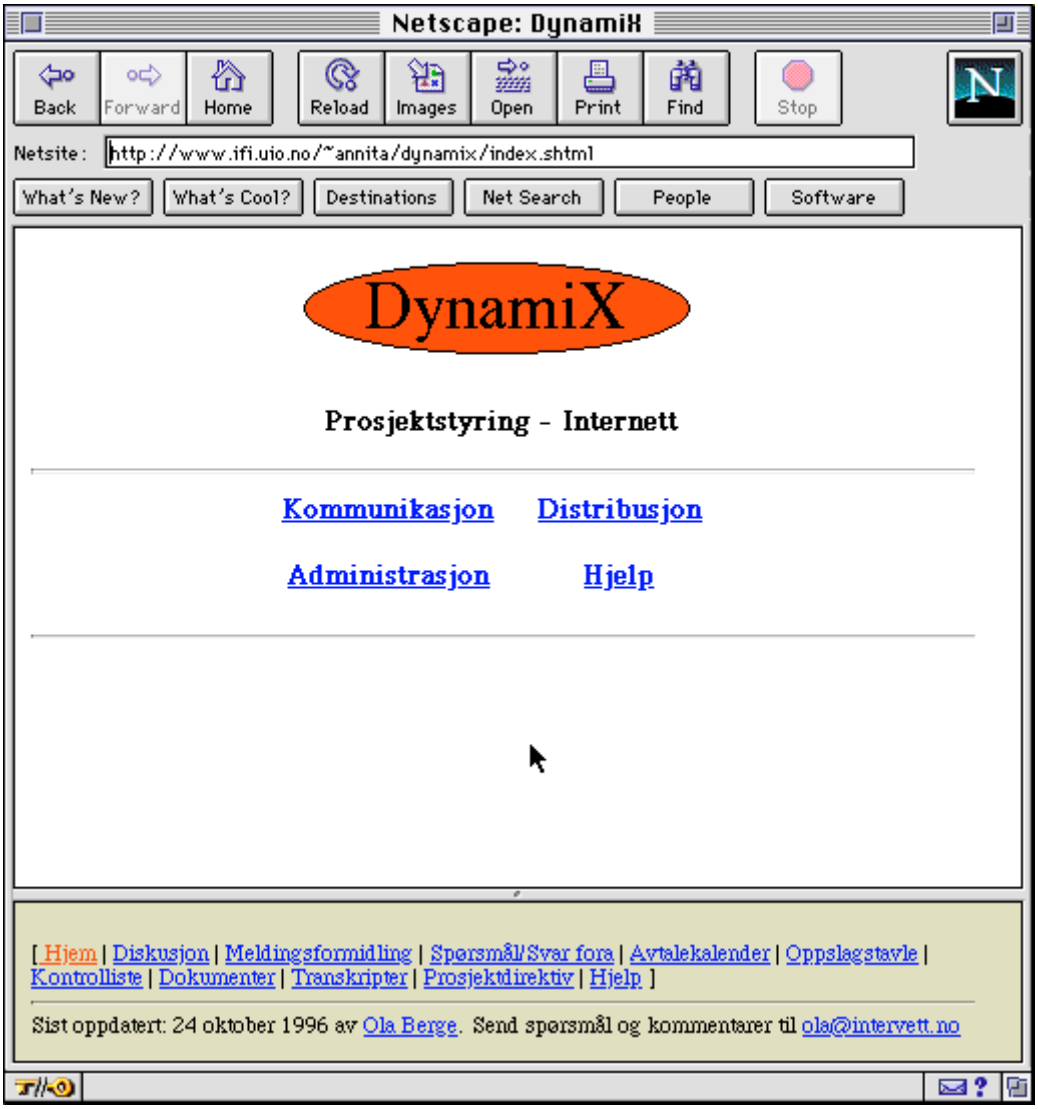
The multiple perspectives may be sources for confrontations. These perspectives are coupled as dialectical contradictions in order to indicate or make clear both the interdependence and the 'fight' between them. Such an array of perspectives is a means to structure the problem situation. It is also a means for further reflections and active cognition in the meaning of accommodation. The main idea is not to solve the contradictions, but to critically reflect on them in order to get a deeper insight.

Discussion of the Descriptions

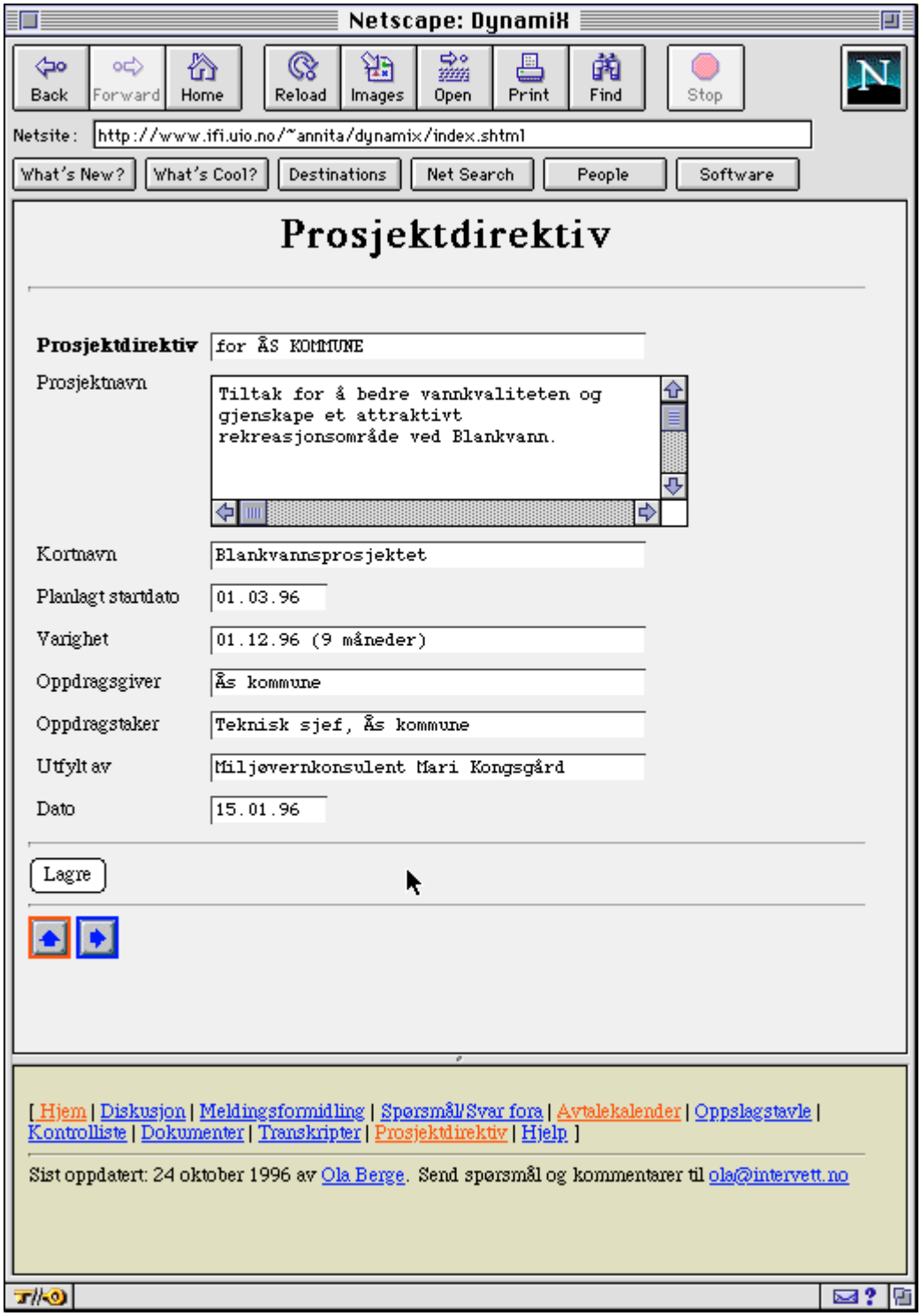
The presentation of perspectives as theoretical ideal-types, in contradictions, helps to discuss the problems in a way that emphasizes the problem area—and not the people involved. The emphasis on identity of the contradiction, and the need for both perspectives, also stimulate further discussions. This in turn may lead to new perspectives, new confrontations, new drawings and new contradictions.

Appendix 2: Dynamix

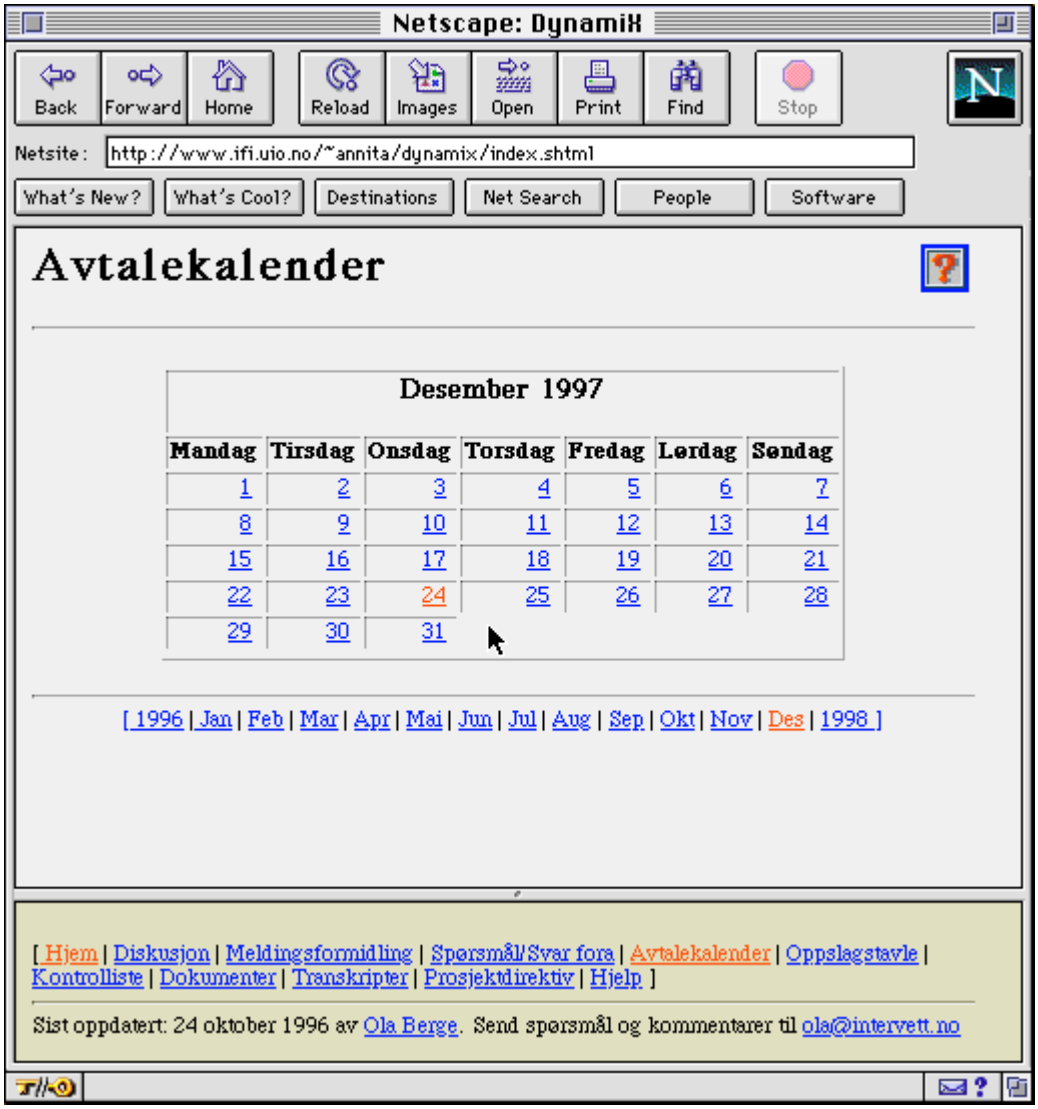
The opening page:



The Project Directive:



The Scheduler:



[1] I use the notion of 'interactional processes' because interaction is crucial with respect to learning. I have adopted this notion from Strauss (1988).

[1] I base this view on practical experiences of designing and organizing CSdCL situations over a four year period. These experiences are briefly presented and discussed in section 5.1.

[1] Annita Fjuk is the first author. A previous version of this paper—Sammenføyningsarbeid i distribuerte kollektive læreprosesser—is published in: Danielsen, O. (Ed.): Læring og multimedier, pp. 145-176. Aalborg Universitetsforlag, Denmark.

[1] Annita Fjuk and Ole Smørdal have a shared responsibility. The paper is based on: Fjuk, A.; Smørdal, O.; Nurminen, M. I. (1997): Taking Articulation Work Seriously. An Activity Theoretical Approach. TUCS TR 120 (Technical Report). University of Turku, Finland. ISBN 952-12-0036-7.

[1] Elsebeth Korsgaard Sorensen has the responsibility of the section named 'Interaction: The Basis of Human Existence'. Annita Fjuk has the responsibility of the section named 'Perspectives Behind Distributed Collaborative learning'. The responsibility of the rest of the paper is held by both authors.

[1] Annita Fjuk is the first author.

[1] Annita Fjuk is the first author.

[1] Computer Supported Cooperative Work

[1] Other conferences were created to take care of questions directed towards the administrative staff, technical expertise, and social activities usually taking place at cafés.

[1] 100 students participated during the pilot project. The investigation is based on interviews of 25 students and five teachers, supplemented with observations in the computer conferences (Fjuk and Jenssen, 1990). The number of students increased to 1000 during the period of 1990-1992 (Fjuk, 1992). During the period of 1992-1994, the number of students decreased to 50, and 20 at the lowest. The investigations are based on quantitative questionnaires, observation and informal conversations with the students and the teachers.

[1] The seminar was designed and run during my work period at the NKS.

[1] In collaboration with Astrid Jenssen (University Center of Information Technology, University of Oslo)

[1] This project constituted the last part of my research.

[1] My supervisor (Leikny Øgrim), a master thesis student of mine (Ola Berge) and myself.

[1] Ola Berge implemented the pilot system.

[1] http://www.intervett.no/~ola/thesis

[1] It has to be made clear that this correlation is difficult to measure. It can only be predicted since there can be several causal factors behind the learning effects of interpersonal interactions. The correlation between learner-content interaction and interpersonal interaction is predicted by examining the contents of the conference messages (Fjuk, 1993).

[1] Translated in collaboration with Eevi Beck.

[1] A discussion in PortaCOM.

[1] Other systems such as e.g. Lotus Notes were examined. Lotus Notes was evaluated to be too expensive for short term-use and too difficult to install for the students.

[1]The discussion is based on the follwoing cases in section 2: Distributed pedagogical seminar (NKS Distance Education), problem-oriented projects (The University of Aalborg), and to some extent Online Education and Training (The British Open University).

[1] Translated in Fjuk and Dirckinck-Holmfeld (1997).

[1] Translated in Fjuk and Dirckinck-Holmfeld (1997).

[1] During the modern times several dramatist have designed plays with the purpose of engaging the audience. One example is the German dramatist Bertolt Brecht, who introduced the epic theater. Other modern forms of theater, such as impro theater, streets theater and action theater, focus on participation from the audience and, thus, unforeseen happenings.

[1] In this paper I use the notion of CSCdistanceL to present the problem area.

[1] Ola Berge implemented the pilot system as a part of his master thesis. As Berge's supervisor, I collaborated closely with him in the design of the pilot system.

[1] http://www. ifi.uio.no/~annita/dynamix (User name: anonymous, Password: guest).

[1] Appendix 2 shows the opening 'Web-page'.

[1] CGI (Common Gateway Interface) scripts were chosen for implementing the system. CGI-scripts were written in Perl (Practical Extraction and Report Language) as it enables quick (further) development of prototypes. Some of the problems met can be reduced by using Java.

[1] The Project Directive is shown in Appendix 2.

[1]The Scheduler is shown in Appendix 2.

[1] The Ped-Tek project. The project is initiated by Department of Informatics (University of Oslo), The College of Hedmark, The College of Oslo, NKI Polytechnical College, in joint collaboration.

[1] The concept contradiction includes the concept conflict, but is richer. This is because the unity - the interdependence - of the aspects is just as important (Øgrim, 1993).

[1] We use the term 'CSdCL' to underline the distributed or distance nature of collaborative learning in which telecommunication technology is applied to mediate collaborative and individual activities.

[1] Both authors have been involved in the design, delivery and evaluation of the cases investigated. Elsebeth K. Sorensen was a guest lecturer, observator and evaluator of the OET case. She was also a participant, observator and evaluator of the POS case. Annita Fjuk was designer, organisator and evaluator of the POS case. Both authors have been supervisors at (distributed) collaborative projects at the University of Aalborg, and are currently involved in research activities within this area.

[1] Aristotle (384-322 B.C) was a student and the successor of the philosopher Plato, and he was the tutor to Alexander the Great.

[1] Pacing implies meeting deadlines for starting course, assignments and exmainations. These deadlines can be flexible or rigid (Paulsen, 1992, p. 61)

[1] The references included in this appendix, are found in the original reference list.

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