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Concurrent Design Approach to the Design of Customized Corporate E-Learning

Thesis for the degree of Philosophiae Doctor

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To my family…

Abstract

Background: In today's knowledge-based economy corporations have an increasing need for employees with appropriate competencies, and customized e-learning can be a means to cover some of this need. Higher education institutions (HEIs) can take part in this market by offering e-learning-based training and education customized to the needs of the corporate clients. There is, however, a variety of needs that should be taken into account to form sustainable e-learning courses and related training services for the students, and this implies that it is challenging to design e-learning deliverables customized for corporate clients. To succeed in developing holistic e-learning designs which cover most relevant requirements, participants representing different roles such as customer representatives, domain experts, pedagogues, technical experts, economists and market people, students, and people from the administration should be present in the design phase. Furthermore, these stakeholders should utilize modern computer-supported cooperation, while they strive to produce high quality results in a time and cost effective manner. Concurrent design is an approach used to solve complex and interdisciplinary design issues in which interactions between different disciplines is essential to achieve optimal and comprehensive solution. This thesis considers the use of a concurrent design approach, when customized e-learning deliverables are designed and developed for corporate clients. It is a paper-based thesis which includes six scientific and peer-reviewed papers, besides four secondary papers that are not included in their entirety but only where general information is described.

Aim: The overall research aim was to contribute with basic motivation, implementation experience, and requirements for practical realization, regarding methodological approaches for concurrent design of e-learning deliverables for corporate clients. The following research questions were answered:

1. Why should HEIs apply a concurrent design approach when they aim to deliver e-learning to corporate clients?
2. How should a concurrent design approach for the development of customized e-learning for corporate clients be materialized? That is to say, how should this approach initially be described, and how should it eventually be tested and evaluated?
3. What are the key requirements for a concurrent design approach to the design of customized e-learning for corporate clients?

Methods: This study was inspired by design-based research, and various research methods that were suitable to answer the research questions faced as the project progressed, were utilized. This includes literature reviews, questionnaires, interviews, design science, action research, besides qualitative data analysis and coding of collected data.

Contributions: The main contribution of this thesis is the concurrent design inspired methodological approach to the design of new e-learning solutions for corporate clients, which are customized to the current context and the project in question. The following contributions were identified:

1. Detected motivation and conditions for applying a concurrent design approach to the design of customized e-learning for corporate clients.
2. The concurrent e-learning design method; which includes a description of processes, roles, models, tools, a concurrent design facility, and an appropriate infrastructure.
3. Experience from using action research as a means of introducing new artifacts at higher education institutions.
4. Requirements and guidelines for concurrent design of customized corporate e-learning; which includes 16 principles of concurrent e-learning design and some additional prescriptive approaches that should be considered for distributed workspaces.

Conclusions: It is the e-learning design processes and the corporate use of e-learning provided by higher education institutions, that forms the basis for this doctoral project. In this context, a concurrent design approach to the design of customized corporate e-learning is materialized. To a large extent this also concerns computer-supported cooperative work on a more general level. This thesis is thus a contribution in instructional design, which also provides experience regarding how technological solutions should be used and what requirements shall apply to solutions that support computer-supported cooperation in interdisciplinary design processes.

Preface

After 13 years in the Nordic IT industry, mainly in relation to the development of ERP systems, I started as an assistant professor at the Faculty of Informatics and e-learning at Sør-Trøndelag University College in summer 2007. Although the job as a lecturer was both new and exciting, I quickly realized that I lacked both expertise and experience in relation to research and scientific dissemination. Therefore, it was natural for me to apply for the position, when the institution later that year announced the position as a PhD candidate in e-learning. Luckily, I got this opportunity and this thesis documents the work carried out during my PhD study, which started the 1 August 2008 and ends the 31 July 2012.

The PhD project has been conducted in collaboration with the Department of Computer and Information Science (IDI) at the Norwegian University of Science and Technology (NTNU), and the Faculty of Informatics and e-Learning (AITeL) at Sør-Trøndelag University College (HiST). In this context, NTNU/IDI is the PhD-awarding institution, while HiST/AITeL is the employer. The main supervisor has been Associate Professor Arvid Staupe (NTNU/IDI), while Professor Torbjørn Skramstad (NTNU/IDI) and Associate Professor Geir Magne Maribu (HiST/AITeL) have been co-supervisors.

This thesis is submitted to the Norwegian University of Science and Technology (NTNU) for partial fulfillment of the requirements for the degree of philosophiae doctor. The work was funded by a PhD research fellowship given by Sør-Trøndelag University College, which in turn had funding from the Ministry of Education and Research.

Acknowledgements

A PhD project, as presented in this thesis, is basically very open and it is the people we collaborate with and the projects we are involved in, which greatly affect the work. This has been an interdisciplinary project in which collaboration between a number of people have been crucial for both the research process and the provided contributions. I could not have done this work alone, and I am grateful for all the collaboration I have been taking part in, as part of my doctoral project.

I would like to thank my main supervisor Arvid Staupe, my co-supervisor Geir Magne Maribu, and my co-supervisor Torbjørn Skramstad for providing support, guidance, and valuable feedback throughout my period as a PhD candidate.

I want to thank my colleagues at AITeL. I would like to start with thanks to Per Borgesen and Thorleif Hjeltnes who first gave me the opportunity to start on this PhD project. Next I want to thank Thorleif, Geir, Monica, Tor Atle, Bjørn, Magnhild, Per, Greta, Geir Ove, Tore, Svend Andreas, Jostein, André, and Tor Ivar who I had the pleasure to work with in one or more R&D projects that had impact on my study. Then I want to thank Mildrid for significant assistance within statistical methods when I took the course in business research methods, and Ali who gave me useful feedback on some papers. Finally I want to thank the PhD candidates (Rune, Puneet, and Ivar) for a good working environment and numerous useful conversations.

Collaboration with external partners has been very valuable to me in this work, and I would like to thank external participants from Norway and abroad in the BITØK/EIK, CCeD, and UnderstandIT projects. Furthermore, I thank Simtano™ and Knut I Oxnevad for having inspired us in relation to concurrent design, for having shared his expertise in several meetings and for the 4 days of concurrent design team and facilitator training he provided us.

I want to thank my co-authors (Arvid Staupe, Tor Atle Hjeltnes and Geir Magne Maribu) who contributed to the papers included in this paper-based thesis, and I would also like to thank the anonymous reviewers of these papers for constructive feedback. Also I acknowledge the editorial assistance from Stewart Clark.

Finally, I would like to thank the assessment committee who voluntarily are willing to spend time to review this work.

Contents

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Abbreviations

AACE	Association for the Advancement of Computing in Education
ADDIE	Analysis, Design, Development, Implementation, and Evaluation
ADL	Advanced Distributed Learning
AITeL	Faculty of Informatics and e-learning (at HiST)
BITØK	Bedriftstilpasset e-læring i IT og økonomi (Customized corporate e-learning within IT and economy)
BPMN	Business Process Modeling Notation
CCeD	Concurrent E-Learning Design
CD	Concurrent Design
coUML	*cooperative* Unified Modeling Language
CSCW	Computer-Supported Cooperative Work
DELTA	Development of European Learning through Technological Advance
E2ML	Educational Environment Modeling Language
EADL	European Association for Distance Learning
EDEN	European Distance Education Network
EIK	Et Innovativt Kompetanseprosjekt (An innovative competence project)
EML	Educational Modeling Language
ESA	European Space Agency
EU	European Union
HCI	Human-Computer Interaction
HEI(s)	Higher Education Institution(s)
HiST	Sør-Trøndelag University College
ICT	Information and Communication Technology
ID	Instructional Design - Also called Instructional Systems Design (ISD)
IDI	Department of Computer and Information Science (at NTNU)
IEC	International Electrotechnical Commission.
IEEE	Institute of Electrical and Electronics Engineers
IMS	IMS Global Learning Consortium
IMS CP	IMS Content Package. A standard way of describing learning content that can be read by several computer programs.

IMS LD	IMS Learning Design. A specification for a meta-language which enables the modeling of learning processes
ISD	Instructional Systems Design - Also called Instructional Design (ID)
ISO	International Organization for Standardization
ISO/IEC	An information center jointly operated by ISO and IEC
IT	Information Technology
ITIL	IT Infrastructure Library
ITSM	IT Service Management
JITOL	Just In Time Open Learning
JPL	Jet Propulsion Laboratory
LCMS	Learning Content Management System
LMS	Learning Management System
LOM	The IEEE 1484.12.1 – 2002 Standard for Learning Object Metadata
LSS	Learning Support Systems
MISA	Learning System Engineering Method. MISA is a French acronym for Méthode d'ingénierie des systems d'apprentissage.
NADE	The Norwegian Association for Distance Education
NASA	National Aeronautics and Space Administration
NITOL	Norway-net with IT for Open Learning
NKR	Nasjonalt kvalifikasjonsrammeverk (Norwegian Qualifications Framework)
NOU	Norway Opening Universities
NTNU	Norwegian University of Science and Technology
OMG	Object Management Group
R&D	Research and Development
SCORM	Sharable Content Object Reference Model
SE	Software Engineering
SME	Subject Matter Expert
TISIP	A research foundation at HiST/AITeL
UML	Unified Modeling Language
VET	Vocational Education and Training
VLE	Virtual Learning Environment

PART I

1. Introduction

This chapter introduces the motivation for this thesis. It starts by describing why corporate e-learning is demanded and why a concurrent design approach to the design of customized e-learning for corporate clients is interesting. Then, the context for the research is briefly presented, followed by an overview of the research questions, and a brief explanation of the research design used to answer these. Next, there is a list of research articles that are part of this work, before the main contributions are presented. Finally, the structure of the thesis is outlined.

1.1 Motivation

The capability to gain and apply competence is very important in today's knowledge-based society where the labor market has an increasing need for employees with appropriate competencies. Workplaces have become an arena for learning where employees act as lifelong learners. Employees seek to continue with education while employers both encourage and are in charge of the organization of such learning activities. This implies that the market for corporate education is growing rapidly and e-learning is now regarded as a mainstream approach to educational deliverables in this market (Kakoty, Lal, & Sarma, 2011).

Many, but not all Higher Education Institutions (HEIs) currently offer e-learning based education for corporate clients. However, it is not necessarily easy to succeed with this and e-learning research shows that there are many very different factors that must be well thought out (Kahiigi, Ekenberg, Danielson, & Hansson, 2008). To achieve successful implementation of e-learning deliverables for corporate clients the educational provider (e.g. HEIs) should take the stakeholders into account and consider factors such as: (1) adaptation of academic content and learning outcomes, (2) adaptation of pedagogy and learning activities, (3) use of various technologies that support a range of activities relevant for learning, teaching, coaching, assessments, administration, evaluations, and marketing, (4) flexibility so that busy lifelong learners have the possibility to participate, preferably anytime and anyplace, (5) a sustainable business model which contributes to attractiveness for all stakeholders, (6) access to services that allow participants to find answers and perform tasks that arise, and (7) management involvement from both the customer and supplier.

This suggests that successful implementation of e-learning depends on diverse factors and that the process of Instructional Design (ID) is demanding and requires involvement of individuals with complementary knowledge and skills. In order to design sustainable customized e-learning for corporate clients, an approach is required that involves different stakeholders which represent various areas of expertise with the necessary decision-making authority.

Such problems requiring multidisciplinary solutions exist in various contexts and concurrent design (CD) is a methodical approach that is developed to solve complex industrial design problems in an effective and efficient way. CD can be considered the early phase of the concurrent engineering process and there was an increasing use of this approach within space technology institutions during the 1990s. In CD the various experts cooperate in intensive sessions where they utilize computer equipment adapted to their own area of expertise. The sessions are conducted by a dedicated facilitator while the customer and other relevant stakeholders typically are present (Lonchamp, 2000; Bandecchi, Melton, Gardini, & Ongaro, 2000; Osburg & Mavris, 2005).

In my quest to understand how CD actually works and whether this approach can be used for the design of customized e-learning for corporate clients, I also discovered that the challenges faced in this context have much in common with those discussed in the Computer-Supported Cooperative Work (CSCW) literature, i.e. how to best perform and coordinate cooperative activities by means of computer systems (Bannon & Schmidt, 1989; Carstensen & Schmidt, 1999).

There are many approaches to ID and we can hardly say that some are more correct than others (Gagné, Wager, Golas, & Keller, 2005). However, the ADDIE model of ID is considered fundamental and generic and the five phases (Analysis, Design, Development, Implementation, and Evaluation) deal with topics that we find in several other models, even though instructional designers practice this very differently (Kirschner, van Merrienboer, Sloep, & Carr, 2002; Peterson, 2003; Visscher-Voerman & Gustafson, 2004). This doctoral study investigates a concurrent design approach to instructional design. Thus it was also natural to study instructional design models where the upcoming e-learning delivery is represented in distinct models which are developed concurrently and in parallel (Paquette, 2004a; Davidson-Shivers & Rasmussen, 2006).

In this section I have discussed how I was initially motivated to test a methodical approach for the design of e-learning solutions for corporate clients that were inspired by experience from both concurrent design and instructional design. Furthermore, I have pointed out that this deals with interdisciplinary interactions which can be considered as a part of the application of computer-supported cooperative work. During the project, the concurrent design approach to the design of customized corporate e-learning has been challenged on several levels, and this might be considered as requirements for flexibility. On the one hand, it is necessary to have flexibility in terms of what is to be made. E-learning comprises all forms of ICT-supported learning and teaching and varies from e-learning courses for formal higher education to self-paced e-learning systems for informal training. The need to use this methodological approach is considered in this doctoral project and involves the design of different kinds of e-learning solutions that are customized for corporate clients, higher education campus courses, and national and cultural adaptation of existing courses within vocational training. On the other hand, flexibility is required in terms of availability and how the cooperation should take place, i.e. it should be possible to cooperate both synchronously and asynchronously, with participants who are both co-located and distributed. In total, this means that I have gradually adopted a more general motivation in relation to the success of CD, when this approach is applied for different design challenges. CD implies a dedicated form of coordinated and computer-supported cooperation that could be applied to various interdisciplinary challenges, where the aim is to bring forward innovative solutions in an effective and efficient way.

This thesis is about: (1) understanding why HEIs should have a interdisciplinary focus when new educational deliveries are designed, (2) how a method for concurrent e-learning design should be defined, (3) how such a method can be implemented by an HEI, and (4) what principles and prescriptive approaches that should be taken into account when coordinated and computer-supported cooperation (i.e. a concurrent design approach) is applied to the design of e-learning deliverables.

1.2 Current R&D Projects

The research presented in this thesis has been carried out in conjunction with the following three R&D projects:

(1) BITØK/EIK – An internal project where HiST/AITeL, NTNU/IDI, and TISIP worked to deliver customized corporate e-learning within IT and economics to selected organizations in the Ytre Namdal region in Norway.

(2) CCeD – A Norwegian project where HiST/AITeL, NTNU/IDI, and TISIP received financial funding from the Norway Opening Universities (NOU) and collaborated with selected corporate clients in the Ytre Namdal region to utilize concurrent design for the development of customized corporate e-learning.

(3) UnderstandIT – An EU-based project where HiST/AITel are collaborating with six European partner institutions to develop customized training programs to increase Information and Communication Technology (ICT) competencies among Vocational Education and Training (VET) teachers, trainers, and tutors.

The courses in the BITØK/EIK project ran over four semesters starting in autumn 2008, CCeD was running from March 2009 until March 2011, while UnderstandIT started in October 2010 and will continue until October 2012. More information about the current R&D projects is presented in Section 3.2 – Research Context.

1.3 Research Questions

The overall research aim for this thesis is **to contribute with basic motivation, implementation experience, and requirements for practical realization, regarding methodological approaches for concurrent design of e-learning deliverables for corporate clients.**

This means that I want to study how multiple stakeholders who represent different roles (e.g. customers, suppliers and various experts such as domain experts, educational experts, technicians, economists, and administrators) can cooperate in the e-learning design process. I want this cooperation to be as efficient as possible, while producing design solutions that take into account the relevant needs from all the involved stakeholders. A systematic and thorough design phase where all relevant stakeholders are involved concurrently should first contribute to a comprehensive design, and later to solutions that satisfy complete and compound demands.

On the basis of the above-mentioned research aim and challenges, the following research questions are formulated:

- RQ1: *(Basic motivation)* - Why should HEIs apply a concurrent design approach when they aim to deliver e-learning to corporate clients?
- RQ2: *(Implementation experience)* - How should a concurrent design approach for the development of customized e-learning for corporate clients be materialized? I.e. how should this approach initially be described, and how should it eventually be tested and evaluated?
- RQ3: *(Requirements for practical realization)* - What are the key requirements for a concurrent design approach to the design of customized e-learning for corporate clients?

The overall goal of this work is to achieve improved quality and a better adaptation to customer expectations when customized corporate e-learning is developed, while at the same time achieving cost reductions through increased quality, reduced development time, and an improved decision process. The proposed concurrent design approaches should help to achieve this overall goal.

1.4 Papers

This thesis includes papers and in this section the six selected peer-reviewed papers are listed in chronological order. More information on each paper is found in Chapter 4 while these papers are in full text in Appendix A.

P1 Strand, K.A. & Staupe, A. (2009). To Provide Online Distance Learning as a Portfolio of Services. In G. Siemens & C. Fulford (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2009 (pp. 4433-4442). Chesapeake, VA: AACE.

P2 Strand, K. A. & Hjeltnes, T. A. (2009). Design of Customized Corporate E-Learning. Seminar.net - International journal of media, technology and lifelong learning, 5(2), 14.

P3 Strand, K. A. & Staupe, A. (2010). The Concurrent E-Learning Design Method. In Z. Abas et al. (Eds.), Proceedings of Global Learn Asia Pacific 2010 (pp. 4067-4076). AACE.

P4 Strand, K. A. & Staupe, A. (2010). Action Research Based Instructional Design Improvements. In Falmyr, T. (Eds.), Norsk konferanse for organisasjoners bruk av informasjonsteknologi, NOKOBIT 2010, (pp. 25-38). Gjøvik University College.

P5 Strand, K. A., Staupe, A. & Maribu, G. M. (2012). Prescriptive Approaches for Distributed Cooperation. In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2012 (pp. 1011-1020). Chesapeake, VA: AACE.

P6 Strand, K. A., Staupe, A., & Hjeltnes, T. A. (2013). Principles of Concurrent E-Learning Design. In K. Patel, & S. Vij (Eds.), Enterprise Resource Planning Models for the Education Sector: Applications and Methodologies (pp. 48-75). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-2193-0.ch004

1.5 Contributions

The main contribution of this thesis is the concurrent design inspired methodological approach to the design of new e-learning solutions for corporate clients customized to the current context and the project in question. This methodological approach implies an emphasis on challenges related to the facilitation of computer-supported cooperation, which can be done synchronously and/or asynchronously while the participants are co-located and/or distributed. This suggests that the contributions are relevant for researchers in ID and e-learning, CSCW, and Human-Computer Interaction (HCI). Both the organizational level at HEIs and employees who work with design and development of e-learning deliverables will be able to take advantage of these contributions, which should provide better solutions for customer and supplier organizations and their main stakeholders, i.e. students, teachers, ICT employees, and others who might help with e-learning arrangements.

To clarify my results I choose to distinguish the following four contributions:

- C1: - Detected motivation and conditions for applying a concurrent design approach to the design of customized e-learning for corporate clients.
- C2: - The concurrent e-learning design method; which includes a description of processes, roles, models, tools, the facility, and the infrastructure.

- C3: - Experience from using action research as a means of introducing new artifacts at higher education institutions.
- C4: - Requirements and guidelines for concurrent design of customized corporate e-learning; which includes 16 principles of concurrent e-learning design and some additional prescriptive approaches that should be considered for distributed workspaces.

More information on each contribution is found in Chapter 4.

1.6 Research Approaches

Several different approaches have been applied in connection with the research conducted as a part of this doctoral project. However, I have mainly used qualitative research methods and focused on understanding human behavior in a context where different experts utilize computer-supported cooperation to design new and holistic solutions. Furthermore, I emphasize design-based research (Reeves, Herrington, & Oliver, 2005) as an important source of inspiration for the research methodological approaches. This is because my doctoral project developed over several years, included cooperation between a number of people, utilized various research methods that were suitable to answer the research questions faced as the project progressed, identified design principles that can be further developed and used in other contexts, and ensured dissemination of results while the project was in progress.

The following list shows the most prominent research methods that were utilized when this design-based research project was ongoing:

- Literature review (Hart, 2001; Kitchenham, 2004) was used to identify and document "state of the art" within the relevant research fields.
- Design Science (Hevner, March, Park, & Ram, 2004) was used to develop new artifacts, i.e. the concurrent e-learning design method with connected artifacts such as the processes description, different templates, session plans, action lists, and decision lists.
- Action Research (Susman & Evered, 1978; McKay & Marshall, 2001; Davison, Martinsons, & Kock, 2004; Baskerville & Myers, 2004) was used to introduce new artifacts (i.e. the concurrent e-learning design method) into the target organization.
- Qualitative data analysis and different approaches to coding qualitative data were used to uncover principal conditions, mainly towards the end of the doctoral project (Saldaña, 2009; Bazeley, 2007).

While I used these research methods, data collection strategies or techniques such as video filming, sound recording, field studies and observations, interviews, and surveys were also used. For my own part, I have both planned and carried out video filming, audio recordings, interviews, observations, surveys, and discussions in project groups, while bachelor's level students performed observations in which I used the results.

In order to analyze the collected data, I used qualitative data analysis software (i.e. NVivo 9 which is a trademark or registered trademark of QSR International Pty Ltd). QSR International (2011) describes the product as follows: "NVivo 9 is software that helps you to work with unstructured information like documents, surveys, audio, video and pictures - so that you can ultimately make better decisions. Whatever your materials, whatever your field, whatever your approach, NVivo provides a workspace to help you at every stage of your project".

I have taken research ethics guidelines into account by entering into agreements in relation to what the projects actually deal with, and how the collected data could be used. All surveys have included information about this in the beginning while it is entered into separate agreements for video filmed observations and audio recorded interviews. These agreements for instance contained information which states that material can be used for research and publication, and that the data will be neutralized in this context.

Figure 1 presents the connections in the research presented in this thesis.

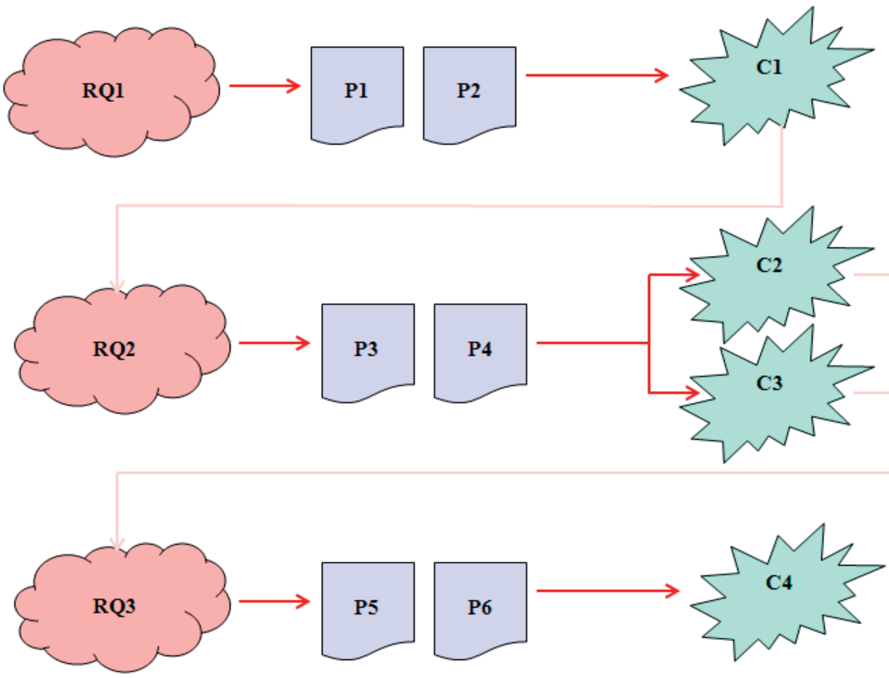

Figure 1: Connections between Questions, Papers, and Contributions

Figure 1 shows the progress from research questions (see Section 1.3), via research papers (see Section 1.4), to research contributions (see Section 1.5). In addition to the fact that the research papers contribute to a direct connection between the research questions and research contributions, there exist clear links between early contributions and research questions that were addressed later on. In Figure 1, this link is visible by the fact that there is a connection from C1 to RQ2 and from C2/C3 to RQ3. A more in-depth review of research methods and research context is outlined in Chapter 3.

1.7 Thesis Structure

The rest of the thesis is organized as follows:

Chapter 2: State of the Art – In this chapter the state of the art relevant for this interdisciplinary doctoral project is presented. This includes e-learning and instructional design for e-learning deliverables, in addition to software engineering, industrial concurrent design, and computer-supported cooperative work.

Chapter 3: Research Methods and Context – This chapter first presents relevant research methods used in this doctoral project. Next, I describe the R&D projects I have been involved in, before an explanation regarding which research methods that have been used in connection with the different research questions are presented.

Chapter 4: Results – This chapter first presents the main contributions of this thesis, then a summary of each research paper is presented, and finally the connections between research questions, research papers, and contributions are made clear.

Chapter 5: Evaluation and Discussion of Results – This chapter first discusses challenges related to interdisciplinary research. Next, I evaluate the research questions and the associated methods, then I evaluate the four research contributions, and finally the trustworthiness of this research is discussed.

Chapter 6: Conclusion – This chapter first sums up the main contributions, as well as the research questions and the research methods that led to these contributions. Next, some ideas in terms of future work are discussed, and finally, some concluding remarks are presented.

Appendix A: Selected Papers – This appendix contain the six peer-reviewed and accepted papers, which this thesis is based upon.

Appendix B: Secondary Papers – This appendix includes general information on one peer-reviewed paper and three project reports not found relevant enough to be included in its entirety.

Appendix C: Statements of co-authorship – This appendix is used to declare authors' contributions in connection with each paper.

2. State of the Art

Applying a concurrent design approach to the design of customized e-learning for corporate clients involves dealing with interdisciplinary issues. In this doctoral project this approach has involved well-established disciplines such as e-learning in higher education, instructional design, software development methodologies, concurrent design, and computer-supported cooperative work. This chapter first introduces the issue of customized e-learning deliverables from higher education institutions (educational provider) to corporate clients (customer). Then it considers the field of instructional design and different approaches for how e-learning deliverables are developed. Next, it discusses the field of software engineering and different approaches regarding implementation of software development processes. Then it presents the concurrent design methodology that was developed through the 1990s, before looking at a few selected topics from computer-supported cooperative work. Finally, ten statements summarize this chapter that serve as a basis for a concurrent e-learning design approach.

2.1 Moving with the Times: E-Learning in Higher Education

The Norwegian Association for Distance Education (NADE) was founded in 1968 as a national membership organization for institutions involved in distance education, and this happened at a time when distance education was synonymous with correspondence schools. Today, the members of NADE are independent distance education institutions such as public HEIs, private institutions, and training centers for business and industry and NADE is itself a member of several international organizations such as the European Association for Distance Learning (EADL) and the European Distance Education Network (EDEN). The objectives of NADE since its inception have been to contribute to disseminate knowledge about distance education in the Norwegian educational system (NADE, 2012).

The same year that NADE was established, more precisely on 9 December 1968, Douglas C. Engelbart and his group of 17 researchers in the Augmentation Research Center at Stanford Research Institute were able to demonstrate shared-screen collaboration involving two participants at different sites communicating over a network with audio and video interfaces (Engelbart, 1968). Although these two events had nothing to do with each other, they both form a part of the history of today's modern distance education. Since then there has been a rapid development in both the demand for education and training, and the technological solutions available for development and delivery of such educational programs. The concept of distance education is now replaced with terms such as online education, online learning, online distance learning, or web-based learning. The quality standards for online education which were published by NADE in 2011, define online education as: "educational programmes that are adapted for provision via the Internet and that facilitate communication between teacher and student, and between students" (Eide & Slåtto, 2011, p. 3).

It is mainly ICT-based technology that has contributed to the shift from distance education to online education since this technology comprises online solutions that enable actors access from anywhere, i.e. the actors can be located anywhere Internet access is available. However, ICT-based technology can be used for other purposes than distributed access and e-learning is possibly a term that covers this better since e-learning comprises all forms of ICT-supported learning and teaching and varies from e-learning courses for formal higher education to self-paced e-learning systems for informal training. It is also quite common to deliver parts of an educational program as e-learning while other parts are composed of face-to-face activities that do not necessarily use ICT. Such a mix of different learning environments is referred to as blended learning in educational research (Graham, 2006) or blended e-learning (Wills, 2006).

The following quote, which largely sums up what e-learning covers is from Andrews & Haythornthwaite: "By e-learning research, we mean primarily research into, on, or about the use of electronic technologies for teaching and learning. This encompasses learning for degrees, work requirements and personal fulfilment, institutional and noninstitutionally accredited programmes, in formal and informal settings. It includes anywhere, anytime learning, as well as campus-based extensions to face-to-face classes. E-learning includes all levels of education from pre-school to secondary/high school, higher education and beyond" (2007, p. 1).

There are many terms which in fact are variations on similar themes, i.e. they deal with ICT-supported learning and teaching in different ways. The literature studies in this doctoral project are based on a wide range of research articles which primarily are collected from electronic databases. I have searched in numerous databases including the ACM Digital Library, EdITLib Digital Library, IEEE Xplore, ISI Web of Science, SCOPUS, besides the Google Scholar search engine that indexes scholarly literature from several sources. I have combined search terms such as e-learning, online learning, distance learning, online distance learning, distance education, web-based learning, and blended learning and all these terms yields results that are relevant to e-learning in higher education and e-learning for corporate clients. Nevertheless, I choose primarily to use the term e-learning in my own dissemination (e.g. concurrent e-learning design), and in some cases, I use online learning as a specialization and a subset of e-learning. This is because I am concerned with approaches for effective and efficient design of ICT-supported learning and teaching in one form or another, and because ICT-supported learning and teaching always can be considered e-learning.

The market for e-learning has been growing rapidly over the past decade and the U.S. based study by (Kakoty et al., 2011), states that e-learning now accounts for 15 percent of all training delivered while classroom training has dropped from 70 percent to 62 percent. There have also been relatively large investments in e-learning during the past decades in EU.

The DELTA Programme (Development of European Learning through Technological Advance) from the late 1980s was a pioneering program in this context. This program aimed at increased learning and training opportunities for the adult population by means of advanced learning technologies (Delta, 1987). The JITOL project (Just In Time Open Learning) from the DELTA Programme was also a source of inspiration to the creation of NITOL (Norway-net with IT for Open Learning). NITOL was established in 1994 and resulted in several Norwegian HEIs collaborating to develop distance education (Haugen & Ask, 2012).

The Socrates Programme was the first European initiative covering education at all levels and this project formed a part of a broader approach to the concept of lifelong learning. Socrates was launched in 1995 and ran until the end of 1999 and it was replaced by the Socrates II programme in January 2000, which ran until 2006. Socrates and Socrates II had special programs for e-learning called ODL under Socrates and MINERVA under Socrates II and these programs supported transversal measures relating to open and distance learning and the use of ICT, including multimedia, in the field of education (Sustain, 2000). In addition, the European Commission's eLearning Programme was ongoing from 2004 to 2006. eLearning was a European programme in the field of ICT for education and training which promoted the inclusion of ICT in all learning systems and environments, i.e. both formal and informal education and training at schools, HEIs, and adult education (eLearning Programme, 2012).

At the moment we have the European Commission's Lifelong Learning Programme. This programme has a budget of nearly €7 billion for 2007 to 2013, and although there are no special sub-programs for e-learning in this programme it is fully possible to focus on e-learning within the four sub-programmes. In this context it is worth mentioning the Grundtvig programme for adult education (one of the four sub-programmes) which aims to support innovative ICT-based educational content, services and practice, or the Leonardo da Vinci programme for the vocational education sector (another sub-programme) which aims to make vocational education more attractive to young people, by helping people gain new skills, knowledge, and qualifications (Lifelong Learning Programme, 2012). These EU sponsored programs must also be considered as part of the basis for this doctoral project since the three institutions I have worked with (i.e. HiST/AITeL, NTNU/IDI, and TISIP) during the last few decades have been involved in several projects in DELTA, NITOL, Socrates, Socrates II, eLearning, and the ongoing Lifelong Learning Programme (TISIP Research, 2012) .

Although substantial resources are invested to exploit the potential of e-learning in HEIs, it is often bottom-up approaches which are not always successful. "The sustainable implementation of eLearning requires an encompassing change process which has to consider the strategic, didactic, organizational, economic and cultural dimension within the university –otherwise eLearning will remain a nice gimmick in the niches of the university" (Schoenwald, 2003, p. 6). The motivation to engage in e-learning can be diverse and it is therefore important to be aware of what one's own institution wants to achieve with such an investment.

First, e-learning and typical e-learning tools like Learning Management Systems (LMS) help to streamline the traditional forms of teaching, learning, and administration. This is because information, learning materials, and training programs are available via web-based systems that can be accessed anytime from anywhere, and which have additional features to support the learning processes, e.g. discussion forums, presentation forums, chat functions, or conferencing tools. The use of such tools will also contribute so that part-time students easily can attend classes at HEIs, even if they have other obligations which traditionally have not been easy to combine with studies (Laurillard, 2006).

Second, e-learning is an approach that can be used in relation to a growing need for alternative teaching methods for ordinary students. “The interactive computer could be used to give students an alternative to writing as a form of active participation in knowledge-building. It can model real-world systems and transactions, and can therefore create an environment in which learners can explore, manipulate, and experiment. The features of the digital environment are fully controlled by the program so that it can be designed to offer as much or as little freedom to the learner as is appropriate to their level of mastery” (Laurillard, 2006, p. 10).

In addition, e-learning can be the platform that is needed to meet the growing demand for knowledgeable and skilled personnel in the labor market. Independent lifelong learners and employees who single-handedly seek to continue with education in the workplace form a part of this (Kahiigi et al., 2008). Furthermore, it is a tendency for corporate clients (whether they are small, medium-sized or large enterprises) to cooperate with e-learning providers, when they design, develop, and deliver e-learning to meet the needs of the corporation in question (Paulsen & Vieira, 2006).

Competence and competencies development are very important for many corporations nowadays, and education is consequently becoming increasingly vital in the modern knowledge society. It is natural that HEIs, whose primary task is to engage with education, want to take part of this market, and e-learning is a natural approach in this context. “However, while e-Learning provides a flexible learning environment, it requires more than just transforming learning material into web-based environments and learning online. Successful implementations of e-Learning environments require an understanding of the technology and pedagogy integration for learning to take place effectively” (Kahiigi et al., 2008, p. 82).

Furthermore, customized e-learning for corporate clients must be designed so that the needs of both the client and the e-learning provider are taken care of. This means that needs regarding learning outcomes, learning activities, technical development and delivery, business matters, administrative matters, and additional services must be balanced to form comprehensive and sustainable solutions. This is about e-learning design which is the subject of the next section.

2.2 E-Learning Design

An e-learning design process is a series of steps and actions taken in order to achieve a particular e-learning design, i.e. a plan or convention for the construction of e-learning deliverables. The verb design thus reflects the design activity, while the noun refers to the design product that typically describes how a system should be put together, e.g. a blueprint or a comprehensive design document. An e-learning system is an arrangement of resources and procedures to facilitate learning and can be considered as a special kind of an instructional system which is produced and delivered by means of ICT. The processes for creating an instructional system is called Instructional Design (ID) and it deals with identifying and solving instructional problems (Gagné et al., 2005).

ID has its origin back to the early nineteen century, and many researchers have helped to develop models and theories (Paquette, De La Teja, Léonard, Lundgren-Cayrol, & Marino, 2005). In the 1970s the concept of Instructional Systems Design (ISD) was established and this was an attempt to apply systems theory and systems analysis as an approach to solve instructional design problems. “Instructional designers believe that the use of systematic design procedures can make instructions more effective, efficient, and relevant than less rigorous approaches to planning instruction. The systems approach implies an analysis of how its components interact with each other and requires coordination of all activities” (Gustafson & Branch, 2002, p. 18).

The Dick and Carey Systems Approach Model (also known as Dick & Carey) is a well-known ISD model which was originally published in 1978. This model made a significant contribution to the field of ID by its holistic system focus which consists of the interrelationship between context, content, learning, and instruction. Today, both ID and ISD are in most cases synonymous with the design of e-learning systems and there are several tasks and activities that are necessary to build different types of e-learning systems, i.e. strategic matters, instructional design approaches that combines clear learning goals with pedagogical models, technological choices that benefits the various stakeholders, and exploitation of various systems and services such as Learning Content Management Systems (LCMS), Learning Support Systems (LSS), and Learning Management Systems (LMS) (Ismail, 2002). This complexity has resulted in that ID models and tools now are renewed to support the development of modern e-learning deliverables, such as distributed learning systems or mobile learning approaches which to a great extent utilize modern ICT solutions (Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009).

There are several approaches to ID and a number of these are based on a problem-solving process with a series of phases like Analysis, Design, Development, Implementation, and Evaluation (ADDIE) (Peterson, 2003; Gagné et al., 2005). Instructional designers have different approaches to the ADDIE models, depending on experience and background among project participants, as well as the different kinds of products that are developed (Visscher-Voerman & Gustafson, 2004). Instructional designers also tend to have a different approach when they are in a university context with traditional campus students, compared to a more business oriented context with corporations as clients (Kirschner et al., 2002).

Corporations conduct learning activities to support the business goals and needs, and they aim to achieve advantages such as increased competitiveness, profit, and efficiency. Learning activities for corporations often focus on work situations, and how to master certain competencies or solve certain task, whereas learning at educational institutions is based on scientific disciplines or defined knowledge areas (Welle-Strand & Thune, 2003). The different stakeholders have to be involved sufficiently when e-learning is developed, and this applies increasingly for corporate e-learning. Designers of corporate e-learning (business designers) are much more client-oriented and emphasize the importance of client involvement in the process to a much greater degree than university designers (Kirschner et al., 2002).

Even though the ADDIE models for ID are based on a series of sequential phases, the practitioners often follow alternative approaches. Dick, Carey, & Carey (2001) is for example a model that looks different from the ADDIE model on the surface, but incorporates all aspects to differing degrees. Another example is found in the MISA[1] instructional engineering method which has an iterative cycle and where the different models (i.e. the knowledge model, the instructional model, the media model, and the delivery model) evolve in parallel through the different phases (Paquette, 2004b). The Web-Based Instructional Design (WBID) model by Davidson-Shivers & Rasmussen (2006) also explains that some stages are conjoined rather than isolated and must be performed in tandem. This is described as concurrent design, and indicates that the design, development, and formative evaluation tasks are conducted simultaneously. Some of the arguments for using concurrent design principles are given in Davidson-Shivers & Rasmussen: "With many web-based instruction projects, especially complex ones, it is not possible to complete all of the design activities for the entire project before starting development. Constraints of resources, time, and money, and the desire to be responsive to the customer suggest that concurrent design may be a good approach. Concurrent design also permits unforeseen technical difficulties to be resolved well before the final web-based instruction is completed" (2006, pp. 172–173).

[1] MISA is a Learning System Engineering Method with a French acronym: Méthode d'ingénierie des systems d'apprentissage.

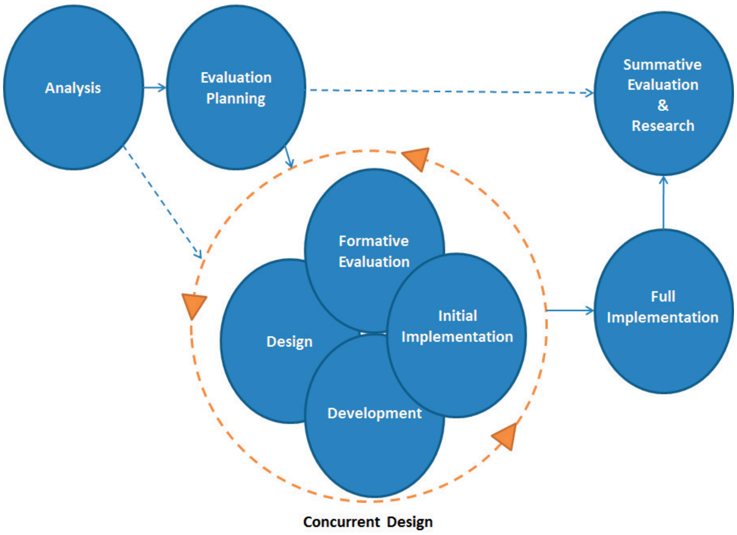

Figure 2: The WBID-Model. Based on Davidson-Shivers & Rasmussen (2006).

Figure 2 presents the eight phases of the WBID-Model process. The fully drawn arrows indicate the order of the process while the dashed arrows indicate information that is transferred between the phases. There are two conditions which are fairly characteristic and distinctive in the WBID-Model, which also has been an inspiration for the e-learning design approach materialized in this doctoral project. First, it is the model's focus on both formative and summative evaluation that comes very early in the process compared with other methods. Formative and summative evaluation is also essential components in other models such as Dick & Carey but it is first covered towards the end of the process (Dick et al., 2001). Second, it is the multidisciplinary and integrated interactions taking place when the solutions are designed, developed, implemented, and formatively evaluated, i.e. the approach which is referred to as *Concurrent Design*[2].

Evaluation is an aid used to determine the value of an educational product or program and the WBID-Model distinguishes between formative and summative evaluation. Formative evaluation is used in the early phase when the e-learning deliverables are designed and developed and the goal is to get the best possible product, while summative evaluation is performed after the product is implemented in its target organization, to determine if it works as intended. Evaluation is seen as so important in the WBID-Model that it is made explicit and as separate phases (i.e. Evaluation

[2] The concept of concurrent design as used in the WBID-Model must not be confused with the same concept as used by the space agencies such as NASA and ESA. The WBID-Model uses the term just to explain that the various activities are taking place in parallel, while the space agency's refers to an entire methodology that is rather strictly defined. (See Section 2.4 for more information about concurrent design).

Planning and Formative Evaluation) which comes in addition to the final evaluation phase in ADDIE models. However, evaluation may also be an important aspect of other ID models and this might apply even if concepts such as formative and summative evaluation are not used. Internal versus external validity and qualitative versus quantitative evaluations are examples of other dimensions that might be used instead of formative and summative evaluation (Mandinach, 2005).

Figure 2 shows that Evaluation Planning is the second phase of the WBID-Model and in this phase detailed determinations regarding formative evaluation are taken, besides general and preliminary plans and decisions for the summative evaluation. The plan for the formative evaluation can typically include: (1) who the stakeholders are, (2) what should be evaluated, (3) who will conduct the evaluations, (4) the evaluation methods to be used, (5) when and how the evaluation will take place, and (6) how to communicate and disseminate the results of the formative evaluation. The value of e-learning deliverables is evaluated along the following dimensions that are used both for formative and summative evaluation:

(1) Effectiveness and the extent to which the learning outcomes are fulfilled, i.e. measurements that determine whether learners achieved the instructional goals.

(2) Efficiency regarding how the resources are utilized, i.e. measurements that determine whether savings in time, money or other resources take place.

(3) Appeal and the extent to which the system is appealing and captures the students' attention while it has a usability which ensures that they remain in the system.

Dick & Carey, MISA, WBID-Model and other traditional ADDIE models all serve as frameworks and cyclical processes that can be used when new e-learning deliverables are developed. The models provide recommendations in relation to what one should focus on and when different events should occur in the development process. Although there are some differences (e.g. sequential versus iterative process approaches, timing of evaluation, and the level of guidance from different learning theories), there are also many similarities. "ISD models are representations of the concepts of a systematic approach to instructional design. There is not one best model, a right model, or a wrong model in any theoretical or abstract meaning of the concept" (Gagné et al., 2005, p. 42). Most ID or ISD models are generalized and prescriptive models provide guidelines and frameworks to organize and structure the process of creating instructional activities and materials. Here is a brief description of some typical activities within the different ADDIE phases:

1. Analysis aims to answer fundamental questions about needs and requirements related to the upcoming e-learning deliverables, e.g. for what problem is e-learning a solution, what is the purpose, what should be the goal, what is the context, and who are the learners?

2. Design aims to turn results from the analysis phase (e.g. needs, requirements, and goals) into more concrete formulations such as learning outcomes, learning activities, and assessment specifications. It is common to use classification systems when learning outcomes are described and to use different categories (e.g. knowledge, skills, and attitudes) to clarify the competencies associated with

achieved learning outcomes (Harden, 2002). Gagné's Categories of Learning (1985) and Bloom's et al. Taxonomy for the Cognitive Domain (1956) are two commonly used classification systems for learning outcomes.

3. Development involves preparation and production of materials, activities, and technical mechanisms included in the upcoming e-learning deliverables.
4. Implementation is the phase where the e-learning deliverables are tested in their target environment. Designers and developers should provide help or support as needed and continue to analyze, redesign, and enhance the product.
5. Evaluation is the final phase where plans for different evaluation activities are implemented, e.g. student evaluation, program evaluation, or evaluation of the entire e-learning product with regard to future maintenance and revision.

Many theoretical presentations of how ID takes place have a homogeneous representation with a problem solving process that follows certain phases (e.g. analysis, design, development, implementation, and evaluation). However, it turns out that ID in practice is much more heterogeneous and diverse than what these phase models indicate. This is in many ways natural and the following factors may help to explain them:

- Different products are development (e.g. generic curricula for primary or secondary schools, formal higher education courses, or customized training programs for corporate clients), and it is natural that these are handled differently.
- Different projects vary with parameters such as size, time frame, the number of participants, and budget.
- Instructional designers have different profiles including knowledge, skills, practical experience, and formal education that also serve as a guideline in relation to how ID is really implemented.

The next section discusses different approaches to ID which different practitioners might apply.

2.2.1 Divergent Approaches to Instructional Design

Instructional designers have a variety of approaches and these differences are explained in different ways by various researchers. Visscher-Voerman & Gustafson (2004) refer to a study of experts in ID and this study intends to identify how these experts design in practice, and more specifically what they actually do in the different situations that arise. As an explanation, a framework consisting of four design paradigms is developed: 1-Instrumental Paradigm, 2-Communicative Paradigm, 3-Pragmatic Paradigm, and 4-Artistic Paradigm. Stubbs & Gibbons (2008) provide an explanatory model that resembles some of this, in that they have identified four modes representing distinct but common approaches to ID. These modes were developed from observations of design practices and they were named: 1-Instructional Manufacturer, 2-Instructional Engineer, 3-Instructional Architect, and 4-Instructional Artist. A different approach to how instructional designers actually work was presented as Sixteen Design Principles by Irene Visscher-Voerman in 1999 and these principles are also used in Kirschner et al.

(2002). Kirschner et al. (2002) conducted two experiments in which experts in ID and their actual approach to the design tasks are investigated and the design principles from Visscher-Voerman (1999) are used to explain how different designers prioritize.

The purpose of the study presented in Visscher-Voerman & Gustafson (2004) was to discover similarities and differences between various design strategies. Sometimes it was contradictory answers in relation to why instructional designers should perform specific activities or what the value of these specific activities was. The researchers searched for a structure in the collected data and argued that they found a connection to philosophical literature. This resulted in the development of a framework consisting of four design paradigms, which could be related back to one of the following four philosophical movements: (1) modernism, (2) critical theory (3) pragmatism, and (4) postmodernism. Here is a brief introduction to each of these four design paradigms:

- **Instrumental Paradigm** – The instrumental paradigm is based on modernism where hypotheses that can help solve the current problem are formulated on the basis of theories. The instrumental rationality within modernism is further discussed in a separate section in Visscher-Voerman & Gustafson (2004, p. 78). Most models of ISD as described in the literature belong to the instrumental paradigm and these are the models that are most often used by practitioners. According to the instrumental paradigm, a design should satisfy some predefined and absolute standards. There should be a clear connection between defined goals and the process one should undergo in order to achieve these goals. Because of this, the formulation of objectives and targets are seen as a key activity and a part of the analyses that are performed early in the design process, e.g. requirement analysis or needs analysis. In order to work as efficiently as possible, the designers seek answers to these analytical issues as early as possible and they need these answers in order to allow the design process to progress. Some of the strengths of the instrumental paradigm are that it provides guidance regarding how work should be done and consequently it acts as a useful communication tool. Furthermore, this systematic approach leads to products that are internally consistent and measurable in terms of established specifications.

  Some of the weaknesses of the instrumental paradigm are that it might be difficult to describe the goals at the start of a project and that it ignores the fact that goals may change during a project. Furthermore, it might be inefficient to follow a strictly defined process in some cases and one runs the risk of developing products that actually do not satisfy the end users' real needs.

  In the instrumental paradigm instructional designers are typically those with expert knowledge in relation to design and development of e-learning deliverables and they are naturally responsible for the prepared design. The client acts as a provider of information and as a person responsible for approving the project activities and final results.
- **Communicative Paradigm** – The communicative paradigm is based on critical theory in which one does not necessarily seek to discover the truth, but rather how one wishes to achieve consensus. Communication between stakeholders is important within this paradigm and a design specification is considered appropriate if it meets

the standards, such as the parties have agreed upon during their conversations. The communicative rationality within critical theory is further discussed in a separate section in Visscher-Voerman & Gustafson (2004, p. 80). Activities that aim to achieve clarity and agreements between the parties in relation to what to create (the product) and how to create it (the process) are means to reach acceptable quality within the communicative paradigm.

Designers should prepare by formulating a platform of ideas that contains relevant and familiar themes, e.g. different problem definitions, requirements for materials, or tentative product concepts including how these could be developed. Such a platform of ideas will be part of the input to the communication process, in which different ideas are tested and some become a part of the final solution, while others are discarded. Some of the strengths of the communicative paradigm are that good relationships with different stakeholders (end users) are established, by asking for input when prototypes are evaluated. In this way, these stakeholders also claim ownership for the product under development.

Some of the weaknesses may be that the communication process is difficult and that the developed design specifications suffer from this. Handling of communication challenges that arise, such as endless discussions, require experience and skill from the designers. It can also be difficult to determine who should finally approve decisions in relation to the product, when different interests are contradictory. Instructional designers act as facilitators who help the customer to define requirements, which in turn is used to develop the product. The responsibility for the product is more or less divided between instructional designers and customer representatives and the customer contributes both with design activities and decisions, in addition to providing necessary information for the project.

- **Pragmatic Paradigm** – This is related to pragmatism where a statement typically is true if it works and if it is considered useful. Within this paradigm, designers can only be satisfied if the produced e-learning deliverables work and are useful for the end users. The products are considered to be good if it can be proved that they are practical and effective for users within the context they are meant to operate. The pragmatic rationality within pragmatism is further discussed in a separate section in Visscher-Voerman & Gustafson (2004, p. 82).

  It is common to develop early prototypes that are the subject of formative evaluation within this paradigm, and the use of prototypes is a means to understand the design problem and how users will interact with the final product. Limited analysis activities are performed before the design phase starts, but analysis becomes an integral part of the design activities. This is because evaluations of early prototypes are considered more useful than lengthy analysis in the beginning, which is more common within the instrumental paradigm.

  Some of the strengths of the pragmatic paradigm are its efficiency, since the paradigm in some cases helps to achieve good results, quickly and at a low cost. Furthermore, the user involvement leads to products that to a large extent are tailored to the user needs. Although the pragmatic paradigm in some cases can be very effective and efficient it can also result in the opposite. The process can be inefficient because of its experimental method of problem solving (trial and error), which can lead to numerous revisions. Furthermore, it may be difficult to plan and manage the process and there is always a risk of conflicts between the various

stakeholders that will delay the design process.
In the pragmatic paradigm instructional designers are considered experts who are responsible for the prepared design. However, the designers are dependent on input and information from customer representatives who typically are future users of the e-learning deliverables.

- **Artistic Paradigm** – The artistic paradigm is based on postmodernism where the aim is to dissolve the boundaries between science and art in some way. The designer's unique experience and expertise is essential for what should be designed within this paradigm. The designers' decisions are therefore dependent on the situation in which they work and the design process cannot really be planned in advance. Designers are considered "artists" who really can choose from an infinite number of ways to represent reality and this might imply a focus on some aspects of the design situation, while other aspects are neglected. The artistic rationality and postmodernism is further discussed in a separate section in Visscher-Voerman & Gustafson (2004, p. 83).
  The strength of the artistic paradigm is that this approach can lead to unique and creative products, since the designer does not limit the solution's options. However, there is also a danger in that focusing too much on the designer's own ideas will neglect end users' needs and requirements from other stakeholders. Furthermore, the process can hardly be defined clearly and explicitly and therefore it might be difficult to document the process and learn how it works. Within the artistic paradigm the instructional designer is an "artist", who uses his/her own subjective and unique knowledge and reflections. The designer is fully responsible for the design and the customer is primarily a user of the product who is sometimes consulted during the design and development process.

Four modes are used to develop a broader understanding of the process of ID in Stubbs & Gibbons (2008). This approach has much in common with the four paradigms as presented in Visscher-Voerman & Gustafson (2004) since the purpose of this study also was to classify how instructional designers work on the basis of observations of ID practice. In this case they are not based on main philosophical movements but rather on different and characteristic professions. The four identified modes differ in several dimensions and there is now a brief discussion regarding how different practitioners actually do their work:

- **Instructional Manufacturer** – The manufacturer typically uses a defined process and seeks to develop the product as effectively and efficiently as possible. It is important to finalize the product on time and ensure profit, whereas it is less important to involve users and other stakeholders. This mode has much in common with the instrumental paradigm that was discussing earlier in this chapter.
- **Instructional Engineer –** The engineer will to a greater extent than the manufacturer involve customers and other stakeholders in the design process. Furthermore, the engineer typically spends time designing higher-level learning materials, e.g. interactivity between the participants, interactive exercises, or simulated models of complex phenomena. This mode has similarities with several of

the above mentioned paradigms, e.g. the communicative paradigm and the pragmatic paradigm.

- **Instructional Architect** – The architect will to an even greater extent than the engineer design new and innovative solutions that promote high-level learning. The architect is typically motivated to extend the boundaries of available media and develop new solutions that actually contain more than what is included in initial pedagogical and technical specifications for the instructional problem. This mode has also similarities with several of the above-mentioned paradigms, e.g. the communicative paradigm and the pragmatic paradigm.
- **Instructional Artist** – The artist can be considered as an instructional explorer who uses instructional challenges as stimuli to experiment with different solutions. Instructional artists do not need external clients, as they often can serve as their own client. Furthermore, such artists are very concerned about aesthetics while they care less about profit. This mode has much in common with the artistic paradigm from Visscher-Voerman & Gustafson (2004).

In conclusion of this review instructional designers are encouraged to act more like instructional architects and instructional artistic. In this context there are eight key areas which it is recommended to work with to become a better instructional designer (Hokanson, Miller, & Hooper, 2008, p. 16).

Another approach to classify how instructional designers actually do their work is to define the principles they utilize as a basis for the work. This is what Irene Visscher-Voermans did when the sixteen design principles were introduced in Visscher-Voerman, (1999). These principles are also used in the study presented in Kirschner et al. (2002). In this study they conduct two experiments in which experts in ID and their actual approach to the design tasks are investigated. These two experiments were carried out by fifteen experts, of whom nine belong to academia (Open University of the Netherlands), while the other six belong to a private consulting firm (Arthur Andersen). The experiments show that there are both similarities and differences between these two groups from academia and private consultancy. Everyone seems to agree that ID should be based on the students' needs rather than academic content and they both highlight the following four principles as important:

- Designers should develop prototypes early in the design process and use these in dialogue with the customer. This will serve as a tool with regard to how the different solutions should be designed and developed.
- It is important for designers to spend time and use energy to establish a dialogue with customers and other stakeholders. This will ensure that these stakeholders feel ownership with the product under development.
- A useful tool when you want to help clients, partners, and other stakeholders to select a solution or formulate a product specification is to let them see relevant solutions, i.e. other products or solutions that are developed and used in other projects.
- Designs should always be based on students' needs rather than a content-based structure when new instructional designs are to be developed.

The main difference between these two groups was the fact that those with an academic background were more formal, while those from private consultancy had a greater customer focus. In practice, those with an academic background typically examined several alternative solutions while they also focused on the project plan and the different characteristics of the design document, i.e. they were formal and in accordance with the defined process. On the other hand those from private consultancy focused on the customer. It was important to establish a good dialogue with the customer early in the project, and to show the customer relevant examples from previous projects.

Although the studies in this section classify instructional designers in terms of the design paradigms, design modes or design principles which they prefer, it is important to emphasize that most instructional designers vary their approach to ID (Kirschner et al., 2002; Visscher-Voerman & Gustafson, 2004; Stubbs & Gibbons, 2008). Several researchers have also questioned whether ID truly is a design activity, as compared to general practice in design found within disciplines such as architecture, industrial design, or software engineering and Stubbs & Gibbons (2008) refer to several studies which concluded that ID really is a subset of design.

However, it is pointed out that most design professions today rely heavily upon various types of drawings. These drawings are used for the development of ideas and for communication between the stakeholders meaning that a design drawing can be considered a visual language for ID. "It is a paradox that a field that relies so heavily on visualization for the outcome of its designs has not studied its use in its process. In spite of the apparent similarities between ID and other design fields, and the importance of drawing to design in those fields, design drawing as a tool or skill of ID has not been adequately addressed in the ID literature" (Stubbs & Gibbons, 2008, p. 35). Various standards, tools and methods that can be used in connection with design, development and implementation of e-learning deliverables are the subject of the next section.

2.2.2 Standards and Tools towards Instructional Engineering

Nichols provides the following simple definition of e-learning: "E-learning is pedagogy empowered by digital technology" (2008, p. 2). In this context it is important to emphasize that the technology is a means to support the pedagogy which in turn is a means to achieve specific learning outcomes. The technology is not a goal in itself and a technological infrastructure for e-learning should not be built without considering academic and educational requirements for the e-learning program (Levy, 2003). Although the technology is subordinate to the pedagogy we have to deal with the fact that technology, in terms of technological standards and tools is a very important part of the nature of e-learning. Several studies that aimed to uncover what it takes to succeed in e-learning point out that the technology is only a means to achieve the goal. Nevertheless, at the same time these studies emphasize that the technology is important. The technology must be mastered and understood in order to be optimally utilized, and training in technology for both staff and students is recommended in this context (Volery & Lord, 2000; Levy, 2003; Williams, Nicholas, & Gunter, 2005; Menchaca & Bekele, 2008).

This section contains a review of some important technological standards and tools which are used in connection with design, development, and delivery of e-learning. We start with a brief review of the IMS[3] Learning Design (IMS LD) and a few other standards and tools that are natural to mention in this context. Next, we present several tools that can be used to design, develop and deliver e-learning. Finally, we refer to a concrete example of how standards, tools and processes together constitute a holistic approach to ID, which is referred to as instructional engineering.

Standards

The Open University in the Netherlands made a strategic decision in relation to e-learning in 1997 and as a consequence of this a pedagogic meta-language named Educational Modeling Language (EML) was developed over a period of three years. EML version 1.0 was first released in 2000 and later accepted as the basic specification for the development of IMS LD. IMS LD version 1.0 which was freely available from February 2003, represents a language that users should understand, regardless of educational approaches, and the goal was to make it possible to migrate existing designs into IMS LD (Koper & Tattersall, 2005). The purpose of IMS LD is therefore to describe e-learning environments and this involves the following:

- To create a standardized description of teaching and learning processes that can be adapted to different situations and implemented by means of e-learning.
- The courses are developed before they are used and they could possibly be used by different students or student-groups at different times. This means it is based on multiple runs where the solutions are developed once before they are used many times.
- The courses are largely managed by computer programs (IMS LD) and less of teachers and administrative personnel.
- The courses are designed so that a given target group (persons with certain conditions and constraints) can reach defined learning goals and learning outcomes in an effective manner.
- The standard provides support for all types of education which can be based on different pedagogical approaches and different learning theories.
- Learning activities and supporting activities have the main focus and these activities are considered more important than the course content.
- The representation is neutral and largely independent of media and technical devices, i.e. it acts as an integrated framework for a large number of open standards and technologies such as IMS CP (Content Package), IEEE LOM (Learning Object Metadata), and the Sharable Content Object Reference Model (SCORM).

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[3] IMS - The formal name of IMS is IMS Global Learning Consortium Inc. IMS GLC is also used. Originally (in 1997) was IMS an acronym for Instructional Management System project, but today only the abbreviation IMS is used.

The IMS LD specification consists of three main documents: (1) IMS LD Best Practice and Implementation Guide, (2) IMS LD XML Binding, and (3) IMS LD Information Model. Detailed specifications which are freely available from the IMS Global Learning Consortium web sites can be used by developers who aim to create tools and systems that implement IMS LD (IMS, 2012). Here are some key concepts from the IMS LD specification:

- Learning Design - A learning design is a description of a method where the student should achieve learning objectives by performing learning activities in a planned sequence and within a certain environment.
- Unit of Learning - A unit of learning might be a subject, module, or lesson. A unit of learning is typically associated with resources which can be files, references, assessment programs, teaching materials, and various services. A package mechanism is needed so that the learning design and associated files can be placed into a content package.
- Content Package (CP) - A content package contains a file structure that must have a manifest and associated files. Details of the manifest are a part of the IMS Content Package specification.

The concept of IMS LD is presented in part one of Koper & Tattersall (2005). This covers the IMS LD specification and it serves as a guideline for both architecture and tools that are recommended if e-learning courses based on IMS LD are to be developed. Even though this part is rather technical it shows several references to open source applications that could be used to get started with IMS LD (Koper, 2005; Olivier & Tattersall, 2005; Wilson, 2005; Griffiths, Blat, Garcia, Vogten, & Kwong, 2005). Instructional designers will typically use tools with a higher representation level when they perform their tasks and produce new learning designs, e.g. the RELOAD Learning Design Editor which is a freely downloadable editor that provides support for IMS LD version 1.0 (RELOAD, 2012).

A common way to provide e-learning is by means of Learning Management Systems (LMSs) which may also be referred to as Virtual Learning Environments (VLEs). There are many different systems used for this purpose and the standards mentioned above (i.e. IMS LD, IMS CP, IEEE LOM, and SCORM) intend to help designers be able to design solutions that can be used by one or more LMSs. The aim is to develop learning resources (e.g. learning designs or learning objects) that can be reused across time, place, and available technology. IMS LD is an educational modeling language and there are several software tools to produce IMS LD output. An IMS CP is a kind of a learning object which allows the transference of e-learning content from one system to another and which allows import and export into and from LMSs, without specifying any pedagogical recommendations or standards. The IEEE LOM standard specifies the syntax and semantics of learning object metadata. LOM is used to describe learning objects which is digital or non-digital entities that can be used, re-used, or referenced during technology supported learning. LOM is a double IEEE and IMS standard and it is integrated in IMS CP, meaning that LOM can be used to describe both individual elements and the package as a whole. SCORM is a specification of the Advanced Distributed Learning (ADL) Initiative, which comes out of the Office of the United States Secretary of Defense. SCORM does not introduce new standards or specifications but it coordinates and refers to already established standards and specifications. The SCORM 1.2 profile extends IMS CP with more sophisticated sequencing and contents to LMS communication, while the SCORM 2004 profile includes IMS Simple Sequencing, which is an educational modeling language to define learning sequences (Bohl, Scheuhase, Sengler, & Winand, 2002; Balatsoukas, Morris, & O'Brien, 2008).

The use of standards and specifications contributes to platform independent and open technologies and e-learning systems with the user in focus. This is expressed by virtue of: (1) interoperability where content from different providers can be used within a multitude of systems, (2) re-usability so that content and code easily and quickly can be reused, (3) manageability so that learners have access to relevant materials and tasks while the work progresses, and (4) accessibility so that learners can access the relevant material regardless of the time, place, and with an appropriate device (Varlamis, Koohang, & Apostolakis, 2006). However, there are several researchers who argue that learning specifications such as IMS LD, IEEE LOM, and SCORM are of limited use. This is because they are not sufficient to provide an advanced level of support to the learning process, such as recommendations regarding which content should be used in a certain situation or a link between the learning design and the applied learning theories. As a response to these challenges, several researchers have worked to define ontologies, i.e. formal explicit descriptions of concepts that could be used to characterize specific learning situations (Psyche, Bourdeau, Nkambou, & Mizoguchi, 2005; Jovanovic, Gaševic, Knight, & Richards, 2007; Paquette & Léonard, 2008).

Tools

There are various tools and technologies that can be used in connection with e-learning. Some of these are intended for design or development of e-learning deliverables, while others are used during delivery of e-learning programs, e.g. to support the interactions between involved parties. Paulsen (2002a) presents the Jigsaw Model and the Hub Model for online education systems and in these models a distinction is made between: (1) content creation tools which course designers and teachers use to create content that could be plain text, slides, graphics, pictures, animations, simulations, assessments, audio, or video, (2) learning management systems (LMSs) which are very widely used for administration, documentation, tracking, and reporting in e-learning programs, (3) student management systems which is the core system in educational institutions that is used for information about students, faculty, courses, applications, admissions, payment, exams, and grades, and (4) enterprise resource planning systems which typically includes an accounting system for financial transactions, a human resource management system for the management of employees, and a customer relationship management system for the institution's interactions with customers (i.e. existing and prospective students). LMSs are probably the single tool that is most widespread when HEIs offer online education. Paulsen (2002b) refers to a Nordic study where it is claimed that it is difficult to find Nordic institutions without experience with LMSs. However, there are also many educators who are critical. The Norwegian it magazine Computerworld had an article on LMSs on 12 December 2011, where it is claimed that such systems are not always functioning optimally and in relation to pedagogical needs. Furthermore, it is stated that there are many alternative solutions, which also are freely available and can help solve educational challenges better, e.g. web 2.0 technologies that provide teachers new and meaningful ways to engage their students (Computerworld, 2011).

Tools and technologies that are used during the implementation and delivery of e-learning courses can be considered as instructional media and selection of appropriate instructional media is a part of the ID process. In the selection of appropriate media for e-learning courses, it is important to consider whether we aim for synchronous or asynchronous learning environments and whether we aim for symmetrical or asymmetrical learning environments. A synchronous learning environment supports live and bidirectional communication between all participants (instructor and student) which could be text based, oral, or audiovisual, while asymmetrical interactions is when the information flow is single directed such as lectures, textbooks, or simple computer-based instructions (Holden & Westfall, 2006). The selection of instructional media and relevant technologies to support the upcoming e-learning deliverables is referred to as an important part of the ID process (Holden & Westfall, 2006).

In this doctoral project, I have focused mostly on the ID process and specifically on a concurrent design approach to the design of customized e-learning for corporate clients. In the continuation of this section about tools, I will concentrate on tools supporting the ID process. ID is considered as a design activity and design professions nowadays rely heavily on various types of drawings for both the development of ideas and communication of findings (Stubbs & Gibbons, 2008). The use of design tools has unfortunately been a neglected area within ID, but several researchers have addressed this in recent years. An important contribution in this context is the Handbook of Visual Languages for Instructional Design (Botturi & Stubbs, 2007). This book is divided into three sections:

- Section-I explores the underlying reasons behind visual languages for instructional design. Here there are five papers which point out that instructional design is a collaborative process that requires communication between multiple parties and where the use of visual design languages and tools can be very beneficial (Botturi & Stubbs, 2007, pp. 1–89).
- Section-II contains eleven papers which actually serve as guidance to practitioners who want to try out different instructional design tools. Several tools and visual languages are reviewed in this section and it might be appropriate to utilize some of these when the aim is to implement a concurrent design approach and design customized corporate e-learning (Botturi & Stubbs, 2007, pp. 91–343).
  One example in this context is the Educational Environment Modeling Language (E2ML) which is a specialized process design language that is tailored to educational needs. “The main assumption behind E2ML is that a visual language may foster creativity and enhance communication. Creativity and communication are two important keys for the quality of designs, and better designs mean increased instructional quality, thus allowing more people to learn better” (Botturi, 2008, p. 131).
  Other examples are found in Tattersall, Sodhi, Burgos, & Koper (2008) where a series of tools supporting IMS LD are reviewed. These tools are considered as first-generation tools which served as reference implementations of the IMS-LD

specification. Later, several of the tools referred in this paper are further developed, so that they more easily can be used by instructional designers and others who are not technical experts. An example of this is the Reload learning design editor, which was further developed into the Recourse learning design editor (Griffiths, Beauvoir, Liber, & Barrett-Baxendale, 2009). The purpose was to hide the specification from end users (instructional designers) so that instructional designers and other non-technical experts can realize the ID process without being exposed to the underlying complexity.

- Section-III contains five papers with experience from the practical use of visual instructional design languages. These studies show that modern ID has become very complex and that communication between instructional designers and other stakeholders in the design process is of crucial importance. It is argued that the practice of ID can benefit from design drawings, but the use of visual languages are not fully understood so far. It is a challenge to move the current use of visual languages and tools from being a practice among specialists to become useful for mainstream educators and other stakeholders (Botturi & Stubbs, 2007, pp. 345–438).

There are various tools that can be used in the ID process. However, it is not necessarily easy to find tools that support our particular needs. One alternative may be to use different tools for various purposes and combine design models with different focus to make a comprehensive design model for the entire e-learning deliverable. A challenge with such a strategy may be the integration between the different tools. Changes in one design model or one tool should ideally be reflected in other models and tools, but this requires integration solutions that do not necessarily exist. Furthermore, there may be a threshold to master visual languages and supporting tools for participants in an ID project. It requires both knowledge and experience to become skilled instructional designers who are able to utilize relevant tools properly.

ID can be described as knowledge work, i.e. work characterized by perennial processing of non-routine problems that require non-linear and creative thinking (Reinhardt, Schmidt, Sloep, & Drachsler, 2011). The knowledge of the workers is the true means of production in knowledge work and it requires significant education and training to be able to generate, develop, and implement ideas which are innovative, sustainable, and adequately competitive. "Designing, including instructional design, is knowledge work. Many of the activities of knowledge work are verbal and visual. They involve sharing, recording, notating, and creating ideas–most supported by some technology, the most ubiquitous being paper" (Hokanson, 2008, p. 77).

As an alternative to paper, it is also very useful to apply general ICT tools such as word processing tools, spreadsheets, or mind-mapping tools. Today, such tools also exist as distributed versions where several designers (whether they are co-located or distributed) can work synchronously or asynchronously to produce comprehensive design documents, also across organizations and countries. Furthermore, these could be delivered as cloud computing services (Armbrust et al., 2009) such as Google Docs[4] for collaborative writing or Mindjet Catalyst[5] which could be used to co-edit mind maps.

The use of ID tools can to a great extent be systematized in order to better support the design process where the tools are used, i.e. tools and processes are adapted to fit each other. In the next section we will look closely at one such approach which is entitled instructional engineering in networked environments (Paquette, 2004b).

Instructional Engineering

Paquette (2004b) uses the term instructional engineering in connection with a renewed instructional design method entitled MISA. The work to develop the MISA method started at the LICEF Research Center of Télé-université of Québec in Canada in 1992. MISA is described as an instructional engineering method and it is based on instructional design, software engineering, and knowledge engineering. The method consists of a process which is followed when instructional engineering projects are implemented. The input to this process is typically a need for a new training system, while the output is a fully developed e-learning system. The process consists of 6 phases which among other things deal with problem definitions, design and development of an architecture for the e-learning system, design and development of instructional materials, validation, and preparation for final implementation of the entire e-learning system. Through the MISA process the upcoming e-learning system is described along four dimensions and various design principles are utilized along the way. The design models for new e-learning systems thus consist of 4 separate sub-models that make up a comprehensive and unified model:

1. The Knowledge Model which contains a graphical representation of the content included in the e-learning system.
2. The Instructional Model which contains learning scenarios where learning activities and support activities are specified and linked to resources in the environment.
3. The Media Model which defines materials (learning objects) by means of media components, source documents, principles for presentation, and other factors which for instance graphical designers can utilize.
4. The Delivery Model which describe where and how the various actors can use learning materials and resources such as different kind of tools, communication devices, and services that are needed when the actual e-learning course is implemented.

MISA also defines some design principles to be used when e-learning deliverables are designed and developed. These principles are part of the input to the process when the project starts and they are used throughout the process:

[4] Google Docs is a trademark or registered trademark of Google Inc.

[5] Mindjet Catalyst is a trademark or registered trademark of Mindjet LLC.

- The self-management principle. Students should have control over their progress and manage their own studies. Formative assessment and reporting in relation to students' progress are very useful in this context.
- The information processing principle. E-learning deliverables will contain rich information resources which are both static and dynamic. These should be clearly related to specific activities that are to be carried out.
- The collaboration principle. Interactions and individual activities must complement each other and one should implement both synchronous and asynchronous interactions.
- The personalized assistance principle. Both human facilitators and machine-based systems should contribute to a flexible learning environment which supports the students, and this should mainly be based on students' own initiative.

There has been developed various modeling tools which also support IMS LD in connection with the MISA method. An example of this is the MOTPlus editor which is a generic graphical modeling application and where a specialized version supporting IMS LD exists. This version contains predefined object which are consistent with the IMS LD specification, so that it is easy to define IMS LD compatible units of learning at level A. As a continuation of this work are some additional tools related to the different MISA models developed. This includes the TELOS (TELelearning Operation System) Scenario Editor and the TELOS Ontology Editor that are discussed in connection with the conceptual framework TELOS. The ontology editor is typically used to define the knowledge model and the needed content, while the scenario editor is used for the instructional model, including relationships between various participants, activities, documents, tools, and products (Paquette & Léonard, 2008).

Paquette defines instructional engineering as: “A method that supports the analysis, the creation, the production, and the delivery planning of a learning system, integrating the concepts, the processes, and the principles of instructional design, software engineering, and knowledge engineering” (2004b, p. 56). Instructional engineering processes are complex and we need several different disciplines represented to establish a complete instructional engineering team. All of the individuals involved in e-learning projects may be considered stakeholders and we need contribution and decisions from different stakeholder during the instructional engineering process. Stakeholders will vary from project to project but the following list from Davidson-Shivers & Rasmussen (2006, p. 29) might be of help with respect to which individuals that should be considered stakeholders in a particular project: (1) Clients (e.g. owners, customers, or project sponsors), (2) employees (e.g. staff, training participants, or students), (3) shareholders, administrative board, and advisory committees, (4) suppliers, distributors, or vendors, (5) professionals (e.g. designers or evaluators) and other specialists such as subject matter experts, web-masters, computer technicians, or graphic and media artists, (6) project managers, and (7) governmental and accrediting agencies, and the public.

Although ID with associated pedagogical issues is of great importance when e-learning deliverables are designed and developed is also essential to think of modern e-learning deliverables as software products. Software engineering is concerned with theories, methods, and tools needed for the design, development, testing, and evaluation of software products (Sommerville, 1997). This is the theme of the next section.

2.3 Software Engineering

At the end of the 1960s a crisis in software development occurred for the first time. This crisis resulted directly from the introduction of the third-generation computer hardware which was much more powerful than the second-generation hardware while it also became cheaper and more available. Implementation of applications that were able to take advantage of this new hardware required large software systems to be built. The notion of Software Engineering (SE) occurred after a conference in 1968 where challenges in relation to the design and development of large and complex software systems were on the agenda (Wirth, 2008). The challenge of SE is to develop software of high-quality with a finite amount of resources and to a predicted schedule. The following four fundamental process activities are common to all software development processes: (1) software specification which deals with definition of software functionality and constraints on its operation, (2) software development which is to produce software that meet the specification, (3) software validation which is to ensure that the software does what the customer wants, and (4) software evolution which is to take into account that software must evolve to meet changing customer needs. There is no SE process that is always right, but the various processes decompose these activities in different ways (Sommerville, 1997).

Both the research literature and practitioners use different names about the various approaches to software development and maintenance, e.g. software engineering, software development processes, software development life cycle models, system development life cycle models, or simply development processes. An attempt to establish a well-defined terminology, which can be referenced by the software industry, is the ISO/IEC 12207:2008 Systems and software engineering – Software life cycle processes standard. This is an international standard that aims to establish a common framework for software life cycle processes that include all the tasks required for developing and maintaining software. However, the continuation of this section contains just a brief presentation of some of the best known approaches to software development since these also are relevant for the development of customized e-learning for corporate clients.

Specification-based Models

One of the first and most well-known approaches regarding how large software development projects should be carried out was described by Dr. Wintston W. Royce in 1970. He argued that larger software projects require a greater degree of formality than had previously been the case. In addition to the analysis step and the coding step which is necessary for both small and large projects, he argued that several additional development steps are required. These additional steps do not contribute as directly to the final product as analysis and coding, and they will all drive up the development cost (Royce, 1970). This life-cycle model is now termed the waterfall model and it consists of a set of phases or stages that are performed sequentially. Each phase deals with development of sub-products or specifications which have to be completed and accepted before being used as input to the work of the next phase. There are numerous variations of this process model and here is a standard representation: (1) requirements analysis and definition where the software functionality and its operating constraints are specified in a manner which is understandable by both users and developers, (2) system and software design where the overall structure of the software is designed and specific software components are identified, (3) implementation and unit testing where software units are developed by means of a programming language and where each unit is verified against its specification, (4) integration and system testing where all the individually developed units are integrated into a complete system and tested, and (5) operation and maintenance where the software is delivered to the customer and where software modifications are performed to meet changing requirements and correct errors discovered in use (Royce, 1970; Sommerville, 1997).

There are several weaknesses with the original waterfall model and therefore various models have been developed that are viewed as variations of the model. These models improve certain features of the original in different ways. The ‘b’ model improves the operation and maintenance stage which is not adequately covered in the original (Cadle & Yeates, 2008). The “V” model (or “Vee” model) consists of individual steps almost similar to the waterfall model, but there is one central difference. At the coding phase the process steps are bent upwards, and this forms the typical V shape. The motivation for this is that there is found a connection between what is specified early in the project and what have to be tested later on. This means that the “V” reflects both the shape, besides the model's focus on verification and validation, which is enhanced compared to the original waterfall model (Forsberg & Mooz, 1998). Incremental models are another development of the waterfall model where the aim is to involve users during the development phases and allowing them to provide feedback and specify changes while the software development project is ongoing. This approach splits the development into a series of increments that are formally specified, developed, and delivered one by one. It allows users to test parts of the system early and to use their experience to help clarify requirements for later increments (Mills, 1980).

It is argued that the specification-based models are most applicable to large SE projects where the requirements are well understood and the business area with its requirements is stable. If parts of the system are to be developed in parallel by different organizations it may be very necessary to develop and approve requirements such as system specifications and system architecture, early in the development process (Sommerville, 1996).

Evolutionary Development Models

There are various development projects and situations where the requirements of what is to be made are not known in advance. This may be because users do not know what is going to be made, they do not fully understand what should be made, it is difficult to specify the requirements, and it might be difficult to determine how proposed solutions actually will function. The spiral model of software development and enhancement (Boehm, 1988) introduces an evolutionary and iterative approach to systems development which is significantly different from the stage-by-stage process in the waterfall model. In the waterfall model specifications from one stage are finalized and approved before the next stage is started, but in the spiral model there are no fixed phases. Instead the projects have to go through a set of loops in a spiral and each loop is split into four sectors:

- The first sector is where we have to determine the aims of analysis (objectives), find different possible way of achieving the objectives (alternatives), and find factors which limit the possibilities (constraints).
- The second sector deals with evaluation of different alternatives, besides risk assessments and risk reduction. Prototypes are typically developed to reduce specification uncertainty and to simplify communication between developers and users.
- The third sector deals with software requirements and requirement validations, software product design and design validation and verification, besides coding, testing, and implementation. Which activities that should be undertaken in a particular iteration, depend on the loop in question and what is done in former project loops.
- The fourth sector deals with planning of the next phases. The project is reviewed and if it is decided to continue, so are plans for the next project loop drawn up. I.e. a requirements plan, a lifecycle plan, a development plan, or an integration and test plan is produced, depending on how far the project has come and what has been done before.

The spiral model introduces some important concepts into the overall cycle, e.g. objective setting, risk management, and ongoing planning, and this can be very useful from a project manager's point of view (Cadle & Yeates, 2008). Furthermore, prototyping is emphasized as one of the activities in the second sector of the spiral model. However, prototyping could also be considered as an independent and evolutionary design and development process, and this is discussed in the next few paragraphs.

Prototyping is the process of building prototypes and prototypes are early samples or models built to test and demonstrate a concept and to serve as a means for communication between involved stakeholders in a development project. When prototyping is used in conjunction with SE is typically a distinction made between rapid prototypes and evolutionary prototypes. The goal of rapid prototyping is to develop prototypes very quickly so that the design team can evaluate several alternatives and easily discard what does not work. These prototypes can be created with simple tools such as paper and pencil (offline rapid prototyping), whilst computer-supported tools can be used to create higher precision prototypes (online rapid prototyping). While rapid prototypes usually is discarded or used as part of the system specification so are evolutionary prototypes intended to evolve into the final product. This means that traditional development tools often are used when evolutionary prototypes are developed since the prototypes are refined to become a part of the final product (Beaudouin-Lafon & Mackay, 2003).

In Tripp & Bichelmeyer (1990) it is argued that rapid prototyping also is an alternative ID strategy. Potential advantages of rapid prototyping in connection with ID processes include the following: (1) it serves as a tool for involving students and other stakeholders in the design process, (2) changes becomes a natural part of the design process, (3) clients can more easily understand their requirements when they see sample implementations, (4) an approved prototype serves the same purpose as a paper specification but errors can be detected earlier, (5) prototyping can increase creativity through quicker user feedback, and (6) prototyping might accelerate the development process. However, it is also important to be aware of possible drawbacks. A prototype does not eliminate the need for front-end analysis and it cannot substitute completely for paper analysis since there may be many ID problems which could not be addressed by prototyping (Tripp & Bichelmeyer, 1990).

Evolutionary development models are best suited when facing projects where it is difficult to establish a detailed system specification. This may be because we do not know how the system should work in advance and we need rapid system iterations so that suggested changes can be incorporated and demonstrated as quickly as possible. Widely used approaches in such projects are the development of domain models, i.e. abstract representations of knowledge and activities within a particular application domain which facilitate communication between involved participants. Some such models are discussed in the next section.

Model-Driven Software Development

Ivar Jacobson et al. claim that: "System development is a gradual transformation of a sequence of models. The first model describes the customer's requirements and the last step is the fully tested program. Between these two endpoints are a number of other models" (1992, p. 14). Model-driven software development focuses on developing and exploiting different domain models, i.e. conceptual models of a domain of interest. Domain models represent both the vocabulary and the key concepts, and they identify entities with attributes and relationships among all the entities within the scope of the problem domain. The phrase "model-driven" software development has been used for decades and it was especially in connection with the software industry's transition to object-oriented methodologies, in the early 1990s, that it became popular. Within object oriented software engineering it became normal to let model creation drive the development process, and it was developed different object-oriented notations and associated tools that were used to model different aspects of the upcoming software systems (Wirfs-Brock, Wilkerson, & Wiener, 1990; Coad & Yourdon, 1991a; Coad & Yourdon, 1991b).

The distinction between different object-oriented approaches led to the proposal of a unified object-oriented model, and the Unified Modeling Language (UML) emerged in 1995 as a continuation of three leading object-oriented methods. These methods were: (1) The Object Modeling Technique (OMT) (Rumbaugh, Blaha, Premerlani, Eddy, & Lorenson, 1991), (2) Object-Oriented Software Engineering (OOSE) (Jacobson et al., 1992), and (3) The Booch Methodology (Booch, 1994). UML was subsequently standardized by the Object Management Group[6] (OMG) and the software industry has after this adopted UML as a de facto standard for software modeling (Liddle, 2010). The latest version of UML (2.4.1) was released in August 2011 and this version defines seventeen different diagram types, i.e. graphical representations of a model of a system. This includes ten structure diagrams showing the static structure of specific system concepts, and seven behavior diagrams showing the dynamic behavior of the system objects (OMG, 2012). Complex system descriptions can better be managed through multiple models, where each model captures different aspects of the entire solution. UML models aim to provide concepts close to the problem domain at hand so that participants more easily can communicate about different model properties (Sendall & Kozaczynski, 2003).

Model-driven design and development is also used in connection with ID. An example of this is cooperative UML (coUML) which is a visual modeling language for modeling instructional designs for cooperative environments. coUML is based on UML but extends this with a modeling profile with features suited to model complex cooperative learning environments. This extension is realized with UML's built-in extension mechanisms to define required modeling elements, and it is separated into primary, secondary, and auxiliary artifacts. The primary artifacts of coUML are the course activity module and the course structure module, secondary artifacts are roles (e.g. instructor, student, or tutor), goals (learning goals), and documents (learning resources), whilst auxiliary artifacts are the course package module that intend to provide condensed course information (Derntl & Motschnig-Pitrik, 2008). Another example of model-driven ID is found in connection with the MISA instructional engineering method which also was discussed in section 2.2.2. MISA uses the Modeling with Object Types (MOT) knowledge representation system. MOT serves in many ways the same purpose as UML but it is especially designed to support ID, both in academia and at the workplace. MOT models are composed of six types of knowledge and seven types of relationship and there are developed several graphical modeling tools supporting this knowledge representation system (Paquette, 2004b; Paquette & Léonard, 2006; Paquette, 2006).

There is little doubt that the models, methods, processes, standards, and tools discussed in connection with SE in this section, might be heavyweight approaches to SE. As a reaction to these approaches evolved agile software development from the mid-1990s, and this is the subject of the next section.

Agile Software Development

The lightweight software development methods that evolved in the mid-1990s, as a reaction against heavyweight SE approaches, are today known as agile methods. A well-known event in this context was when 17 software developers met to discuss lightweight development methods in February 2001. They published the Manifesto for Agile Software Development and this manifesto defines the approach now known as

[6] OMG has been an international, open membership, not-for-profit computer industry consortium since 1989, and any organization may join OMG and participate in the standards-setting process.

agile software development. The manifesto includes four core values for software development, besides twelve principles which underlie the Agile Manifesto (Fowler & Highsmith, 2001).

Agility means to strip away heaviness and emphasize characteristics such as quick response to changes in user requirements, adaptation to changing environments, and accelerated project deadlines. There are various agile methods and there are several researchers who have done extensive research in relation to the adoption and use of agile practices, and which benefits and challenges software developers face in this context (Abrahamsson, Salo, Ronkainen, & Warsta, 2002; Dybå & Dingsøyr, 2008; Hneif & Ow, 2009). "The ability to meet client needs and the delivery of quality software products on time are significant benefits of agile development, while a steep learning curve and its unsuitability for projects characterized by distributed environments and large development teams are identified as minor concerns" (Vijayasarathy & Turk, 2008, p. 1).

When it comes to the management of agile development projects, the scrum method has received considerable attention in recent years. Organizations and people that have adopted scrum are often very enthusiastic since scrum teams provide a high degree of work satisfaction, while the customers are provided with frequent deliveries of usable software (Cadle & Yeates, 2008). However, there is no guarantee that you get well-functioning development team using scrum (Moe & Dingsøyr, 2008), and although the method is now widely used there exist examples showing that the introduction of scrum can be problematic (Hajjdiab, Taleb, Ali, et al., 2012).

Scrum is composed of various elements such as different roles, activities, and artifacts, and briefly scrum projects can be defined as iterative and incremental, with the development work structured in cycles called sprints. A sprint has a fixed duration, mostly between one and four weeks, and it ends on a specific date whether the work has been completed or not, i.e. it is never extended. At the beginning of each sprint a cross-functional team selects items (customer requirements) from a prioritized list, and they commit to finish these items by the end of the sprint, i.e. items are moved from the Product Backlog to the Sprint Backlog. Each day during the sprint, occurs a project meeting called Daily Scrum where participants report in relation to the status (e.g. progress, problems, and remaining work), and in the end of the sprint should integrated, fully tested code be available for the customer (Deemer, Benefield, Larman, & Vodde, 2010).

Although scrum is widely used there are also other approaches to agile project management that are based on the agile manifesto (Highsmith, 2009). Furthermore, there are also a number of alternative approaches that focuses efficiency and quick deliverables by concentrating only on what is actually required. Lean software management (Middleton & Joyce, 2012) and Kanban (Kniberg & Skarin, 2010; Nikitina & Kajko-Mattsson, 2011) are two examples, both of which originated from Just In Time (JIT) manufacturing at Toyota manufacturing plants in Japan.

"The most appropriate software process model depends on the organization developing the software, the type of software being developed, and the capabilities of the staff. There is no ideal model and it makes little sense to try to fit all development into a single approach" (Sommerville, 1996, p. 271). A concurrent design approach to the design of customized corporate e-learning is the main focus of this doctoral project, and therefore it is also necessary to gather inspiration from industrial concurrent design, which is the subject of the next section.

2.4 Concurrent Design

Concurrent design is closely related to concurrent engineering, which has been practiced for decades. The term concurrent engineering has different definitions, but the thinking behind this approach is well described in the following definition from the American Institute for Defense Analysis: “Concurrent Engineering is a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle conception through disposal, including quality, cost, schedule, and user requirements” (Winner, Pennell, Bertrand, & Slusarczuk, 1988, p. 11). Concurrent engineering deals with integrated product development with an emphasis on customer involvement and a well cooperating multidisciplinary team. The purpose is to avoid sequential office-to-office communication between experts representing different disciplines, if the tasks are interdependent and better resolved in interdisciplinary teams working concurrently. The following definition of European origin reflects this: “Concurrent Engineering is a systematic approach to integrated product development that emphasises the response to customer expectations. It embodies team values of co-operation, trust and sharing in such a manner that decision making is by consensus, involving all perspectives in parallel, from the beginning of the product life-cycle” (Bandecchi et al., 2000, p. 329).

The background for the report of the American Institute for Defense Analysis (Winner et al., 1988) was that the materials that were developed or purchased by the American Defense were very expensive, had a long development time, while they did not have the desired quality. The mission behind this report was to determine whether the claims that concurrent engineering would result in improved product quality, at lower cost, and with less development time, actually were the case. The report concludes that this was the case and it includes a discussion regarding what is required to implement concurrent methodologies.

During the 1990s concurrent design was developed to solve complex and interdisciplinary issues in space technology institutions. This started at the National Aeronautics and Space Administration (NASA), and spread to the European Space Agency (ESA) after a while. In recent years, concurrent design has also been applied in other business areas. One company behind this is Simtano™ (Simtano, 2012) and their chief executive officer (CEO) Dr. Knut I Oxnevad. Oxnevad has a background from the Jet Propulsion Laboratory[7] (JPL), and he is recognized as one of the leading pioneers and innovators of concurrent design. Simtano have now applied concurrent design successfully to the oil and gas industry in the North Sea, and they do also see a great potential for this methodology within other business areas such as supporting

[7] Jet Propulsion Laboratory is a federally funded research and development center and NASA field center located in California (JPL, 2012).

organizations working with renewable energy and environmental protection (Simtano, 2012). Our professional communities have been visionary enough to collaborate with Simtano and Oxnevad, and this collaboration has greatly influenced my approach to concurrent methodologies in this doctoral project. Figure 3 is a picture from the concurrent design facility at HiST/AITeL that shows Oxnevad acting as a facilitator for a team who practices in a concurrent design session, while I am an observer who video filmed it all.

Figure 3: Training in Concurrent Design at HiST/AITeL

The concept of concurrent design is used differently by the various practitioners. Some practitioners, do not mark the distinction between concurrent design and concurrent engineering, i.e. they consider these as two sides of same coin. Others, such as (Lonchamp, 2000) claim that concurrent design is originally the early phases of the concurrent engineering process, while Oxnevad (2000) relates concurrent design to a specific methodology that was developed at the JPL. Oxnevad (2000) describes concurrent design as an analysis and design methodology built up around the following eight principles: (1) analysis and design activities are performed by a multidisciplinary team, (2) team-members cooperate in concurrent sessions, (3) customers are involved and participate with team members in the concurrent sessions, (4) analysis and design activities take place in a concurrent, and near real-time fashion, (5) team members in concurrent sessions utilize inter-linked high-end computer tools, (6) these high-end computer tools are used from the early part of the design cycle, (7) common geometrical data is electronically changed between the tools, and (8) geometrical, structural, thermal, and optics data can be exported to and from the design team.

In addition to the eight principles of concurrent design Oxnevad also describes concurrent design as a triangle and a mutual interplay between: (1) all the people involved, (2) the process which they must implement, and (3) the tools used. This is known as the (PPT-Model) People, Process, and Tools Model (Simtano, 2012), and here is a brief elaboration of these elements:

- People – The projects need different experts representing their respective fields and they need to have the authority to make decisions within the field they represent. The customer will normally participate in the sessions and contribute with decisions, besides follow the progress of the projects. In addition, all concurrent sessions are typically conducted by a facilitator.
- Process – The process typically describes what to do and when different events should happen. A very important part of this process is the implementation of

concurrent sessions. These sessions are realized as intensive and interdisciplinary collaboration, which is managed by a facilitator and lasts for approximately 3.5 hours.

- Tools – Different experts will typically use specific tools (expert tools), but some general tools to support the interaction between session participants is also required. This could be project administrative tools such as action lists, decision lists, or project planning tools. In addition a concurrent design facility will normally be equipped with computer workstations and some large public screens that are used to share design elements among all participants. For the exchange of model elements to function as efficiently as possible there are technological solutions that allow any workstation desktop to be displayed on large screens or video projectors.

Oxnevad points out that all the components of the triangle (people, process, and tools) must be present and functioning optimal if one is to be able to achieve the desired effects, i.e. reduced development time, reduced costs, better decisions, and demanded products of good quality. Other results from concurrent design implementations also bring reduced time consumption, improved quality, satisfied customers, and satisfied participants who can contribute more effectively, interactively and transparently to the evolution of the complete system design, as compared with more traditional approaches (Bandecchi et al., 2000).

These positive results have contributed to different implementations by a range of institutions. However, they are all based on the basic concept of a facility (a room to conduct design sessions), where all design team members from different disciplines meet, utilize appropriate modeling and simulation tools and communicate regarding various aspects of the system design (Osburg & Mavris, 2005). ESA established a concurrent design facility in 1998 as described in Bandecchi et al. (2000), and the key elements on which the concurrent design implementation was based were: (1) a process, (2) a multidisciplinary team, (3) an integrated design model, (4) a facility, and (5) an infrastructure.

Teams and team development

Concurrent design implies real-time interdisciplinary cooperation between stakeholders such as the facilitator, the session secretary, various domain experts, the project manager, customer representatives, and others. The goal is to achieve fruitful and effective cooperation between all these stakeholders, so that they eventually cohere as a high-performing team that produces comprehensive solutions that are sustainable and viable. Katzenbach & Smith offer the following insight about teams: “A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable” (1993, p. 45). In accordance with this insight, implementing the following considerations will achieve superior team effects: (1) a meaningful purpose that is sufficiently challenging and that everyone can identify with, (2) specific performance goals that clearly indicate what to achieve and how to measure progress along the way, (3) commitment to a common approach regarding the means of cooperation required to accomplish the team's purpose and goals, (4) a balanced mix of complementary skills (i.e. technical and functional expertise, problem-solving skills, decision-making skills, and a wide range of interpersonal skills), and (5) mutual accountability in that each participant holds themselves, both as individuals and as a team, responsible for the team's performance.

Alternative collaborative approaches

Effective and efficient collaboration is obviously of great interest to many, and there are alternative approaches that have much in common with concurrent methodologies. Winner et al. (1988) point to increased competition particularly from Japanese manufacturers as an incentive for companies to increase the product quality and make product development processes more competitive. The Lean philosophy which originated at Toyota manufacturing plants in Japan is an example of a management philosophy that many subsequently have adopted and which has similarities with concurrent methodologies (Holweg, 2007). The Lean philosophy builds on principles such as: (1) optimize the whole system and take always the totality into account, (2) eliminate waste which really is anything that does not add customer value, (3) focus on quality by detect and fix defects as early in the development process as possible, (4) amplify learning since it is essential to constantly learn, (5) deliver value as fast as possible based on a deep understanding of all stakeholders and what they value, (6) engage everyone since creative and well-adjusted people are the basis of competitive advantage, and (7) always strive to do things better since the point is to develop the people and the systems capable of delivering results (Poppendieck, 2002; Poppendieck, 2012). As a PhD candidate at NTNU it is also relevant to point out that many of the ideas in the Lean philosophy come from the work of the Norwegian psychologist Einar Thorsrud, who was a professor at the Norwegian Institute of Technology in Trondheim (Andersson, 2011). Einar Thorsrud (1923 – 1985) is known for his work in the field of organizational development and particularly the theory concerning participative work design structures

Other alternatives and a continuation of concurrent design are concurrent innovation and concurrent enterprising. While concurrent design originally focused on activity centered concurrency and interdisciplinary teams within a project, there is a tendency to expand this to support collaboration between multiple companies, i.e. organizational centered concurrency and virtual enterprising. This can also be further extended to cover human centered concurrency and concurrent innovation among virtually integrated people which constitutes self-organized teams (Santoro & Bifulco, 2006). The European Society of Concurrent Enterprising Network defines concurrent enterprising as follows: "Concurrent Enterprising is the co-operation among Companies, possibly geographically dispersed, harmonising their processes and involving Customers and Suppliers for the design and manufacturing of products and services. Concurrent Enterprising conjugates the Virtual Enterprise concept and the Concurrent Engineering approach into a new business paradigm" (ESoCE-NET, 2012). The act of supporting cooperation across time and place is also very important in computer-supported cooperative work and this is the topic of the next section.

2.5 Computer-Supported Cooperative Work

The research field of Computer-Supported Cooperative Work (CSCW) emerged from Irene Greif's and Paul Cashman's workshop in 1984 (Crabtree, Rodden, & Benford, 2005) and it was based on computer-mediated communication and technologies such as the time-sharing operating systems that were developed in the 1960s and the experimental ARPANET from 1969, which also was the platform for the very first network based e-mail designs we still use nowadays (Schmidt, 2009). The field of CSCW is large and extensive and covers several aspects of computer support in group work. Key players in the field claim it is fragmented and diverging nowadays and that CSCW research must involve investigations of cooperative work in professional settings, i.e. the ethnographic workplace studies that traditionally have made a substantial contribution to the field (Schmidt, 2009). Although some actors argue that we have to move the focus from professional work to everyday life settings such as homes, games, museums, photography or tourism, and the use of mobile, pervasive or ubiquitous technologies (Crabtree et al., 2005), there are others who believe that the development and utilization of technologies for cooperative work practices has great potential, which only occasionally have been exploited; and this is because we do not really understand what cooperative work and its coordination is about (Schmidt, 2010).

Cooperative work is distributed in principle (Schmidt, 2009) and it consists of communication, collaboration, and coordination, which are considered three functional aspects of cooperation (Fitzpatrick, 2003). Furthermore, awareness is found to be both important and challenging for cooperative work. It is important when we work co-located and an additional challenge when we work distributed (Erickson & Kellogg, 2000; Gutwin & Greenberg, 2002; Schmidt, 2002; Bardram & Hansen, 2004).

Because cooperation (communication, collaboration, and coordination) and awareness also is important for concurrent design, I choose to focus on these four items in this section. I want to determine whether the CSCW research literature concerning communication, collaboration, coordination, and awareness provides us with experience, which also could serve as requirements and guidelines for my concurrent design approach, and especially in those cases where I aim to work distributed and concurrent. In the remainder of this section, these four aspects are discussed in detail.

Communication

Communication is the process by which individuals or groups exchange information and it is common to distinguish between formal and informal communication within organizations. Formal communication consists of all planned arrangements and plans for dissemination of information related to the organization's hierarchical management system, while informal communication is any communication that cannot be considered formal. Informal communication is continuous where people meet and the importance of this communication is very central in modern organizations where knowledgeable workers themselves, to a large extent, have to decide which tasks to solve and how this should be done (Jacobsen & Thorsvik, 2002).

A central part of CSCW deals with computer-based communication between distributed people, with the aim of designing systems that support deep, coherent, and productive communication (Erickson & Kellogg, 2000). It is also important to support informal and spontaneous communication when groups are geographically distributed (Schmidt, 2002). Much communication is informal; creativity often flourishes in informal communication. For communication to work, the systems must offer implicit social translucence and the kind of indirect awareness that we can get from others when we are co-located. To achieve social translucence we need (1) visibility—so that significant information is visible, (2) awareness—so that information about others and what they are doing is available, and (3) accountability—meaning that we understand that we are held responsible for the actions we perform (Erickson & Kellogg, 2000).

A large part of the communication that takes place among knowledge workers is conversation, in which knowledge is created, developed, assessed, and shared between the involved parties. This form of communication is also used as a medium for decision making. Through conversation, we establish a common ground, exchange experience, interpret what is being said, check that we have been understood correctly, provide new contributions, and make decisions. Furthermore, we should strive to make the knowledge that emerges from conversations reusable. In this way the conversation may be a product that others can use and analyze retrospectively (Erickson & Kellogg, 2000).

It is also important to be aware of implicit versus explicit communication when designing systems for computer-mediated communication (Pipek & Kahler, 2006). Communication is not just a separate activity but also an integrated part of doing the work (Schmidt, 2009). Systems must therefore be designed to support implicit communication, and the participants must utilize the possibilities so that communication becomes a direct contribution to the final product.

Collaboration

Collaboration is, according to the Oxford English Dictionary, the action of working with someone to produce something. Work that involves several people and contributes to the products being developed is therefore essential and the central aspect of collaboration. To carry out this work, computer tools must be used in a way that allows various geographically distributed experts to interact synchronously or asynchronously to produce a joint and comprehensive product. There are a number of collaborative software tools that can be used. Some are specific to particular disciplines, such as computer-aided design tools for product design or graphical editors for instructional design, while others are general and support activities such as collaborative writing and collaborative mind-mapping. It is important to emphasize that the tools I focus on under the collaboration umbrella are not necessarily the ones that will be used for communication and coordination, but rather the tools used to produce the final product.

Knowledge production best takes place in smaller forums where participants feel safe and want to contribute. On the other hand, we also want to share knowledge at a broader level of the organization. Erickson & Kellogg offer the following insight about this duality: “One resolution to this tension between privacy and visibility is to support an organizational space within which semiautonomous knowledge communities can exist, each community exercising control over the ways and means through which its knowledge is shared with the larger organization” (2000, p. 69).

Many tools can be used to cooperate to reach a common target. When specific products are selected they may be implemented, configured and used in very different ways. The process of customizing tools to a specific situation is often called tailoring (Pipek & Kahler, 2006). The tools must primarily be adapted to different and changing work contexts. Moreover, tailoring can be done jointly to get the tools to suit a particular situation in the best possible way. Collaborative tailoring can contribute positively to the tools that are used, but this assumes that tailoring mechanisms are available and that a culture for tailoring is established in the project organization (Pipek & Kahler, 2006).

Coordination

Coordination can be defined as interdependent activities or tasks that must be performed by several actors working together in order to achieve a goal. Coordination is regarded as articulation work; this work does not contribute to the final product, but is part of the process that must be followed to arrive at the final product (Schmidt & Simone, 1996).

The work of coordination is to determine the order in which different tasks should be performed, who should perform them, when they need to be done, and coordination is needed to achieve a productive workflow. Factors that may affect the coordination complexity and the management of task interdependencies are: (1) the group composition – since the work might be distributed among several participants with a different background; (2) task complexity – since complex tasks have to be broken down into sub-tasks and coordinated; (3) distribution in time – since the work cannot be accomplished in one session; (4) distribution in space – since the work has to be accomplished in a distributed manner; and (5) distribution in competence – since we might need people with different competencies to get the work done. Management of task interdependencies is more complex the more distributed we are and therefore it is also appropriate to use coordination mechanisms or artifacts for coordination purposes in cooperative work settings (Schmidt & Simone, 1996).

Coordination is also tightly connected with awareness of the ongoing activities that constitute a cooperative effort. We become aware of what has happened, what is happening, what should happen, and to what extent this affects us and the tasks we should perform. Actors who are performing interdependent work need to coordinate and integrate their various actions (Schmidt, 2002).

Schmidt (2002) also highlights monitoring and displaying as two complementary aspects of coordination. We monitor our colleagues by observing, listening, and so on, so that we get an overview and are able to adjust our own work and make it fit in with that of others. In addition, we display what we are doing so that our colleagues can become aware of what is being done, how it is done, etc., and use this information to coordinate their own work.

Awareness

The concept of awareness is very central and important in CSCW research. From the very earliest days of CSCW research, researchers have been concerned with how computer systems can support awareness. Today, however, the concept of awareness is both ambiguous and diluted. Researchers often use adjectives in front of “awareness” to handle this (Schmidt, 2002). In connection with distributed concurrent design is for instance workspace awareness (Gutwin & Greenberg, 2002) typically relevant. Workspace awareness concerns awareness among project participants working in a shared environment or a shared workspace.

The concept of awareness is in itself so liquefied that it is only when we refer to a person's awareness of something that the concept makes sense. Awareness should therefore be regarded as an integral part of the tasks or activities being carried out, so that we know what the actors actually are aware of. The challenge for the actors will be to capture what happens around them and to exploit this in their cooperation (Schmidt, 2002).

Some studies of awareness point out that awareness does not necessarily consist of passively acquired information, but is rather the result of active and conscious actions on the parts of both the observer and those being observed (Schmidt, 2002). The term "social awareness" is used to describe mechanisms which help people adjust their own activities to those of others who are co-located with them. Social awareness is often mediated by the use of social artifacts in a distributed setting (Bardram & Hansen, 2004). This suggests that acts of contribution to and utilization of workspace awareness are skills that can be learned and developed to achieve more efficient and productive cooperation. If we do not manage to take advantage of this, the result is a lack of workspace awareness which in turn is a problem, since the consequences are that we do not know what to do and that cooperation will suffer.

Constraints on the shared workspace are also an important phenomenon. This awareness helps us to exploit the situation in the best possible way within the constraints that exist for us as individuals, for other participants, and for the whole group. It is not obvious which constraints exist in a digital shared workspace, nor how diverse constraints affect different participants. Although this might be a matter of course in face-to-face physical environments, it is not obvious in a shared digital workspace, since equipment and infrastructure can vary between the different sites and participants (Erickson & Kellogg, 2000).

A Platform for Distributed Concurrent Design

In this section I have focused on a small part of CSCW that I believe has significance for concurrent design and especially if the concurrent design approach should be carried out distributed. This concerns communication, collaboration, coordination, and workspace awareness and it forms the basis for a significant part of C4, i.e. requirements and guidelines for concurrent design of customized corporate e-learning. It is mainly P5 that contain this part of the C4.

The next section is a summary of this chapter. It recapitulates the whole chapter and highlights how the presented *state of the art* may affect a concurrent design approach to the design of customized e-learning for corporate clients.

2.6 Towards a concurrent e-learning design approach

A successful implementation of e-learning must take into account various factors such as organizational affiliation, focus on the students and what they actually should learn, appropriate use of technology, staff training and support, student training and support, student services, and rights to the material which are used (Levy, 2003). To cover these factors during the e-learning design and development process, interdisciplinary exploration that naturally builds on key elements from different disciplines is required. The main research aim and challenges of this doctoral project concern a concurrent design approach to the design of customized e-learning for corporate clients, and this chapter provides the state of the art of selected areas, which this approach naturally can be based on.

The knowledge presented in this chapter comes from various disciplines, but nevertheless it represents the foundation which the concurrent e-learning design research in this doctoral project is built upon. In this section I summarize this foundation by presenting 10 statements. These statements are supported by one or several of the disciplines described in this chapter, while they also can be considered as fundamental tenets for the concurrent e-learning design approach:

- A defined and properly described implementation model – Design and development of new e-learning deliverables might benefit from a defined and described implementation model. This approach is common within both ID and SE.
- An iterative, incremental, and dynamic implementation model – The implementation model must not be described so strictly that it becomes a hindrance. It should for instance be possible to do things in parallel and it should be possible to make changes and corrections retrospectively.
- The implementation should be controlled but with a high degree of freedom – A model might typically define activities to be undertaken, when things are to happen, and who are to be involved. At the same the participants must have the freedom to handle the events that occur, and for example choose appropriate pedagogical approaches. The need for pedagogical approaches might vary within the same e-learning delivery, and therefore it might be natural to vary between behavioral learning theories, cognitive learning theories, and constructivist learning theories in relation to needs that arise (Davidson-Shivers & Rasmussen, 2006).
- Interdisciplinary interaction should be utilized – If we succeed in facilitating interdisciplinary collaboration, we get the opportunity to produce effective and appealing solutions efficiently.
- Make arrangements for cooperation across time and place – Today's CSCW solutions allow both co-located and distributed cooperation to take place both synchronously and asynchronously.
- Objectives and goals should be defined and used – Establishment of clear and unambiguous goals in which everyone agrees that one should work towards, is central to achieving a performance team.

- Both the holistic perspective and the details should be covered – Model-driven design and development where several sub-models represents different aspects, may be appropriate for understanding the entire system.
- Make arrangements for formative and summative evaluation – Both the developed solutions and the process must be evaluated during the design process (formative evaluation) and finally when the solutions are put into production (final summative evaluation).
- Take advantage of appropriate standards and tools – There are a number of standards and tools that can be beneficial in the design, development, and delivery of e-learning.
- Establish an infrastructure for the entire project – An infrastructure that ensures easy access to all project materials is important to achieve workspace awareness among the participants.

These statements are intended as a brief summary of this chapter which has served as a basis for the concurrent design approach to the design of customized e-learning for corporate clients, which I have been working on in this doctoral project.

3. Research Methods and Research Context

This chapter deals with the research methods used in this doctoral project. I start with a brief introduction to relevant methods for instructional technology research which also are used in this doctoral project. Next, I discuss how the different methods have been used. In this context, I describe the R&D projects I have been involved in and I describe the research methods used in connection with the different research questions.

3.1 Relevant Research Methods and their Application

The research undertaken in this doctoral project is interdisciplinary (Golde & Gallagher, 1999) and it combines the disciplines of instructional design, concurrent design, and software engineering, in order to answer the research questions. Moreover, the research is characterized as social science since the goal is to achieve effective and efficient interdisciplinary cooperation with various stakeholders involved, even though this cooperation is supported by technologies associated with "hard" science (Glenn, 2010). Furthermore, this work can be considered as instructional technology research since the aim is to improve the methods used when new e-learning deliverables are designed and developed. Efforts are being made towards development goals that focus on new approaches to instructional systems design as well as towards action goals that focus on finding out how these solutions actually work.

Instructional technology research has existed for decades (Clark & Snow, 1975), but this research has also been criticized. Reeves (1995) is highly critical regarding much of the research conducted by instructional technology researchers and in Reeves (2000) he contributes with some advice in relation to how this research can be conducted. First, we have to define research questions before choosing the research method to be used. Next, the research must be relevant and have an impact on both the field and the practitioners, i.e. the research should be inspired by quest for fundamental understanding or it should be inspired by considerations of use. In addition, it is often necessary to arrange for a long period of research and to be prepared to vary the use of research methods while the project progresses. This kind of research is inspired by development goals and it aims at making both practical and scientific contributions, i.e.

to solve real problems while simultaneously constructing design principles that can inform future decisions. Reeves (2000) uses the concept of development research when describing this approach but in studies conducted later there are other concepts such as design research (Reeves et al., 2005) or design-based research (Seeto & Herrington, 2006; Ma & Harmon, 2009) that are usedwhen the same type of approach is discussed.

Design-based research has also been a source of inspiration in my doctoral project. This is because I have a long-term project that lasts for several years, it explores challenges with a broad interest, uses different research methods to suit varying needs toward different objectives, involves various stakeholders, covers several aspects of the development of new educational deliverables, reflects on the design process, aims to define design principles for concurrent and cooperative instructional design, and has a focused attention on dissemination while the research work is in progress. Reeves (2000) presents design-based research as a process in four phases and Figure 4 provides a graphical representation of this process.

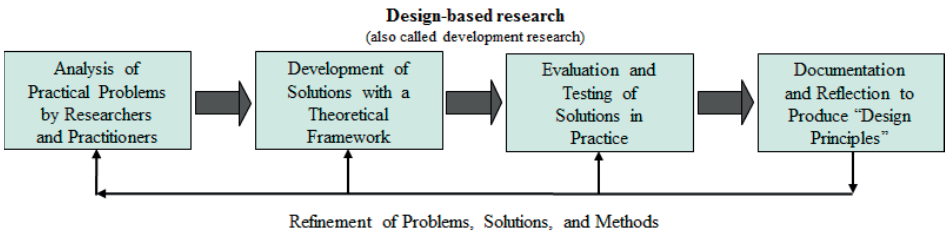

Figure 4: The Design-based Research Approach - Inspired by Thomas Reeves.

The model of design-based research which is presented in Figure 4 is consistent with the research process used in this doctoral project. Therefore, I choose to use these phases as a framework and an aid to help structure the presentation of relevant research methods and their application. The following sections (3.1.1 – 3.1.4) are inspired by the four phases of design-based research and within each section the different research methods and techniques relevant for this doctoral project are first introduced and then discussed with the practical experience from this doctoral project in mind.

3.1.1 Analysis of Practical Problems

Analysis of practical problems by researchers and practitioners is the first phase of design-based research. Exploratory research designs fits well in this phase where we have no hypotheses to test but rather need to obtain the best overview of the problem area (Armstrong, 1970). Cooper & Schindler offer the following insight about exploratory research: "The first step in an exploratory study is a search for secondary literature. Studies made by others for their own purposes represent secondary data. It is inefficient to discover anew through the collection of primary data or original research what has already been done and reported at a level sufficient for management to make decision" (2008, p. 148).

A search for secondary data can ideally start in one's own organization since reports from own and previously undertaken research projects may contain valuable information in relation to what has previously been tested, what challenges that were faced, what methodologies that proved to be successful, and reflections concerning further work. Other sources for secondary data are books and papers that are prepared and published by external contributors. A literature review is used to get an overview of the state-of-the-art research within some area (i.e. literature relevant to the topic) besides literature on research methodology and data collection techniques (Hart, 2001).

Analytical reading of relevant literature is an essential prerequisite for all research. The results from such studies can be published as independent literature review papers, or as a minor part (i.e. a literature review section) of a study that also uses other research methods. Literature reviews are processes that can be accomplished more or less elaborate and if the ambitions are to search through all the relevant literature it is considered a systematic review. Kitchenham defines this as follows: "A systematic literature review is a means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest" (2004, p. 1).

A systematic review should be explicit about research questions and how sources are collected, so that the review is reproducible for other researchers. This means that the procedures for systematic literature reviews are extensive and time consuming. Most research projects actually use a more pragmatic approach when performing literature reviews. Creswell (2003, pp. 33–35) presents a simple literature search model with the following seven steps: (1) identity relevant key words, (2) search for articles containing selected keywords, (3) point out an appropriate amount of articles (e.g. 50 articles), (4) look over the abstracts and skim the articles, (5) design a literature map or a visual picture of the research literature of the topic, (6) draft summaries of the most relevant articles and take into account that this will be part of your final literature review, and (7) finalize the literature review by structuring the literature thematically or organize it by concepts that are addressed in the study.

In addition to relying on secondary data it is also necessary to collect primary data during the initial and exploratory phase of the research project. This can typically be done by observations or by conducting surveys that make use of questionnaires or interviews. These data collection methods are also typically used by those who have an ethnographical research approach. That is: (1) researchers who study things in their natural surroundings in which the activities of interest normally occur, (2) researchers who aim to describe a holistic view and avoids studying some activities in isolation since this can provide a limited and potentially misleading understanding of that activity, (3) researchers who seek to understand how things actually work rather than evaluating the efficacy of peoples practice, i.e. the aim is to provide descriptive and not prescriptive understandings of people's behavior, and (4) researchers who seek to obtain an insider's view of the situation (Blomberg, Burrell, & Guest, 2003).

Today questionnaires are usually developed and conducted using computers and the Internet, and there are numerous things one should take into account when such surveys are to be used. In connection with this doctoral project I have specifically been inspired by Chapter 12 and 13 in Cooper & Schindler (2008), which among other things points to the following in connection with questionnaires and measurement scales: (1) question construction involves decisions about the questions to be asked, how they should be formulated, and which response strategies that should be used, (2) the objective of the study affects the decision of whether to use open-ended or closed questions and a mixture of these may well be considered, (3) for each question one must consider whether response types such as rating, ranking, categorization, or sorting should be used and how any response scales should be built up (e.g. balanced versus unbalanced rating scales or single-response versus multiple response multiple-choice scales), (4) the Likert scale (which was developed by Rensis Likert) is probably the most frequently used variation of the summated rating scale in which I use in several surveys in this doctoral projects, (5) the order of the questions must be considered carefully and we should start with simple and general questions and move on to more complicated and specialized questions towards the end of the survey.

Interviews can also be implemented in several different ways, e.g. individual interviews versus group interviews, or structured interviews versus unstructured interviews. In this doctoral project I used so-called semi-structured interviews which also sometimes are called focused interviews. A semi-structured interview combines the structural approach (i.e. a set of specific questions where the answers normally can be quantified) with the unstructured approach (i.e. the interviewer suggests the themes as the interview progresses but perhaps with a few specific questions in mind). A semi-structured interview will thus combine specific questions to bring forth some expected information with open-ended and free-response questions that aim to collect unexpected types of information (Hove & Anda, 2005).

The research methods described in this section have largely been used in connection with RQ1 which was to identify the basic motivation regarding why HEIs should apply a concurrent design approach when they aim to deliver e-learning to corporate clients. This has in turn resulted in C1 which is the detected motivation and conditions for applying a concurrent design approach to the design of customized e-learning for corporate clients. This materialized as P1, P2, and SP1 in the early phase of the doctoral project.

3.1.2 Development of Solutions

Development of solutions with a theoretical framework is the second phase of design-based research. Development of new solutions is also the main aim of the design science research paradigm which is often used within information systems research. Design science is used to create and evaluate IT artifacts that intend to solve identified problems within an organization (Hevner et al., 2004; Kuechler & Vaishnavi, 2008; Hevner & Chatterjee, 2010). This research paradigm fits into the philosophy of pragmatism (Kolås, 2010) and this approach was used in connection with RQ2. In this phase of the doctoral project the objective was to determine how a concurrent design approaches to the development of customized e-learning for corporate clients should be materialized. In this context, we had to decide how this approach initially should be described, and how it eventually should be tested and evaluated. Our approach to the design science research method was inspired by the seven design science research guidelines from Hevner et al. (2004). The following list describes the approach to each of these principles:

- First, we designed as an artifact since we produced a method to solve important organizational challenges related to design and development of customized e-learning for corporate clients. Our artifact was the Concurrent E-Learning Design Method (CCeD Method) including process descriptions, templates for several e-learning design sub-models, a facility for the implementation of design sessions, and an infrastructure to support the project.
- Second, the problem relevance was thoroughly recognized both within our own institutions and more broadly as described in several research articles I referred to as a part of my literature reviews. Development of high quality e-learning for corporate clients is challenging and appropriate stakeholder involvement, which is also emphasized in my project, is considered a key factor in this context.
- Third, design evaluation was on the agenda and the utility, quality, and efficacy of the CCeD Method was continuously evaluated during the first development phases. The method was further evaluated and tested later on and this is discussed in the next section (Section 3.1.3 Evaluating and Testing).
- Fourth, the research contribution was considered. Our goal was to make the new method contribute to improved quality, reduced costs, and reduced time consumption when designing e-learning deliverables for corporate clients.
- Fifth, research rigor was ensured by the fact that we based the research on the method of design science, and that we evaluated the CCeD Method thoroughly and in several iterations before the final version was distributed to a wider audience. This focus on evaluation and testing is also discussed in the next section.
- Sixth, we designed as a search process since we made use of available theories within the subject areas of instructional design, concurrent design, software engineering processes, and computer-supported cooperative work. This search for secondary data started in the first phase of the design-based research project as the discussion about literature review in the previous section (Section 3.1.1 Analysis of Practical Problems) indicates. We used an iterative and search-based design process where a broad base of alternative solutions was investigated. In turn, this served as input to the new CCeD Method under development.
- Seventh, communication of research was dealt with and the results were presented both to academically-oriented audiences (i.e. peer-reviewed scientific papers) and management-oriented audiences (i.e. technical reports, method descriptions, and lectures on practical experience).

Design science is essentially an independent and complete approach used to create innovative solutions within the information systems discipline. Although this encompasses several phases of design-based research (i.e. analysis of practical problems or evaluation and testing) so is the main focus of design science covered by the second phase (Development of Solutions with a Theoretical Framework) within design-based research. Design science was used when I worked with RQ2. This led to C2 and the concurrent e-learning design method that includes a description of processes, roles, models, tools, the facility, and the infrastructure. Paper P3 and P5 used design science as the most prominent research approach.

3.1.3 Evaluation and Testing

Evaluation and testing of solutions in practice is the third phase of design-based research. In the previous section a discussion regarding the use of design science research guidelines from Hevner et al. (2004) was discussed and I described how each guideline has been exploited as part of this doctoral project. However, Guideline 3 concerning design evaluation and Guideline 5 concerning research rigors required the artifact (i.e. the CCeD Method) to be implemented and tested in its intended environment. It was in this context I wanted to take advantage of action research and in particular the principles of canonical action research from Davison et al. (2004). Action research has much in common with design science, and this is also confirmed by the similarities in the fundamental characteristics of action research and design science as highlighted in Järvinen (2007). However, I also believe they complement each other well in terms of using action research for evaluating the utility, quality, and efficacy of the artifacts that are developed and described during the design science process.

Action research is typically used in connection with the introduction of new artifacts in an organization (Susman & Evered, 1978; Baskerville & Pries-Heje, 1999; Davison et al., 2004). Action research is a cyclical and iterative study that contributes to the collection of data, which in turn may be subject to both qualitative and quantitative data analysis. The analysis of data from action research projects can either be done along the way or with the use of qualitative and quantitative data analysis techniques performed retrospectively. Data analysis performed while the project progresses could be based on a Grounded Theory approach (Glaser & Strauss, 1967), i.e. theories could be "grounded" in empirical research and generated while data becomes available and analyzed in the iterative action research process. Action research might well be combined with grounded theory and the grounded action research approach described in Baskerville & Pries-Heje (1999) is an example of such an integration which seeks to add rigor and reliability to the action research theory formulation process.

The work to evaluate and test the CCeD Method was inspired by the principles of canonical action research which is described in Davison et al. (2004). My approach was to use these principles as a guide, and in this section I use them as a basis for explaining how the action research has been conducted. The following five sections discuss each of these principles.

The researcher-client agreement
Formal agreements were established between the action researchers (we who developed the CCeD Method) and the clients who wanted new design documents for e-learning deliverables to be developed. The objectives were twofold in these projects since the client's main goal was to arrive at a good design document while we as action researchers also focused on gaining experience and collecting data to help improve the CCeD Method.

The CCeD Method development team was open in that the method was under development and that action research was used to evaluate the method in parallel to the development of the client's design document for new e-learning deliverables. We relate to the twofold objectives by focusing on both the method and the new e-learning design during the evaluation process. Such twofold evaluations were conducted at the end of each cooperation session as well as in online questionnaires which the participants answered afterwards. We learned that clients are willing to describe observations regarding the method or process that leads to the new product as long as attention is also directed at the product itself. Furthermore, we believe the client should know to the greatest extent possible what is expected when an action research project is to be carried out. Based on experience from this doctoral project this involves the following:

- First, the client should be made aware of the project's focus. This means that we are clear on expected input (project directive), the process to be followed (preparation, execution, and conclusion phases) and the requirements of the final project deliverables (e.g. the e-learning design document).
- Second, the project schedule should be clearly defined with a series of actions (i.e. cooperation sessions) where intermediate objectives and intermediate deliveries are defined. We used a session plan where each cooperation session was described with items such as time, place, duration, participants, preparatory tasks, objectives, goals, and expected results.
- Third, the roles and the associated responsibilities and authority were defined in advance so that all participants knew what would be expected of them during the cooperation sessions. When the CCeD Method was tested and evaluated the client's roles were related to: (1) the content (subject matter experts), (2) the pedagogy (instructional designers), (3) the technology (technical delivery experts), and (4) business matters (business experts). Specialized roles such as facilitator, session secretary, and project manager were conducted by participants of the CCeD Method development team.
- Fourth, all participants need access to the project infrastructure and necessary tools while the project is in progress. In this context, we tried web-based mind mapping tools to co-edit mind maps (e.g. Mindjet Catalyst) or freely available tools for collaborative writing (e.g. Google Docs). The necessary tools and the produced data were available over the Internet while the project was ongoing and this worked well both in and between the cooperation sessions.
- Fifth, the customer must be aware that they are part of a research project and therefore understand the importance of formative and summative evaluation. It is always important to perform formative evaluation for products under development. Likewise, it is equally important to evaluate the process and the method used to develop the product in an action research context. Even if the customer has no interest beyond the product itself, they must contribute to the method and process evaluation, when participating in an action research project. The client must know that research is part of the program and that surveys in connection with each session and possible follow-up interviews, therefore, must be expected. My impression was that this went well but it must be on the agenda from the beginning and expressed in writing in the contract or other steering documents.

The Cyclical Process Model
Although the cyclical process model of action research from Susman et al. (1978) can serve as a good guide, justified deviations could also be made. Challenges with respect to the twofold objectives are also well known among other action researchers. These challenges include customers who are concerned with the product while the researchers also are concerned about the process and method that leads to the product. In McKay & Marshall (2001) this is referred to as the dual imperatives of action research and a dual cycle process for action research is presented. In this dual approach the problem solving interests (about the product) and research interests (the method and the process) are depicted as two processes operating in tandem with one another. Nevertheless, the following figure (Figure 5) focuses on the action research used to improve the CCeD Method, and we are in this context less concerned about the product (the new e-learning design document) under development.

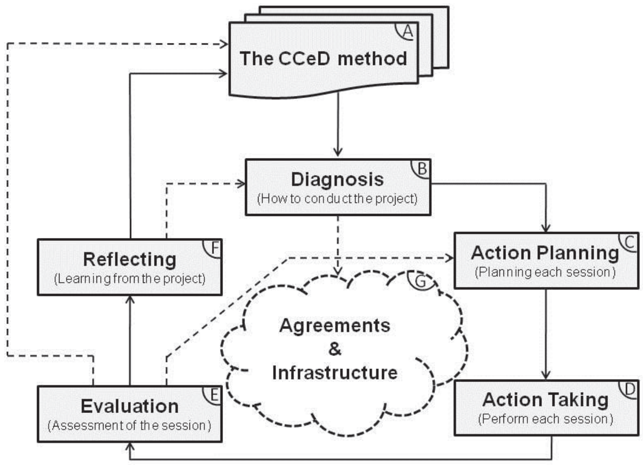

Figure 5: The Cyclical Process Model of Action Research

The purpose of Figure 5 is to form a basis for the explanation of the cyclic process model approach that was used when the CCeD Method was evaluated and tested and the boxes in the figure are marked with letters, to help the explanation. These letters are shown in parentheses in the following explanatory text:

The CCeD Method (A) is an artifact from a design science project, and one of the main aims of the action research project was to test this artifact in an organizational context. In this way the CCeD Method (A) works as a central input to the project. Furthermore, the method was updated based on evaluation activities (E) that take place after each cooperation session and reflecting activities (F) that are intended to specify learning based upon extracted lessons from experience. This means that an updated and improved CCeD Method (A) resulted from the project together with the product developed, i.e. the new e-learning design document.

Diagnosis (B) which is a means to identify and define the problem, is traditionally the start and the first phase of action research projects. In our project this phase was somewhat special, because the new method was described and about to be tested, and much of the diagnosis had been made as part of this preparatory work. However, I had to make diagnoses in relation to the project we intended to start. Typically, this is about the establishment of a dialogue with the client, to get a common understanding of the requirements such as purposes and objectives plus scope, time, and cost constraints.

The action planning phase (C) mainly consisted of preparation for the cooperation sessions. In accordance to the CCeD Method, each session was planned with: (1) time, place and participants, (2) overall objective of the session, (3) the preparatory work, (4) deliverables to be produced, and (5) the tasks to be performed in the session. These tasks varied in relation to the roles (subject matter experts, instructional designers, technical delivery experts, and business experts). Different templates indicated which questions to be answered by the respective roles.

Action taking (D) in this context describes the execution of each cooperation session with all parties involved. The facilitator is particularly important when cooperation sessions are conducted since this person coordinates the work performed by the other resources. The facilitator should strive for a balance between plenary activities and group activities with the aim of reaching good interdisciplinary solutions that take varying needs into account. Moreover, the session secretary also fills an important role during these sessions. This person will typically ensure that all decision points and all actual decisions are recorded and made available for the rest of the project.

The evaluation (E) that takes place after the action taking step (D) is twofold. First, the end of each session is used for plenary evaluation. Here the achieved results are presented while both the processes and the product are discussed and evaluated. Second, online questionnaires were developed for each session, and all participants had the opportunity to answer these. Although the results of the evaluation phase often is input to the reflecting phase (solid arrow), we also had examples where these evaluation results directly affected the action planning for the next session or caused a direct update of the CCeD Method (dashed arrows). In this way the entire project team including client representatives, was involved in making changes and improvements that were implemented and tested by the first and best opportunity.

The reflecting phase (F) can be regarded as a more thorough evaluation where learning is specified and the model is updated (solid arrow). We conducted workshops in the CCeD project team (clients did not participate), and the main purpose was to generalize on the basis of gained experience and update the CCeD Method on this basis. Input to this reflecting phase can be the results of surveys or evaluation notes, but also the design document under development. Evaluations regarding strengths and weaknesses of the produced design can typically help to get a more appropriate focus for the next project implementations. Although the results of the reflecting stage can influence an ongoing project (dashed arrow to the diagnosis), it is the update of the CCeD Method that has been most important for this doctoral project.

Agreements and infrastructure (G) are regarded as a central core in canonical action research projects, and this was also true for our projects. It symbolizes the client agreements as well as the equipment and infrastructure needed to perform a project. Consequently, this supports all phases (B to F) that the projects must go through.

Theory

In accordance with the principle of theory, action researchers should rely on existing theories to guide and focus their activities. In the projects I refer to, much of the theoretical foundation was incorporated into the CCeD Method which was developed in advance. The CCeD Method is actually a mix of instructional design and concurrent design, and hence it includes theories from these disciplines. For example, guidelines concerning learning outcome descriptors (i.e. knowledge, skills, and general competence) were based on the Norwegian Qualifications Framework (NKR). NKR is a national extension of the elaboration of a European Qualifications Framework for lifelong learning (EQF) and the European qualifications framework for higher education in the Bologna process (NKR, 2012). These and other theoretical foundations are integrated into the CCeD Method. Furthermore, these learning outcome descriptors were an integrated part of the discussion when the evaluation and reflecting activities took place.

Change through Action

In connection with the change through action principle, both the action researcher and the client should be motivated to improve the situation. This means that they must agree on what actions are to be performed, when they should happen and what results they are trying to achieve.

In the test projects I refer to, we absolutely had changes through action. First, the project itself aimed to implement and test a new e-learning design method and this dealt with the introduction of changes through action. Second, we attempted to modify and improve the cooperation sessions as the project progressed. An example of this was the increased attention to decisions. It emerged that decisions should be lifted during the cooperation sessions, discussed in plenary, and documented in project documents available for all participants. However, we did not particularly involve the client when such modifications were discussed. This is due to the twofold objectives in the actual projects. We experienced that the client was concerned with the product under development, while these changes (change through action) in the first place cover the method or process (i.e. the CCeD Method) with which the action researchers were most concerned.

Learning through Reflection

Learning through reflection by explicitly specifying the learning achieved is regarded as one of the most critical activities in action research (Davison et al. 2004). This can be achieved if the researcher conveys status along the way, and if achieved learning is immediately specified when it occurs during the project.

At the end of each session the team performed evaluations and each participant was given the opportunity to reflect on achieved results by answering online questionnaires. Furthermore, learning was specified more deeply by conducting workshops where the purpose was to reflect in relation to gained experience and use this as a source for CCeD Method updates. In this way, I claim that we made reflections and collected data. However, unfortunately I did not always adequately describe what we actually learned and what we could build upon and I did not always communicate the learning to all relevant stakeholders. The results from the surveys were communicated to everyone, but in raw data form. This means that the main points and the achieved learning was not always extracted and specified explicitly during the projects.

Summary of the Evaluation and Testing
Evaluation and testing of solutions in practice is an important part of the design-based research process where the goal is to develop solutions that actually work. Ma & Harmon offer the following insight about this: "Evaluation is a common practice in research and development, but this phase is critical in design-based research in that a rigorous research process should be followed to evaluate the project and answer the research questions" (2009, p. 83). This section has shown that I used the principles of canonical action research to help make rigorous and trustworthy evaluations. This work is connected with the part of RQ2 that concern how the CCeD Method should eventually be tested and evaluated. The result of this work is C3 which is identified as experience from using action research as a means of introducing new artifacts at higher education institutions. Paper P4 has a focus on evaluation and testing of the CCeD Method by means of canonical action research.

3.1.4 Documentation and Reflection

Documentation and reflection to produce design principles is the fourth and last phase of design-based research. After completing the three initial phases of a design-based research project, large amounts of data should normally be available. These data are usually suitable for both qualitative and quantitative analysis and the researchers will typically vary the methodological approach according to requirements and suitability.

The main aim of quantitative research is to perform precise measurement of things, for example the behavior of students, achieved knowledge, opinions, or attitude. Quantitative data analysis is used to answer questions related to how much, how often, how many, when, and who and the use of surveys is considered dominant for quantitative researchers (Cooper & Schindler, 2008). Furthermore, quantitative research is associated with numbers as the unit of analysis and it is often associated with a specific focus such as theory testing. The researcher must maintain a distance from the research to avoid biasing the results since the whole point of quantitative research is to produce objective numerical data that exist independently of the researcher (Denscombe, 2007).

However, in this doctoral project I had most focus on qualitative methods, although it is possible to quantify some of the data from the surveys that were conducted since a mix between free-response questions, dichotomous questions, multiple-choice questions, checklists, and rating questions with the Likert scale were used. Qualitative research includes a set of interpretive techniques where the goal is to describe, decode, translate, and otherwise understand phenomena in the social world that occur more or less naturally (Cooper & Schindler, 2008). Qualitative research produces large amounts of data in non-standard format (Denscombe, 2007), and this was also the case in my doctoral project. Having been through the first three phases of design-based research as described in the previous sections, I had a lot of qualitative data in different formats. This included for example, video clips, audio recordings, completed questionnaires, interview notes, project documents, training materials, design models, and fully developed courses.

With all this data available, it was natural to begin to work with RQ3 concerning requirements for practical realization, i.e. what are the key requirements for a concurrent design approach to the design of customized e-learning for corporate clients? In order to answer RQ3 I used qualitative data analysis and coding. Since, the data were in several different formats I decided to handle the data using NVivo 9, which is qualitative data analysis software from QSR International. My approach to the coding process was inspired by Bazeley (2007) and Saldaña (2009), in that I carried out iterative coding in three cycles.

In the first cycle a descriptive initial coding was used to name the ideas in the data and represented them as nodes in NVivo 9. A total of 74 nodes were identified and each node refers to ideas and works that help aggregate extensive and varied raw data into a brief summary format. In the second cycle I did axial coding to extend the analytic work from the first cycle. During this process all the nodes from the first cycle were categorized in relation to what each node actually concerned. After completing this cycle I had five categories (i.e. adaption to the surroundings, stakeholders, activities, infrastructure, and results) containing their respective nodes. In the third cycle the nodes were reduced to a total of sixteen principles and I used data associated with the different nodes to describe each of the sixteen principles in detail.

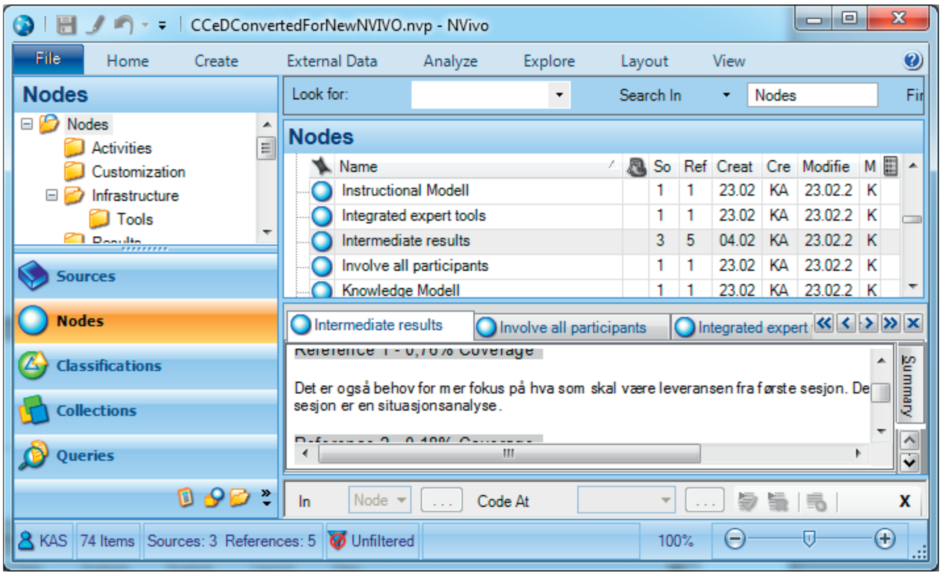

Figure 6: Use of NVivo 9 for Qualitative Data Analysis and Coding.

Figure 6 shows a screen dump where NVivo 9 is used for qualitative data analysis and coding. In this case the node *Intermediate results* is selected in the *List View,* while the Norwegian text in the *Detail View* below, which is the result from a survey carried out during the project, states the importance of having fairly detailed requirements for intermediate results that should be completed at certain times while the project is in progress. *The principle of requirements for intermediate results* and the corresponding category (*Results)* was later identified based on this node. This example shows that the goal and fundamental reasons for performing any project is to pursuit results and it is important to know what results we want to achieve both while the project is ongoing and when it is completed.

This section is about documentation and reflection to produce design principles. Towards the end of the doctoral project I conducted qualitative analysis of data collected over several years in order to identify the principal characteristics of concurrent e-learning design. In this context were sixteen principles of concurrent e-learning design identified. These principles were grouped into five categories and they were described in detail in research paper P6. Furthermore, qualitative data analysis techniques were used in conjunction with other research approaches (i.e. literature review and design science), when the prescriptive approaches for distributed concurrent design was finally identified and described in research paper P5. In total this constitutes research contribution number 4 (C4), i.e. requirements and guidelines for concurrent design of customized corporate e-learning; which includes 16 principles of concurrent e-learning design and some additional prescriptive approaches that should be considered for distributed workspaces. This contribution resulted from RQ3, which was intended to figure out what are the key requirements for a concurrent design approach to the design of customized e-learning for corporate clients.

3.2 Research Context

As a part of this doctoral project I have been involved in several R&D projects and I have used different research methods to answer the various research questions that have been on the agenda. While the previous section was intended to explain the research methods I have used, this section will discuss the different R&D projects I have been involved in and the context in which the different research methods have been used.

3.2.1 R&D Projects and Participants

As mentioned in Section 1.2, the research presented in this thesis is carried out in conjunction with the following three R&D projects:

1. BITØK/EIK – An internal project where HiST/AITeL, NTNU/IDI, and TISIP worked to deliver customized corporate e-learning within IT and economics, to selected organizations in the Ytre Namdal region.
2. CCeD – A national project where HiST/AITeL, NTNU/IDI, and TISIP received financial funding from the Norway Opening Universities (NOU) and collaborated with selected corporate clients in the Ytre Namdal region to utilize concurrent design for the development of customized corporate e-learning.
3. UnderstandIT – An EU-based project where HiST/AITel collaborate with six European partner institutions to develop customized training programs to increase Information and Communication Technology (ICT) competenciess among Vocational Education and Training (VET) teachers, trainers, and tutors.

The following sections provide some information about each of these three R&D projects.

BITØK/EIK

The EIK-project was initially made up by representatives from five companies in the Ytre Namdal region (Telenor, Gothia, Manpower, Aktiv Kapital and Lindorff), besides Norsk eLæring and representatives from NTNU/IDI. In spring 2008 the EIK-project signed a contract with HiST/AITeL (educational provider), NTNU/IDI (technical provider), and TISIP (local partner), concerning a formal e-learning program where eight 7.5 credit subjects at bachelor's level, were to be offered over a two-year period. The courses in the BITØK/EIK project ran over four semesters starting in autumn 2008. HiST/AITeL used the name BITØK for this project and that is the reason why I operate with two names (BITØK and EIK). In connection with this project the need for a holistic approach and customer involvement during the e-learning design process was identified. This includes the necessity to involve various areas of expertise to cover all needed aspects when new e-learning deliverables are designed, and the importance of customer involvement in order to produce deliverables that are actually requested. This project was a great help in relation to the first research question and the basic motivation for this thesis, i.e. why should HEIs apply a concurrent design approach when they aim to deliver e-learning to corporate clients?

CCeD

The CCeD project has been a cooperative project between HiST/AITeL, NTNU/IDI, and TISIP and it was carried out by a project team of six people, representing these three different organizations. The project was funded by the NOU (project number: P31/2009) and it included cooperation with the same partners from the Ytre Namdal region as were participating in the BITØK/EIK project. In connection with this project the new concurrent e-learning design method was developed. This method takes a holistic view in that various sub-models covering different areas (i.e. the instructional model, the knowledge model, the technical delivery model, and the business model) are developed. Furthermore, it contributes real-time interdisciplinary cooperation where various experts meet for design sessions in a concurrent design facility, where the customer is also represented.

The concurrent e-learning design method was first described and then tested through three different projects which all aimed at designing new e-learning deliverables, and the concurrent design facility located at HiST/AITeL was used in all these projects. The CCeD project was from its inception a great help in relation to the second research question and the implementation experience gained in this doctoral project, i.e. how should a concurrent design approach for the development of customized e-learning for corporate clients be materialized? Furthermore, the data collected through this project was important in relation to the third research question, i.e. what are the key requirements for a concurrent design approach to the design of customized e-learning for corporate clients? The CCeD project was running from March 2009 until March 2011.

The development of the CCeD Method was carried out by a project team of six people, representing three different organizations.

UnderstandIT

The UnderstandIT project is a Leonardo da Vinci - Transfer of Innovation project with support from the EU (project number: 2010-1-NO1-LEO05-01839). This project belongs to the Lifelong Learning Programme and it has partners from Germany, Lithuania, Denmark, Italy, Portugal, and Norway. One of the work packages (WP2) in the UnderstandIT project aimed to utilize a distributed concurrent design approach for further development of existing courses about VET teachers' use of ICT, and it was particularly this work package that were significant for my doctoral project.

The distributed concurrent design approach was first defined and established and this was based on own experience from co-located concurrent e-learning, besides CSCW literature studies. Next, all 19 project participants used this approach to adapt existing courses for VET teachers' use of ICT and make them appropriate for four new countries (Lithuania, Italy, Portugal and Norway). The deliverables from this cooperation were twofold. On the one hand, a design document that explains how the courses should be organized in the respective countries was developed. On the other hand, a business plan covering how to produce and deliver sustainable courses for the respective countries was produced. The UnderstandIT project was mainly helpful in regard to the third research question and particularly the identification of requirements for realization of a distributed approach to concurrent design. The UnderstandIT project started in October 2010 and will continue until October 2012.

Project Participation – As a part of a Doctoral Program

There are obvious advantages and disadvantages of engaging in several different projects (BITØK/EIK, CCeD and UderstandIT) as part of a doctoral program. For my part, participation in the above-mentioned projects has largely been positive. These projects have contributed to the identification and actualization of the research problems, and they have been important for the implementation of real testing and the collection of primary research data. Furthermore, participation in these projects helped since they made me able to discuss relevant issues with other researchers who were also concerned with the same research issues and questions.

Participation in R&D projects might put some constraints in relation to the research agenda, and it might generate duties that are not relevant to the doctoral project. However, I claim it has been positive both for me and my doctoral project, to take part in these projects.

3.2.2 From Research Questions to Research Contributions

The overall research aim for this thesis is to contribute with basic motivation, implementation experience, and requirements for practical realization, regarding methodological approaches for concurrent design of e-learning deliverables for corporate clients. Three research questions are identified and the thesis includes six papers which each in their own way address challenges related to these research questions.

This section is grounded on each research question and explains how the work of these has taken place and led to the research contributions of the thesis. However, in this section the main focus is on the research process, while the results (i.e. research contributions and facts of each paper) are outlined in detail in Chapter 4.

Basic Motivation

The first research question (RQ1) deals with basic motivation - Why should HEIs apply a concurrent design approach when they aim to deliver e-learning to corporate clients? This was identified as a significant research question early in my doctoral program and there were several reasons for this:

- First, our institution (HiST/AITeL) had recently started a concurrent design initiative in a more traditional form. In this project, participants from several engineering disciplines (electrical engineering, mechanical engineering, materials engineering, logistics and software engineering) test the concurrent design methodology, as we know it from space technology institutions. As a consequence of this project we became familiar with concurrent design and the infrastructure for concurrent design sessions was established. It was therefore reasonable to test whether this approach could be used to design new courses, especially customized e-learning for corporate clients that should be offered as part of the BITØK/EIK project.

- Second, customized e-learning for corporate clients consists of much more than the actual teaching and it may well be seen as an offer that consists of a portfolio of services. Identification, design, and development of such services require an interdisciplinary understanding and a cooperation that may be in line with a concurrent design approach.
- Third, design of e-learning for corporate clients requires the involvement of the client representatives and adaptation of the educational offer to suit the needs of the clients.

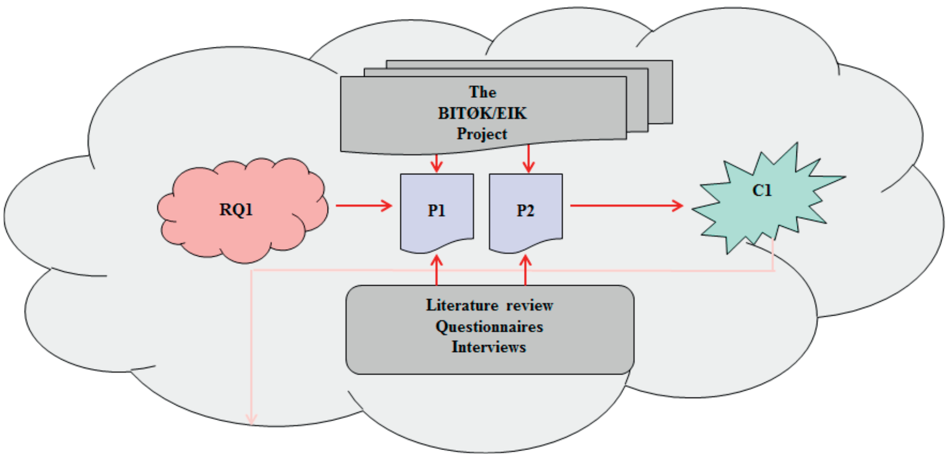

Figure 7: From Research Question 1 to Contribution 1

Figure 7 is intended to summarize the work on the basic motivation and research question 1. As the figure shows much of this work took place as part of the BITØK/EIK project. Furthermore, we see that literature review, questionnaires, and interviews were used as research methods and that this work was published in the form of two papers (P1 and P2).

The study behind P1 was based on a literature review. Some information was taken from five IT Infrastructure Library (ITIL) publications from 2007, while research articles primarily was collected from electronic databases. I searched the databases of SCOPUS, ACM Digital Library, IEEE Xplore, and ISI Web of Science and I used Google Scholar to perform simple search for relevant literature across disciplines and sources. First, I picked up a large amount of articles by combining search terms like: e-learning, online learning, distance learning, distance education, web-based learning, and blended learning with OR in between. Then I searched in this result with IT Service Management (ITSM) terms like: ITIL, service management, ISO/IEC 20000, HP IT Service Management Reference Model, Microsoft Operations Framework and IBM System Management Solution Lifecycle with OR in between and the result was reduced to a few articles. The conclusions from this study include that additional services are important for a comprehensive and sustainable online distance learning program and that few have exploited the ITIL framework in connection with online distance learning. In the continuation of the doctoral project I chose to focus on the design process for e-learning deliverables. This study contributed to both the motivation and the direction of this work, since it made me aware of important properties of comprehensive and sustainable e-learning services.

The study behind P2 was based on a mixed method approach (Creswell, 2003), since both qualitative and quantitative analysis in relation to two specific e-learning projects were conducted. These projects had the fact in common that the customer was a commercial corporation or company who wanted to buy customized e-learning from an academic institution, but they were very different when we consider what kind of e-learning solution the customers wanted:

- In one project (BITØK/EIK), the customer wanted the academic institution to develop and deliver eight customized e-learning courses. All eight courses had to be a part of an already existing bachelor's degree, offered by the institution. It was also a demand from the customer that students who had completed all courses in the program should be able to continue on a full bachelor's program afterwards. The idea behind customizing already existing bachelor's courses was that this would help to make sure that the courses would be sustainable and reusable. The courses should be based on online synchronous lectures using web-conference software. The recordings of the lectures had to be available for streaming and downloading, together with text-based training material and corresponding mandatory exercise work administrated by a learning management system (LMS). The LMS was used to present all learning material related to the courses. In addition the local corporate organizer had to set up an independent portal for administrative purposes. It was also important for the customer that the courses could be followed by the students in a flexible way, since most of the students were company employees with many job related tasks and limited spare time. The eight 7.5 credit courses were to be offered over a two year period, with two courses in parallel each semester.
- In the second project (ANIMALIA) the assignment was to develop a self-paced e-learning course based on web pages containing text materiel, oral presentations, video presentations, and animations. The evaluation program in the course was based on multiple choice tests and the course participants received instant feedback on their answers. The subject domain area for this e-learning course was unknown to the educational provider, meaning that the customer had to contribute as a subject matter expert (SME), and therefore help to describe the content and develop a suitable knowledge model for the training course. The course, once developed, had to be reusable without involvement from the customer or the educational provider. The course was only meant for the customer's employees. This training course was in the area of vocational training for slaughterhouse workers. I did not participate in this project myself but since the project had been undertaken within my institution, I had access to project information and those who had participated.

Qualitative data were collected from these two projects through project documents, scheduled interviews with involved project participants, and analysis of open (free-response) questions from two questionnaires. In addition, I conducted informal interviews with relevant project participants, and I participated in some of the project activities in the BITØK/EIK project. Moreover, a literature review was conducted and this included an article by (Mikalsen, Klefstad, Horgen, & Hjeltnes, 2008) which previously have been published from the second project (ANIMALIA).

The four instructors who lectured the first semester in the BITØK project, and the ICT-technician who was responsible for the technical equipment, were interviewed in semi-structured interviews. Each of these people was interviewed once and the interviews took between 30 and 70 minutes. In these interviews were data gathered about: (1) relevant background and experience, (2) preparations before the program started, (3) preparations before the net-based lectures, (4) problems or challenges faced the first semester, (5) positive experience and what has worked well the first semester, (6) possible adjustments and improvements, (7) issues to be retained and reinforced, (8) fulfillment of the students' expectations, and (9) if the program had been sufficiently adapted and customized with respect to needs of the customers. All interviews were taped and transcribed into text protocols.

Quantitative data were collected using two electronic questionnaires which were given to the students who followed the two courses in the BITØK project in the first semester. These questionnaires were conducted primarily to get an indication of how the students perceived the overall quality in the courses. A mix between free-response questions, dichotomous questions, multiple-choice questions, checklists and rating questions with the Likert scale were used. There were also used several free-response questions that have been used in the qualitative analyzes afterwards. The questionnaires were distributed to the students as part of the mandatory exercise program. All 33 students answered the first questionnaire and 29 students answered the second questionnaire. At the end of the semester 27 students took the final exam in one or two of the courses in the first semester of the BITØK project.

As shown in Figure 7, P1 and P2 together provide contribution 1 (C1), i.e. detected motivation and conditions for applying a concurrent design approach to the design of customized e-learning for corporate clients. The studies behind P1 and P2 were mainly based on literature review, questionnaires, and interviews and the results are considered important, as input to the work of RQ2, which is discussed in the next section.

Implementation Experience

The second research question (RQ2) deals with implementation experience - How should a concurrent design approach for the development of customized e-learning for corporate clients be materialized? This was identified as a significant research question when the work with RQ1 was performed. While RQ1 helped identify what to do, RQ2 primarily focused on the how. RQ2 is essentially a two-part question which on the one hand deals with how the concurrent design approach initially should be described, while it on the other hand deals with how it eventually should be tested and evaluated. Here are some details in relation to these two sub-questions.

How should a concurrent design approach for the development of customized e-learning for corporate clients initially be described? This question generated a host of new questions:

1. How should the process be defined and how should project implementation be carried out?
2. What roles need to be involved and what responsibility and authority should be connected to each role?
3. How should the design be built up when the aim is connect different parts that together form a comprehensive design document for the entire e-learning deliverables?
4. What tools should be used for what purposes?
5. What kind of infrastructure (including premises and technical equipment) are desirable for the implementation of such concurrent design projects?

These were questions that had to be answered in connection with the initial establishment of the CCeD Method. The design science research method was used in this context and the results of this work were published in P3, besides SP2 and SP3. When the method initially had been defined and described some important questions were still remaining:

1. How can such a new methodological approach be introduced at HEIs?
2. How should this work be evaluated and how can we learn from gained experience?

In connection with the introduction of the CCeD Method action research was used. As a part of the CCeD project, three different action research projects were conducted and important CCeD Method experience were collected.

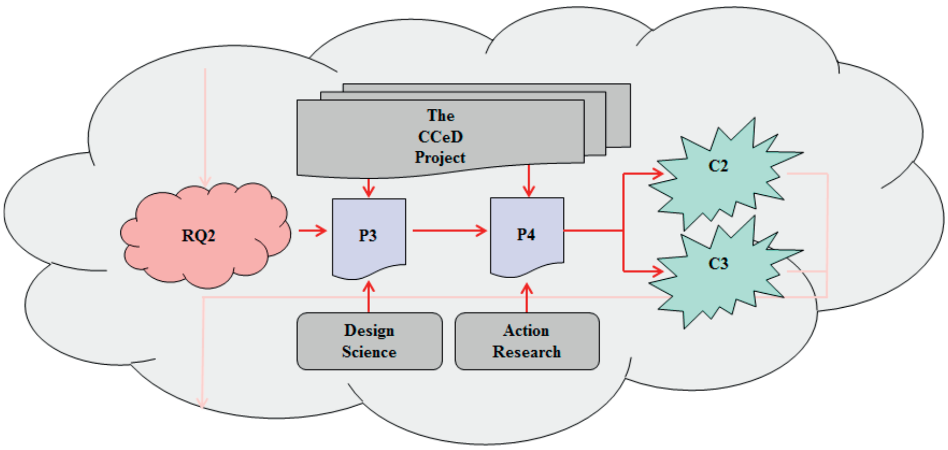

Figure 8: From Research Question 2 to Contribution 2 and Contribution 3

Figure 8 summarizes the work on implementation experience regarding a concurrent design approach to the design of customized corporate e-learning, i.e. research question 2 (RQ2) in this doctoral project. As the figure shows much of this work took place as part of the CCeD project. Initially, the design science method was used to develop the CCeD Method and the results from this were published in P3. Together with SP2 and SP3,P3 constitutes C2, i.e. the concurrent e-learning design method. Furthermore, action research was used in connection with the introduction of the CCeD Method. This was published in P4 and it is considered an independent contribution (C3) of this thesis, i.e. experience from using action research as a means of introducing new artifacts at higher education institutions.

The study behind P3 was based on design science and the CCeD Method was the main artifact from this design science project. Several challenges were faced during this design science project and here are the most relevant examples: (1) to what extent can we draw on existing instructional design methods and what adjustment do we need to make? (2) to what extent can we draw on existing concurrent design experience and what adjustment do we need to make? (3) how should we organize and define the CCeD process? (4) which roles do we need in a CCeD project, (4) which design-models that together constitute an overall model for the entire e-learning offer should we develop? (5) which software tools could we utilize when these models are developed? (6) how should we organize the facility (the room with needed hardware and software tools where concurrent e-learning design sessions are conducted)? (7) how should we facilitate the work and stimulate to an inclusive team environment that contributes to productivity? and (8) how should we define an infrastructure for collaboration and information sharing between all the involved project participants?

In order to answer these questions relevant literature within the fields of e-learning design and concurrent design was reviewed. Furthermore, I exploited the experience my project participants had in relation to e-learning. This work started in the late 1980s and our institutions have offered Internet-based distance education since 1992, as participants in the JITOL project (Lewis, Goodyear, & Boder, 1992). In addition, we brought in external expertise (Dr. Oxnevad) with regard to concurrent design. Oxnevad has worked with concurrent design at JPL from 1996 to 2005 (Simtano, 2012). Besides traditional literature review, both audio and video recordings were used to collect and store data during the project. The project meetings were recorded on audio-files and parts of this material were later transcribed into text protocols. Several activities conducted in the concurrent design facility at HiST/AITeL was video-taped and this includes the four days of concurrent design team and facilitator training Simtano and Oxnevad provided us with, in May 2009. These audio and video recordings were used as input when various aspects of the CCeD Method were described.

All seven design science research guidelines from Hevner et al. (2004) were considered when the CCeD Method was developed. However, Guideline 3 concerning design evaluation and Guideline 5 concerning research rigor, required the artifact to be implemented and tested in its intended environment. It was in this context we wanted to take advantage of action research and in particular the principles of canonical action research from Davison et al. (2004).

The study behind P4 was based on implementation and evaluation of the CCeD Method. To test the CCeD Method thoroughly and form a basis for improvements, we entered into agreements with three different projects. These projects aimed to develop new educational deliverables and eventually use the CCeD Method in this context. At the same time, it was also important that the objectives and the size of these projects were different, because it enabled us to test various aspects of the CCeD Method.

- The objective of the first project was to design a new subject within computer supported cooperative work for bachelor's level students on campus. Five people from the CCeD Method project team had mentoring roles in this project and collaborated with five others during the project for a total of ten people who completed five CCeD sessions as part of the first project.
- The objective of the second project was to design a new subject within the area of service management for some selected companies. Six people from the CCeD Method project collaborated with three customer representatives in this project, where we improvised and adjusted the method approach along the way. A total of four sessions were conducted in the CCeD facility, and we had to conduct one morning and one afternoon session on the same day to reduce participants' traveling time. The fifth final session was not conducted in the CCeD facility, but replaced with traditional meetings to complete the models and the final learning design.
- The objective of the third project was to design a new course regarding the Framework for ICT Technical Support (FITS). FITS was owned by Becta, which lead the national drive in the UK to inspire and lead the effective and innovative use of technology throughout learning and in September 2009 was the FITS Foundation formed to manage the on-going development and support of FITS (FITS, 2012). Five people from the CCeD Method project collaborated with eleven client and customer representatives in this project meaning that a total of sixteen people were involved. The reason the number of people expanded was that several representatives from the client and the client's customers wanted to participate. The CCeD Method is flexible in relation to the number of participants, and this project would also have worked well with a few people, given the necessary competencies. In this project we also experienced changing objectives and, consequently, a need for adaptive adjustments. The first three sessions went more or less as planned, and then some adjustments were made because we gained access to various materials from FITS Foundation that could be adapted and reused in the new course.

In connection with the implementation of concurrent design sessions in these three projects up to five working sessions for each project were carried out. For each of these sessions the action planning, action taking and evaluation steps were conducted. This means that we first planned what to do and which deliveries to produce for each session. Next, the sessions were conducted in relation to the plan, and finally, the end of each session was used to evaluate the results in plenary. All these steps are considered as important data collecting activities and we used audio recordings (Dictaphone) to store these data for future investigations. Furthermore, we used threefold questionnaires with questions concerning: (1) how the session preparations worked (action planning), (2) how the session implementations actually went (action taking), and (3) how the session conclusion worked (evaluation). Within each of these three question categories, the respondents had to answer some closed questions with alternatives and some open questions where free-response was demanded. In this way we obtained the respondents' views in relation to some selected areas (e.g. how the different templates work in a specific session) while we also captured their general opinions by the use of free-response questions. In addition to the threefold division, we also asked questions that helped categorize the participants and this was the first part of the first questionnaire for each of the three projects.

The results of these questionnaires acted as important input when the six in the CCeD Method team conducted evaluation meetings and specified learning that led to method changes and updates. The CCeD Method team conducted short evaluation meetings, lasting for a few hours after each session. In addition two full-day workshops were conducted to specify learning and make decisions regarding final method modifications and updates. Participants' own experience and the results of surveys were extended with the e-learning design models under development. These models always contain the latest documented information with respect to knowledge, pedagogy, technology and business related conditions. In fact, it is the content of these models that ultimately shows how well the CCeD Method works, because these models will constitute the final design document for the new e-learning deliverables.

Requirements for Practical Realization

The third research question (RQ3) deals with requirements for practical realization - What are the key requirements for a concurrent design approach to the design of customized e-learning for corporate clients?

This research question is a continuation of RQ2 in which I try to generalize on the basis of all data collected during the project, and describe how this approach actually should take place. I want to provide solid advice in relation to the application of concurrent cooperation to design e-learning deliverables. To provide this advice we have a two-fold focus. On the one hand, paper 5 (P5) consider a distributed approach to concurrent design, while on the other, a more traditional and co-located approach is considered in paper 6 (P6). In the following two sections I briefly describe the studies behind P5 and P6:

- The study behind P5 aimed to determine whether concurrent design can be performed distributed and how this possibly can take place. The motivation in relation to test a distributed approach was particularly enhanced by the UnderstandIT project. As part of this project the aim was to investigate how today's easily available cooperation technology can be used to implement distributed synchronous and asynchronous cooperation across organizations and countries. The methodological approach was qualitative, and the data were collected from two different source categories. Primary data were collected from the UnderstandIT project while secondary data were based on a literature review that mainly focused on selected parts of the CSCW research area. Furthermore, design science research guidelines were used to define and describe the new artifact, which can be regarded as a continuation and specialization of the CCeD Method.

P5 can be regarded as a report from a design science project (Hevner et al., 2004) for the following reasons. First, the aim was to produce a viable artifact, i.e. prescriptive approaches which may eventually become a framework for distributed cooperation. Second, we believe this is relevant since the streamlining of distributed cooperation can provide benefits for a lot of projects. Third, the results were evaluated as part of the UnderstandIT project, where computer-supported cooperation is a key issue. For example, as part of the UnderstandIT project, we collected oral feedback and online questionnaires after completing each of the four distributed and synchronous cooperation sessions. Fourth, collected data from the UnderstandIT project confirms that the form of distributed cooperation as described and tested in this project works well. (Even though we do not consider this to be proof that it makes us more efficient and productive, we take it as an indication that we should continue this work.) Fifth, our work is largely based on existing research results (the CSCW literature), while our new contributions (the human approach and technological configurations) are tested and evaluated as part of an ongoing EU project. Finally, dissemination of results was performed while the work was in progress.

- The study behind P6 described general concurrent design principles for e-learning design, based on the projects we have completed and the data we have collected. As previously mentioned, the CCeD Method was developed as a collaborative project between several Norwegian institutions: the Faculty of Informatics and E-Learning at Sør-Trøndelag University College; the Department of Computer and Information Science at the Norwegian University of Science and Technology; the research foundation TISIP; and five internationally-operating companies within the telecommunications industry. As part of this work, various research methodological approaches such as literature review, questionnaires, interviews, design science, and action research were utilized, and a lot of data in different formats were collected. Towards the end of the doctoral project qualitative analysis was conducted based on previously collected data with the objective of identifying the principal characteristics of concurrent e-learning design. The results from this work are presented as sixteen principles of concurrent design in P6.

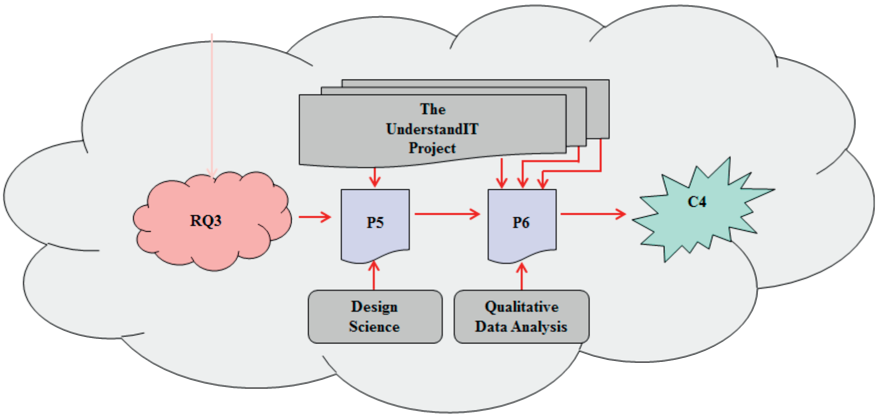

Figure 9: From Research Question 3 to Contribution 4

Figure 9 summarizes the work on requirements for practical realization regarding a concurrent design approach to the design of customized corporate e-learning, i.e. research question 3 (RQ3). As the figure shows this is twofold: on the one hand, I completed a separate design science project to describe how distributed concurrent design can take place (results are presented in P5); on the other hand, I conducted qualitative analysis of data collected over several years to describe how concurrent e-learning design can take place (results are presented in P6). P5 and P6 in addition to SP2, SP3, and SP4 constitute contribution 4 (C4), i.e. requirements and guidelines for concurrent design of customized corporate e-learning.

3.2.3 Summary of Research Methods and Context

In this chapter, I have described the research methods employed in this doctoral project as well as the context in which the different methods were used. Since the use of research methods has varied along the way I argue for design-based research and use the four phases from Reeves (2000) as an overall framework in terms of explaining the use of different research methods as the project proceeded. So this doctoral project can be considered as a method engineering project: “Method engineering is the engineering discipline to design, construct and adapt methods, techniques and tools for the development of information systems” (Brinkkemper, 1996, p. 276).

Some of the experience achieved towards the end of this method engineering project was to consider the concurrent e-learning design method as a situational method. This means that it is essential to adapt the method to the situation of the project at hand and consider the goals of the project we are undertaking, and what results we want to produce, each time the method is used for a new project. Furthermore, it is reasonable to note that the result we wish to achieve is usually not an e-learning system in the traditional sense, but rather a design for e-learning deliverables, offering guidelines for issues such as learning outcomes, subject content, assessment practices, learning activities, teaching strategies, technological choices for development and delivery, administrative needs, economic constraints, and intellectual property rights. This chapter dealt with the research methodological approach of this doctoral project while the achieved results are presented in more detail in the next chapter (Chapter 4). In addition Chapter 5 contains an evaluation and a discussion related to research methods and results.

4. Results

The first part of this chapter introduces an overview of the contributions of the thesis in which each contribution is briefly described. Next, this chapter summarizes the papers that contain the results from the conducted studies. Finally, the relation between papers, research questions and research contributions are presented.

4.1 Overview of the contributions

This thesis deals with a concurrent design approach to the design of customized e-learning for corporate clients and it is based on six peer-reviewed papers. The major contributions in these papers are:

- C1: - Detected motivation and conditions for applying a concurrent design approach to the design of customized e-learning for corporate clients.
- C2: - The concurrent e-learning design method.
- C3: - Experience from using action research as a means of introducing new artifacts at higher education institutions.
- C4: - Requirements and guidelines for concurrent design of customized corporate e-learning.

Although these contributions basically are meant for those who work with instructional design and e-learning we believe they also are relevant to those working with computer-supported cooperative work and human-computer interaction. This is because a concurrent design approach to the design of customized e-learning for corporate clients to a large extent is about to perform efficient and productive computer-supported cooperation. Each of the four contributions is briefly described in the following sub-sections.

4.1.1 Contribution 1: Detected motivation and conditions for applying a concurrent design approach to the design of customized e-learning for corporate clients

Making use of a concurrent design approach means: (1) to involve the customer and other relevant stakeholders, (2) to cooperate in concurrent design sessions with the necessary technical tools (hardware and software) and all relevant stakeholders present, (3) to produce designs that cover several interdisciplinary themes, and (4) to make decisions which all stakeholders immediately can vouch for.

Customized e-learning for corporate clients are educational programs that are tailored to the needs of selected customers. These needs can be both diverse and complex and they might cover topics such as the subject content, pedagogical delivery, technical delivery, business aspects, administrative aspects, and different ICT-based services that contribute to comprehensive offerings for the customers.

Paper 1 (P1), paper 2 (P2), and secondary paper 1 (SP1) contain motivation and conditions with respect to applying a concurrent design approach to the design of customized e-learning for corporate clients. P1 focuses on additional services and that these are important when the aim is to provide complete online distance learning offerings, while P2 focuses on the importance of involving the client and that this is demanded from the early design phase. The concurrent design approach is recommended since several stakeholders should meet and design comprehensive solutions. Approaches to the design of such solutions require that we are able to answers questions such as: (1) how should the content be customized to client demands, (2) what is a suitable pedagogical delivery, (3) how to achieve satisfactory technological quality, (4) what constitutes a sustainable business model, (5) what administrative constraints exists, (6) what additional services should the client have access to, and (7) are there any demands for local organization on the client's side?

4.1.2 Contribution 2: The concurrent e-learning design method

The concurrent e-learning design method is regarded as the main artifact from the design science research (Hevner et al., 2004) which was conducted to define requirements for methods and tools that aim to support collaborative processes for e-learning design. Paper 3 (P3) is the first peer-reviewed description of this method and it describes the method on a general level, while various documents (e.g. secondary paper 2 (SP2) and secondary paper 3 (SP3)) contains more details. SP2 and SP3 were prepared as part of the CCeD project (see Chapter 3).

The CCeD Method offers a concurrent design approach to the design of customized e-learning for corporate clients. This is a novel approach based on experience of instructional design and industrial concurrent design and it was described along six dimensions. These were:

- The *Process* which is materialized as a *Process Description for Concurrent E-Learning Design* (SP2). SP2 describes the focus areas for CCeD-projects throughout the project cycle.

- The *Roles* which are materialized as a list of needed roles with corresponding responsibilities. The roles are described in SP2 and SP3.
- The *Models* that include the instructional model, the knowledge model, the technical delivery model and the business model. These sub-models will in total make up an integrated and holistic model for the entire e-learning design. The sub-models are described in both SP2 and SP3, and it is especially SP3 that provides a detailed description of the templates that form the basis for the respective sub-model.
- The *Tools* including mind-map templates for each model and a secure online workspace for cooperation purposes. Different tools are described in SP2 and SP3.
- The *Facility* which is realized as a physical room with necessary technical equipment. Details about the room itself and the tools used to conduct concurrent design activities in this room are described in SP2 and SP3.
- The *Infrastructure* which includes a secure online workspace for the exchange of project information, documentation and other resources is described in SP2 and SP3.

P3 is the first peer-reviewed paper related to contribution C2 but paper 4 (P4), paper 5 (P5), and paper 6 (P6) also need to be mentioned in this context. P4 deals with practical evaluation and testing of the CCeD Method by means of action research, P5 deals with transference of the concurrent e-learning design sessions (i.e. synchronous cooperation sessions) from a co-located to a distributed workspace, while P6 provides principal conditions for concurrent e-learning design which are based on the analysis of qualitative data collected during the doctoral study.

4.1.3 Contribution 3: Experience from using action research as a means of introducing new artifacts at higher education institutions

Research methods and the use of action research when the CCeD Method was introduced in its target organization was the main focus of the study which I refer to in P4. Based on experience from this study I consider action research as a suitable research approach for introducing such artifacts at higher education institutions. Here is some of the most important experience acquired in this regard:

- Action research contributes to formalism and serves as a guideline in relation to project planning and implementation.
- An established agreement between researcher(s) and client(s) is important and provides a basis for the collaboration between the involved stakeholders.
- Thorough knowledge of client requirements and expectations, early in the project, will help to ease the project implementation.
- It is recommended to follow the cyclical process model of action research (see Fig. 10). This model constitutes largely the principles of canonical action research.
- It is important to provide information and training to the participants, in relation to the research project they actually will be part of.

- The three steps: (1) action planning, (2) action taking, and (3) evaluation (see Fig. 10) must be repeated several times since this cycle helps in assessing what works and consequently provides a basis for identifying general findings and specifying learning.
- The reflecting step (see Fig. 10) can typically be implemented as dedicated workshops. This may result in agreement about how things work (i.e. the input artifact should be updated), as well as proposals for new actions that should be included in the cycle.
- Consider the use of several different techniques to collect most pertinent information, when action research projects are implemented. E.g. reports, surveys, or interviews which can be stored as text, images, audio files, or video files.
- Expect changes and be always prepared to re-plan the actions during the project.
- Take into account the dual imperatives of action research. Meaning challenges that occur due to the twofold objectives in which the client is concerned with the product, while the researcher also is concerned about the process and method that leads to the product.
- This study concluded that action research is well suited when new artifacts such as methods, processes or the similar are to be introduced and adapted into an organization.

Figure 10 was used in P4 to form a basis for the explanation of the cyclic process model used in this study. The same figure (Fig. 5 in Section 3.1.3) was also used when the use of action research in this doctoral project was discussed. Since action research was both a research method as well as a separate contribution (C3) I also consider much of the content in Section 3.1.3 as part of this contribution, i.e. how the principles of canonical action research from Davison et al. (2004), were used in this doctoral project.

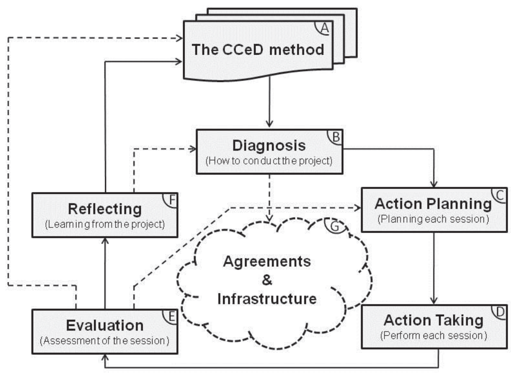

Figure 10: The Cyclical Process Model of Action Research

4.1.4 Contribution 4: Requirements and guidelines for concurrent design of customized corporate e-learning

Contribution 2 describes a method for concurrent e-learning design that make up a relatively fixed framework (e.g. four defined focus areas, five different cooperation sessions, and all participants co-located in the concurrent design facility). However, the research performed retrospectively shows that a concurrent design approach to the design of customized e-learning for corporate clients must be more flexible and adaptable to varying needs, as well as the changes that occur while these projects are ongoing.

With this in mind the fourth and most important contribution in this thesis is defined, i.e. requirements and guidelines for concurrent design of customized corporate e-learning. These requirements exist in different arrangements or categories. P6 applies to the concurrent design approach on a general level where the participants are usually co-located, while the focus of P5 is on distributed cooperation.

In P5, we choose to present the requirements along four dimensions, i.e. communication, coordination, collaboration, and workspace awareness. We draw inspiration for this from the CSCW literature and we conducted testing and evaluation as part of the Understand IT project (see Chapter 3). Figure 11 shows distributed concurrent design as a platform which stands on three legs (communication, coordination, and collaboration) and where the whole construction is surrounded by a cloud of awareness. This summarizes this part of C4 where we draw on experience from the research field of CSCW in order to better understand how distributed concurrent design can be implemented. This figure is also included in P5.

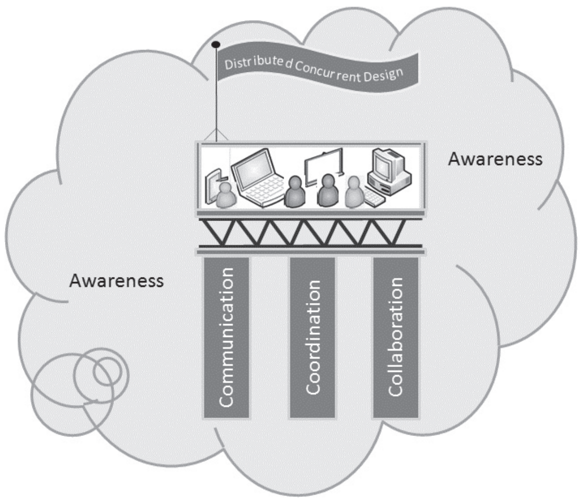

Figure 11: A Platform for Distributed Concurrent Design

In P6 we present 16 principles, divided in five categories. The following figure (Fig. 12) is used in P6 to help explain these categories and here is a brief reproduction of this explanation:

- *Adaption to surroundings* - At the outermost level of the wheel we have placed the category of adaption to surroundings, which refers to the things that must be considered when the method should be calibrated for new projects.
- *Stakeholders, activities, and infrastructure* - On the next level of the wheel, within the external surroundings, are stakeholders, activities, and infrastructure represented. These three categories constitute the framework in concurrent e-learning design. The integration and interaction of these elements and their adaptation to the external surroundings forms the foundation that will produce the results of the design process.
- *Results* - In the center of this wheel we have the results, meaning that results (project deliverables) lie at the core of concurrent e-learning design.

Figure 12: The Wheel of Principle Categories for Concurrent E-Learning Design

The requirements for concurrent design of customized corporate e-learning shows that this concerns computer-supported cooperation which could be co-located (i.e. all participants present in the concurrent design facility) or distributed (i.e. a shared workspace using the Internet), and either synchronous (i.e. activities that take place in cooperation sessions) or asynchronous (i.e. activities that take place between these sessions).

4.2 The Papers

The six papers that represent the results of this thesis are summarized in this section and each summary describes the following:

1. A headline with the full name of the paper.
2. The authors.
3. Where the paper was published.
4. Brief information about what this paper is about.
5. An explanation of why this paper is relevant to this thesis.
6. An explanation of what is my actual contribution in this context.

Each of the six published papers has been peer-reviewed and consequently accepted by other researchers as providing a significant contribution to the body of knowledge. The papers are reprinted in full length in Appendix A of this thesis and they are presented in a chronological order.

This section presents a summary of these 6 papers:

1. Strand, K.A. & Staupe, A. (2009). To Provide Online Distance Learning as a Portfolio of Services. In G. Siemens & C. Fulford (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2009 (pp. 4433-4442). Chesapeake, VA: AACE.
2. Strand, K. A. & Hjeltnes, T. A. (2009). Design of Customized Corporate E-Learning. Seminar.net - International journal of media, technology and lifelong learning, 5(2), 14.
3. Strand, K. A. & Staupe, A. (2010). The Concurrent E-Learning Design Method. In Z. Abas et al. (Eds.), Proceedings of Global Learn Asia Pacific 2010 (pp. 4067-4076). AACE.
4. Strand, K. A. & Staupe, A. (2010). Action Research Based Instructional Design Improvements. In Falmyr, T. (Eds.), Norsk konferanse for organisasjoners bruk av informasjonsteknologi, NOKOBIT 2010, (pp. 25-38). Gjøvik University College.
5. Strand, K. A., Staupe, A. & Maribu, G. M. (2012). Prescriptive Approaches for Distributed Cooperation. In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2012 (pp. 1011-1020). Chesapeake, VA: AACE.
6. Strand, K. A., Staupe, A., & Hjeltnes, T. A. (2013). Principles of Concurrent E-Learning Design. In K. Patel, & S. Vij (Eds.), Enterprise Resource Planning Models for the Education Sector: Applications and Methodologies (pp. 48-75). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-2193-0.ch004

4.2.1 P1: To Provide Online Learning as a Portfolio of Services

Authors: Knut Arne Strand and Arvid Staupe

Published: Proceedings of World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED-MEDIA) 2009, AACE.

About this paper: This paper shows that providing online distance learning to corporate clients can be seen as offering a set of services. Teaching and related services are the core business of educational institutions. These services are largely based on ICT and therefore such deliverables might exploit IT Service Management (ITSM) framework such as the IT Infrastructure Library (ITIL).

This article was written in the initial phase of the doctoral program and I got the idea for this work when I observed the customer and the supplier in the BITØK/EIK project. There were various disagreements between these parties, for example in relation to who is responsible for various administrative student support services, who should be responsible for marketing, how should course content (course material and exercises) be delivered, how should online lectures be organized, when (i.e. how long time after the lecture) should recordings of the lectures be ready for download, and which quality regarding web-based lectures (audio and image quality) should we expect. These are challenges that have much in common with ICT-based service deliveries as we know them from other business areas. Since ITIL actually is a summary of best practice in relation to how ICT-based service deliveries should take place, I chose to examine whether such a service-oriented approach may be appropriate for HEIs.

The conclusions from this study include that additional services are important for a comprehensive and sustainable online distance learning program and that few have exploited the ITIL framework in connection with online distance learning. In the further work section of this paper we suggested to test ITIL implementations on a small scale and to start the implementation of a Service Strategy. In the next run we recommend considering broader scale ITIL implementation.

Later on in the doctoral project, I decided to go in depth on a concurrent design approach to the design of customized corporate e-learning and if we see this in relation to ITSM, I claim that we decided to focus on a smaller part of the Service Design lifecycle of ITIL.

Relevance to this thesis: This paper shows that online distance learning is composed of several services and that administrative support or technical delivery must be taken into account in addition to traditional factors such as learning outcomes and learning activities. This has helped to shape the concurrent design approach to e-learning design, which was focused in later phases of the doctoral project.

My contribution: The idea behind this paper was triggered by my cooperation in the BITØK/EIK project, but this study is primarily based on a literature review. I was responsible for this literature review and I was the leading author of this paper. In addition, I had the pleasure of receiving valuable feedbacks from my co-author who also is my main supervisor.

4.2.2 P2: Design of Customized Corporate E-Learning

Authors: Knut Arne Strand and Tor Atle Hjeltnes

Published: International journal of media, technology and lifelong learning 2009, Seminar.net.

About this paper: The main aim of this paper is to focus attention on challenges faced by educational institutions when customized corporate e-learning is designed and delivered to external clients. Customized corporate e-learning contains three terms and in this paper these have the following meaning: (1) *E-Learning* is training programs offered over the Internet. This includes live and synchronous video-conference based lectures and asynchronous distribution of learning material via a learning management system, as well as self-paced e-learning based on traditional web-pages with audio files, video files, and animations. (2) *Corporate* is used to indicate that the customers are not traditional stand-alone net-students but rather a group of employees belonging to a certain company while the educational provider is a higher education institution which enters into agreements with external companies in order to deliver education for their employees. (3) *Customized* is used to indicate that the e-learning deliverables are adapted to the needs of the client companies. In some situations, these could be small adjustments to existing subjects that are part of a degree, and in other cases we might develop new vocational training programs that do not necessarily lie within the curriculum of the institution.

Primary data for this exploratory study were collected from two different projects carried out by the educational institutions I belong to, i.e. HiST/AITeL and TISIP. These two projects were both on assignment from external clients but their requirements differed a lot. In one project the client wanted the educational institution to develop e-learning based vocational training for their employees, while the customer in the second project required customized formal higher education that could form part of a bachelor’s degree. We used questionnaires for students, interviews with involved project participants and analysis of former project documents as sources for primary data. Secondary data were collected from the e-learning literature while supplementary data were based on our institutions long experience in e-learning and distance education.

Relevance to this thesis: The main findings from this study could be separated in two areas. The challenges we faced when we are in the design phase and those faced when we deliver the e-learning. In the design phase it is really important to establish a good dialog with relevant stakeholders, to ensure that the stakeholders understand the different possibilities, and that the educational institution really understands the customer requirements. Stakeholder involvement is of extra importance when customized corporate e-learning is developed and one should start the collaborative design process by focusing on the needs of the learners. In the delivery phase it is very important that the lecturers know the technology and can vary the use of the technology in a pedagogically sound way. This requires training and we must be aware that lecturers often need much more time to prepare a web-based lecture, compared with a traditional campus lecture. These findings have been valuable input to the process of developing new approaches for e-learning design, which we worked further on in the remainder of the doctoral project.

My contribution: I had the idea for this paper, I was responsible for data collection, I conducted data analysis, and I was in charge of the writing process. My co-author has been involved in the two projects we are referring to and we had very fruitful discussions along the way, which greatly helped to improve the quality of this paper.

4.2.3 P3: The Concurrent E-Learning Design Method

Authors: Knut Arne Strand and Arvid Staupe

Published: Proceedings of Global Conference on Learning and Technology (Global Learn) 2010, AACE.

About this paper: This paper presents the *Concurrent E-Learning Design Method* and it is the first peer-reviewed paper that describes this method in detail. The work with this method (i.e. initial method definition, implementation and testing as a part of real project implementations, and the final analysis of all data collected) has been an important part of my doctoral project, and the R&D projects I have been involved in.

This method is used to design customized e-learning for corporate clients. It approaches e-learning design as an integrated and iterative process and encourages interdisciplinary cooperation between several involved stakeholders. The method builds on key elements from the industrial concurrent design approach as well as several instructional design models that are already well proven in connection with e-learning design. An important part of this doctoral project has been to determine if e-learning design processes can be based on the concept of concurrent design and eventually how this should be implemented. We want to study whether the positive effects from industrial concurrent design implementations (e.g. improved quality, more satisfied project participants, and reduced time consumption) also appear when the principles of concurrent design are applied to design of customized corporate e-learning. To test this thoroughly, we first have to develop and describe a method for concurrent e-learning design and this is the main purpose of this paper.

Concurrent e-learning design consists of five elements and all are described in this paper. This is: (1) the process that defines how the projects should be run from start to finish, (2) the different roles involved in the cooperation sessions, and the tasks they are responsible for, (3) the different sub-models to be developed, which together make up the entire design-model for the e-learning delivery, (4) the tools that the various experts use when their sub-models are developed, and (5) the facility and the infrastructure which should contribute to efficient interdisciplinary collaboration (concurrent design) throughout the project. In addition to these five elements this paper also focuses on the interaction between the involved parties, i.e. the establishment of an integrated and interdisciplinary collaborative environment in which we really can benefit, when new e-learning deliveries are to be developed.

Relevance to this thesis: Since this was the first peer-reviewed paper that describes the concurrent e-learning design approach it was important for the dissemination process and the work in relation to convey what this approach actually is about. The definition of the method as described in this paper is the premise of the empirical studies that we later implemented and the results of these empirical studies constitute the most important contributions of this thesis.

My contribution: This paper resulted from the CCeD project and it sums up much of the work that was done initially in this project. The results presented in this article are thus a result of the collaboration in the CCeD project. I was very active in this collaboration and I contributed to the preparation of project documents that also served as base documents for this paper, i.e., secondary paper 2 and secondary paper 3 in this thesis. Moreover, I was the first author of this paper and I was in charge of both the data collecting and the writing process. However, I had useful discussions with participants in the CCeD project and I collaborated in particular with my main supervisor and co-author when this paper was written.

4.2.4 P4: Action Research based Instructional Design Improvements

Authors: Knut Arne Strand and Arvid Staupe

Published: Proceedings of Norsk konferanse for organisasjoners bruk av informasjonsteknologi 2010, NOKOBIT-stiftelsen and Tapir Akademisk Forlag.

About this paper: This paper is about the research project we conducted when the principles of canonical action research were applied for testing the concurrent e-learning design method. The method was described in advance and in this study it was tested on three different projects.

The research questions we wanted to answer with this study were twofold. On the one hand, we wanted to evaluate the concurrent e-learning design method in real organizational settings and provide with experience to help shape future versions of this method. On the other hand, we wanted to find out how action research can contribute to a thorough, consistent, and credible testing and evaluation when a new artifact like the concurrent e-learning design method is to be introduced by an HEI. It is also worth mentioning that the research questions in relation to the method itself have the main focus of this paper. Nevertheless, the majority of the participants in the three projects we are referring to, focused on the e-learning deliverables that were designed while these projects was conducted.

Relevance to this thesis: This paper is very relevant since it shows the practical testing and evaluation of the concurrent design approach to the development of customized corporate e-learning. The data we collected as part of this study have been important for further analysis and to achieve the overall aim of this thesis, i.e. to contribute with experience and requirements for concurrent design of e-learning solutions for corporate clients.

My contribution: This paper resulted from the CCeD project and it sums up much of the work that was done when the concurrent design approach to the development of customized corporate e-learning was tested in a context of active participants from both customer and supplier side. I had the idea and was responsible for the action research we performed during this study but I could not have accomplished this without collaboration with all involved participants. As the first author I was also in charge of the writing process but I had useful discussions with participants in the CCeD project and I collaborated in particular with my main supervisor and co-author when this paper was written.

4.2.5 P5: Prescriptive Approaches for Distributed Cooperation

Authors: Knut Arne Strand, Arvid Staupe and Geir Magne Maribu

Published: Proceedings of World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED-MEDIA) 2012, AACE.

About this paper: Concurrent design is basically co-located and synchronous cooperation taking place in a concurrent design facility. Within this facility the infrastructure (hardware, software and other necessary equipment) and the involved roles (e.g. the facilitator and various experts with decision authority) is composed to achieve optimal interdisciplinary cooperation with participants in the same place and at the same time.

Conversely, this paper highlights some of the experience we had when the concurrent design approach to the development of e-learning was transferred from co-located surroundings to an online and distributed environment. The hypothesis was that we can save both time and money and become more efficient and productive if we succeed with this kind of distributed cooperation, with the use of modern cooperation technology. To achieve such benefits were also among the objectives of the EU-funded R&D project (UnderstandIT), we refer to in this study.

We established an approach for distributed cooperation based on: (1) communication, (2) coordination, (3) collaboration, and (4) workspace awareness. This approach is named *Distributed Concurrent Design* and it is based on literature studies within the CSCW research field, in addition to own experience with the co-located concurrent design approach. Distributed concurrent design was defined, implemented and evaluated as part of this study, in which the main contribution is prescriptive approaches to this kind of synchronous and work-intensive distributed cooperation.

Relevance to this thesis: This paper is relevant since it focuses on distributed cooperation, which can be considered an additional dimension to the concurrent design approach investigated in this doctoral project. If we can understand how to become efficient and productive when design activities are performed by geographically dispersed participants, it will be very beneficial.

My contribution: I was involved in establishing the infrastructure for distributed concurrent design in this project, I attended as a facilitator when the distributed cooperation sessions were implemented, and I prepared the questions that were used in connection with the evaluations of each cooperation session. I was also responsible for literature studies to uncover how these problems had been handled within the research field of CSCW, and to consider how we could take advantage of this, in this study. Furthermore, I was in charge of the writing process and I had very fruitful discussions with my co-authors, which greatly helped to improve the quality of this paper.

4.2.6 P6: Principles of Concurrent E-Learning Design

Authors: Knut Arne Strand, Arvid Staupe and Tor Atle Hjeltnes

Published: A chapter in K. Patel, & S. Vij (Eds.), Enterprise Resource Planning Models for the Education Sector: Applications and Methodologies (pp. 48-75). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-2193-0.ch004

About this paper: The main aim of this paper is to present the 16 principles of concurrent e-learning design. Concurrent e-learning design is regarded as a methodological approach where the objective is to produce designs for e-learning deliveries that are holistic and cover aspects such as learning outcomes, learning activities, technological production and delivery, financial possibilities and constraints, and administrative features.

In this study we used an inductive approach to qualitative data analysis and coding where we went through data in different formats (e.g. video clips, audio recordings, surveys, interview notes, project documents, training materials, design documents, and fully developed courses), with the goal of identifying general principles. In the first cycle we used descriptive initial coding to name the ideas in the data and have them represented as nodes. These nodes helped us aggregate extensive and varied raw data into a brief summary format. In the second cycle we did axial coding to extend the analytic work from the first cycle. During this process all the nodes from the first cycle were categorized in relation to what each node actually concerned. After finishing this cycle we had five categories containing their respective nodes. In the third cycle the nodes was reduced to a total of sixteen principles and the information associated with each node was used to describe each principle in detail.

The main purpose of this paper is to provide detailed information about each category and each principle within the topical category.

Relevance to this thesis: This article is very relevant to this thesis since the research results we have achieved in connection with the concurrent design approach to the design of customized corporate e-learning are condensed here. We use data that are developed through the PhD project to conduct qualitative analysis and identify and extract the most important experience. Since this paper is produced during the last year of the PhD project and relies on data that are produced throughout most of the project, it is considered as the most important paper in this thesis.

My contribution: The paper is based on data collected over several years and I have personally been involved in the preparation and collection of these data. Furthermore, I have been responsible for the qualitative analysis and coding of the data and I used my co-authors for what Thomas (2006) refers to as *stakeholder checks*, i.e. to assess and give feedback regarding the research findings, interpretations, and conclusions. I was in charge of the writing process of this paper but I was dependent on data which all project participants have helped to collect. Furthermore, I had very fruitful discussions with my co-authors, which greatly helped to improve the quality of this paper.

4.3 Connections between Research Questions, Papers, and Contributions

This chapter has presented the main research contributions and a summary of each research paper, to explain briefly how each paper contributes to answer the different research questions. This section emphasizes the relationship between these elements (i.e. research questions, research papers, and contributions) through the use of two tables. Table 1 lists the relationship between the research questions and the research papers while Table 2 indicates the relationship between research papers and research contributions.

	Research papers					
Research questions	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
RQ1: (Basic motivation) Why should higher education institutions apply a concurrent design approach when they aim to deliver e-learning to corporate clients?	√	√				
RQ2: (Implementation experience) How should a concurrent design approach for the development of customized e-learning for corporate clients be materialized?			√	√	√	√
RQ3: (Requirements for practical realization) What are the key requirements for a concurrent design approach to the design of customized e-learning for corporate clients?					√	√

Table 1: The Relation between Research Questions and Research Papers

Research papers						
P1	**P2**	**P3**	**P4**	**P5**	**P6**	**Research contributions**
√	√					C1: Detected motivation and conditions for applying a concurrent design approach to the design of customized e-learning for corporate clients.
		√	√	√	√	C2: The concurrent e-learning design method.
			√			C3: Experiences from using action research as a mean of introducing new artifacts at higher education institutions.
				√	√	C4: - Requirements and guidelines for concurrent design of customized corporate e-learning.

Table 2: The Relation between Research Papers and Research Contributions

Together, these tables indicate the progression from research questions, via research papers, to research contributions. Figure 1 in Section 1.6 also elaborates on this connection threads between research questions, research papers, and research contributions and represents it in a single figure.

The following bullet list summarizes this Results chapter and helps to explain the overall picture of the research presented in this thesis:

- Initially, a basic motivation was identified which states that corporations have an increasing need for employees with appropriate competencies in today's knowledge-based economy, and that HEIs can take part in this market by offering e-learning-based training and education customized to the needs of the corporate clients.
- Then, concurrent design is proposed as a topical approach to the design of holistic e-learning deliverables customized for corporate clients. This approach involves collaboration between relevant stakeholders who use modern computer-supported tools and endeavor to produce high quality results in a time- and cost-effective manner.
- Based on this, a concurrent design approach to the design of customized corporate e-learning is defined and described as a method (a design science artifact).
- Next, this approach is tested in a number of specific (action research) projects where the educational provider collaborates with client representatives to design and develop e-learning deliverables.
- Finally, the data collected during the previous phases of the doctoral project are the subject of a qualitative analysis that leads to a description of the requirements and guidelines for concurrent design of customized corporate e-learning.

In addition to being an approach to design customized corporate e-learning, I argue that this is also computer-supported and interdisciplinary knowledge work on a general level. Consequently this thesis is a contribution in terms of how technological solutions can be utilized to achieve effective and efficient computer-supported cooperation in modern knowledge work.

5. Evaluation and Discussion of Results

This first part of this chapter discusses challenges related to interdisciplinary research. Next, research questions with associated methods are evaluated, then the four identified research contributions are evaluated, and finally the trustworthiness is discussed on the basis of problem relevance, utility and credibility, novelty, and generalizability.

5.1 Challenges of Conducting Interdisciplinary Research

This doctoral project has dealt with instructional design, in a concurrent design manner, in order to design e-learning solutions for corporate clients. Furthermore, the design process has relied on extensive use of computer tools (computer-supported cooperative work) while the upcoming project deliverables typically can be a comprehensive design document containing details regarding how higher education e-learning courses should be developed and delivered. This means that the research crosses the disciplinary boundaries of instructional design, concurrent design, and computer-supported cooperative work, while information systems research and software engineering (particularly principles from software design processes) also are a relevant source of inspiration.

Multidisciplinary research and interdisciplinary research are two terms used when describing research that crosses disciplinary boundaries and Golde & Gallagher offer the following insight about these terms: "In multidisciplinary research, people bring separate theories, skills, data, and ideas to bear on a common problem. Interdisciplinary research involves bringing together people and ideas from different disciplines to jointly frame a problem, agree on a methodological approach, and analyze the data" (1999, p. 281).

On this basis, I would argue that the work performed in my doctoral project is both multidisciplinary (it relies on different disciplines) and interdisciplinary (concurrent design brings different experts together in integrated design sessions). Furthermore, I claim it is important to deal with interdisciplinary research issues since this covers complex challenges that practitioners also works to resolve. However, an interdisciplinary approach complicates matters, and for example it has been challenging to find all the contributions which are appropriate to build on. The state of the art in this thesis (Chapter 2) conveys my background and a platform for my research, but it has not been obvious to determine what should be included and this is a matter for discussion. It also complicates the situation that the various disciplines use different terminology on matters that actually have a lot in common, for example when literature search is performed.

A common denominator for the multidisciplinary tasks that have been studied is design, i.e. design activities to produce design models for upcoming deliverables. The state of the art chapter also points out that instructional design, concurrent design, and software engineering are concerned with design processes, as well as the development of different models that represent different aspects of the design. Ma & Harmon (2009) emphasize that at an increasing number of researchers work to generate design guidance for practitioner who aim to describe technology-based innovative learning environments and that design-based research is an appropriate approach in this context. With this in mind, I decided to use Reeves' (2000) model for design-based research as an overall explanation in relation to the research methodological approach and the varying use of different research methods in this thesis. More information about the research methodological approach is provided in Chapter 3.

The use of design-based research as a platform for explanations has been useful for the interdisciplinary research in this thesis, since it helped to structure a mixture of research methods that have been utilized during the project. In the remainder of this chapter I will evaluate the research questions and associated research methods, evaluate the research contributions, and reflect on the trustworthiness.

5.2 Evaluation of Research Questions and Associated Methods

This thesis consists of three research questions, which each in their own way help to illuminate the overall research aim for the doctoral project, i.e. basic motivation, implementation experience, and requirements for practical realization, regarding methodological approaches for concurrent design of e-learning deliverables for corporate clients. The following sections evaluate each of these research questions, as well as the research methods used to answer them.

5.2.1 Evaluation of Research Question 1

RQ1 concerns why HEIs should apply a concurrent design approach when they want to deliver e-learning to corporate clients. The basis for this research question was to be able to define and describe the basic motivation for the research that was to be undertaken in my doctoral project.

A basic motivation for all research is to contribute with results which are original, relevant, and significant, and the researcher(s) must have a good overview of the fields to ensure this. This involves exploring what actually exists and determining how it works, besides to acquire expertise on questions that are regarded as important within the research field(s). In order to document whether a contribution is original, relevant, and significant, it must always be viewed in the context of other contributions and the state of the art of the field. I think it was both reasonable and appropriate to start out by identifying a fundamental motivation in relation to why HEIs should apply a concurrent design approach when the aim to deliver e-learning to corporate clients. This is an exploratory research question where the answers were of crucial importance for future research, since research challenges were highlighted and these guided me during the doctoral project.

The research methods I used in this initial phase were literature review, questionnaires and interview. This was both reasonable and beneficial since the literature review provided a good overview concerning what others have done, while the surveys (questionnaires and interview) helped to actualize the research challenges in one's own organization. Therefore, I think it was right to do these studies initially even though I did not have direct use for all results later on. In retrospect it is easy to see that the work of P1 could have been more general in relation to services which form a part of e-learning deliverables and less aimed at ITSM frameworks such as ITIL. Based on P1, I could actually have chosen to focus the entire thesis around ITSM frameworks in connection with e-learning deliverables, but I chose to study concurrent design approaches to the design of customized e-learning for corporate clients. RQ1 contributed to actualize these alternative options and demonstrated a real need in the problem area that I actually decided to pursue.

5.2.2 Evaluation of Research Question 2

RQ2 is about implementation experience. This is a twofold question that on the one hand deals with how a concurrent design approaches for the development of customized e-learning for corporate clients should be described, and on the other hand deals with how this approach eventually should be tested and evaluated. RQ2 is directly based on C1, i.e. the uncovered need for a concurrent design approach to the design of customized corporate e-learning, and the identified guidelines regarding how to organize this approach.

The first part of RQ2 deals with describing a method or a methodological approach. It is essential to produce a thorough description since the use of concurrent design to design customized corporate e-learning is complex, comprehensive, and requires interdisciplinary cooperation. To test this concept in an orderly and thorough manner it must first be described. In this context, it was both reasonable and appropriate to be based on design science and particularly the seven design science guidelines from Hevner et al. (2004). With these principles artifacts produced by means of design science will become viable artifacts, which solve relevant problems, constitute a verifiable contribution, and are rigorously designed and evaluated.

The second part of RQ2 deals with practical method implementation, testing, and evaluation. I have mentioned the fact that a concurrent design approach to e-learning design is complicated and this also applies when this approach is introduced and implemented by an HEI. However, action research is a research method that is useful when changes are to be introduced in an organization and especially when the researcher is to be active in this process. Action research is regarded by many as an ideal research method for information systems research but certain guidelines should be followed to achieve rigorous and relevant action research. A number of characteristic strategies can be used to achieve scientific rigor in action research and Baskerville & Wood-Harper offer the following insight concerning this: “First they must establish an ethical client-system infrastructure and research environment. They must plan their data collection carefully. They must observe iterative phases that formulate theory, plan action, take action, and evaluate the action. Through this process they must promote collaboration by the subjects and support their subjects’ learning cycles. Despite the idiographic nature of the study, the researcher may imply certain generalizations based on the theory and learning. Reports of the research must disseminate the scientific knowledge achieved by the study to allow future work that can confirm or refute any causal suggestions or claims of generalized theory” (1996, p. 244).

I think the projects in which the concurrent e-learning design method was introduced, tested, and evaluated benefited from the use of canonical action research (Davison et al., 2004), and that the above mentioned guidelines regarding rigor and relevance were largely met. The use of action research was important for both C2 (i.e. the method was tested and evaluated in a thorough manner), and C3 (i.e. gained experience regarding how action research can be used when new ID methods are introduced at HEIs).

5.2.3 Evaluation of Research Question 3

RQ3 concerns requirements for practical realization and the aim is to identify and describe key requirements for a concurrent design approach to the design of customized e-learning for corporate clients. This research question is a direct continuation of RQ2 and the main difference is the empirical data that are available and the techniques used to analyze the empirical data.

While the work of RQ2 was largely based on secondary data from literature reviews, a lot of primary data were available when work on RQ3 started. The purpose of RQ3 was to analyze the collected primary data, in order to identify principles that describe how concurrent e-learning design should actually take place.

However, the effort to answer RQ3 was twofold. On the one hand, I conducted qualitative analysis of data collected from the various projects where the CCeD Method was used. These empirical data were mainly collected in connection with the concurrent design sessions which were conducted in our concurrent design facility, i.e. co-located and synchronous cooperation. The results of these studies were published in P6. On the other hand, as a part of the UnderstandIT project (see Chapter 3) it was necessary to describe how a distributed approach to concurrent design could be materialized. This was partly based on personal experience and primary empirical data from concurrent e-learning design sessions, but literature studies and analysis of secondary data from the CSCW research area was also required in this context. Furthermore, design science was used (Hevner et al., 2004) when the distributed variant was defined and documented. The artifact from this design science project was the prescriptive approaches for distributed cooperation as presented in P5.

RQ3 was very important in terms of summarizing the experience of a research project that has been ongoing for several years. Actually, this is the fourth and last phase in the model of design-based research from Reeves (2000), i.e. documentation and reflection to produce design principles. In my opinion it was very useful to go through these final studies, since it is during this final stage we really have a basis for describing how things actually are related.

5.3 Evaluation of Contributions

Four contributions are highlighted in this thesis. These are presented at an overall level in Chapter 4, but it is the six selected papers in Appendix A and the four secondary papers in Appendix B which in its entirety contains these contributions. The following sections evaluate each of these research contributions.

5.3.1 Evaluation of Contribution 1

C1 is described as detected motivation and conditions for applying a concurrent design approach to the design of customized e-learning for corporate clients. This includes: (1) that there is a market for customized e-learning for corporate clients and that it is natural for HEIs to join this market, (2) that multiple stakeholders (including customers) must be involved in designing such educational programs, (3) that we should involve experts who represent different aspects of the educational program, i.e. experts on themes such as the subject domain and the content, pedagogy, technical delivery, economics, and administration, (4) that such e-learning deliverables typically are made up of various ICT-based products and services, and (5) that a concurrent design approach seems to be applicable, while it also requires detailed planning. In this way C1 contributes to the initiation of the work with RQ2, besides answering some questions that must be considered in that context.

In summary, C1 concludes that a concurrent design approach to the design of customized corporate e-learning makes sense, and that this approach must be defined before it can be applied. Furthermore, C1 contributes with experience from instructional design, concurrent design, and software engineering, which provides guidance regarding how the approach actually should be defined. C1 was an important background and motivation in relation to the work that went on in my doctoral project since the need for a concurrent design approach to the design of customized corporate e-learning and some guidelines regarding how to organize this approach were uncovered as a part of this work. P1, P2, and SP1 are the papers that constitute C1.

5.3.2 Evaluation of Contribution 2

C2 is the Concurrent E-Learning Design Method (CCeD Method) and particularly the first definition and description of this method, which was developed further in C4. In contrast to C4 is C2 based on less primary data, less proprietary empirical data, but more on secondary data obtained through literature studies in instructional design, concurrent design, and software engineering. I would also emphasize that C2 is more descriptive than C4. This is because C2 consists of a conceptual framework for how concurrent e-learning design projects are to be implemented, that are less flexible than what was later recommended. While C4 emphasizes flexibility in relation to the fact that each project is unique and that the methodological approach must be adapted to the situation at hand, C2 provides a set of fixed methodological elements that are more strictly defined.

The CCeD Method is a novel method that offers a concurrent design approach to the design of customized e-learning for corporate clients and in SP2, SP3, and P3 this method was described along the following six dimensions: (1) the process, (2) the roles, (3) the models, (4) the tools, (5) the facility, and (6) the infrastructure. These dimensions are also used in the following evaluation of C2.

The Process

The process was materialized as a process description document (SP2) and the process itself consists of a preparation phase, an execution phase, and a conclusion phase. The execution phase is considered the most important in this context since concurrent design sessions are conducted in this phase. It was decided that the following five sessions were to be conducted in each project: (1) a situation analysis, (2) a study of possibilities, (3) an evaluation of possibilities and selection of solution, (4) a detailed preparation of the e-learning design, and (5) the completion of the design document.

It was in many ways very useful to have described the process in advance as this helped us to plan the project and to determine and schedule different project activities. The implementation of the process and the concurrent design sessions went well in the beginning (the first two to three sessions). Then, it became more challenging to focus on the tasks that should actually lead to a completed design document after the last session. It is challenging to cooperate concurrently (synchronously and in parallel) until the final results are finalized and therefore we had to use more traditional approaches (sequential and asynchronous work) to complete the projects. This is also considered an interesting task for future research, i.e. how the project team can achieve concurrent cooperation, right up until the final results.

The disadvantage of using a fixed and defined process (i.e. specific sessions that address predefined themes) is that this can be inflexible and not fully optimized for the project at hand. This was some of the experience we achieved and some of the reasons why C4 reveals that we should identify a set of project activities to be undertaken, rather than using a fixed and pre-defined process.

The Roles

The roles are materialized as a list of needed roles with corresponding responsibilities and they are described in SP2, SP3, and P3. The main task of the different roles can either be regarded as articulation work or cooperative work (Schmidt & Simone, 1996).

In concurrent e-learning design and particularly when cooperation sessions are performed, the facilitator holds a key role which mainly performs articulation work to coordinate all session participants. This has proven to be a very important and demanding role in which practical training and experience is important. The facilitator will also typically be supported by other roles such as a session secretary and the project manager.

The cooperative work (i.e. the work to produce project deliverables) is performed by a team of experts who are responsible for their respective disciplines. In the CCeD Method the following four expert roles were identified: (1) instructional designers, (2) subject matter experts, (3) technical delivery experts, and (4) business experts. Defining these four roles, with responsibility and authority had both strengths and weaknesses. The strengths are that the project will focus on topics that are relevant in a fast and effective manner. However, the weaknesses might be that conflicts between the different roles occur. It may for example be natural for more people to perform the same type of tasks and it may be that some roles are not particularly relevant in certain projects. This was some of the experience we gained and the reason why C4 highlights the principle of defining participants and roles in the process of adaptation to the surroundings in the initial phase of the projects.

It can be positive with a set of predefined roles, but the distinction between the different experts can also be slightly artificial when e-learning deliverables are to be designed. The idea of using different experts who represent their respective area of expertise is taken from industrial concurrent design where the distinctions between disciplines (e.g. electrical engineering, mechanical engineering, materials engineering, and logistics) are more obvious.

The Models

The models include the instructional model, the knowledge model, the technical delivery model, and the business model. These sub-models should in total make up an integrated and holistic model for the entire e-learning design. The sub-models are described in SP2, SP3, and P3 and it is especially SP3 that provides a detailed description of the templates that form the basis for the respective sub-model.

The sub-models are developed based on templates. These templates are built in such a way that the experts will reflect on and respond to selected questions concerning the e-learning deliverables that are to be designed. Each template (i.e. the instructional model template, the knowledge model template, the technical delivery model template, and the business model template) includes its respective questions and within each template the questions are adapted to the project's progress, i.e. the questions are designed to be appropriate for respectively sessions 1 to 5.

Our experience in developing different sub-models that represent different aspects of the system suggests that this has both strengths and weaknesses. The strengths lie in the fact that the designers (different experts) are given an aid and support in the design process, and it forces them to reflect on and consider several important issues. A weakness and challenge might be to synchronize the sub-models so that the same questions and themes not addressed unnecessarily many times, and so that the decisions which are made within one model are captured and applied in other sub-models. Another issue might be that important topics are omitted from the discussion because they are not included in the templates. All in all, I believe it is prudent to use several sub-models that represent different aspects of the design. This is also an important strength of UML which is materialized as different diagram types or extensions such as the coUML. coUML is a visual modeling language for modeling instructional designs for cooperative environments (Derntl & Motschnig-Pitrik, 2008) which also was discussed in Chapter 2.

The Tools

In connection with concurrent e-learning design it is necessary to use different tools for various purposes. In SP2 and SP3 these tools were divided into the following categories: (1) tools to support the sessions technically, i.e. tools that support the interaction in the sessions so that session participants can convey information on specific topics to other session participants, (2) project administration tools that provide access to relevant project information for all participants, (3) project planning tools to plan the project sessions and other activities, (4) expert tools used by the experts during the e-learning design process, and (5) tools to support the session facilitator administratively, e.g. to record decisions and actions during the sessions.

From the beginning different tools in these categories were selected and used and gradually we tried various alternatives. In my opinion this has been a successful strategy since there are many tools that can be used and we just have to choose something to get started. A challenge in relation to the choice of some tools (e.g. expert tools) has been the participants' expertise and experience in using such tools. In the state of the art chapter (Section 2.2.2) I show that there are lots of tools for designing e-learning deliverables, but these tools must also be learned and mastered before they can be used. Since the project participants did not have the necessary experience with specialized tools, we chose the general tools for these purposes, e.g. co-editable mind-maps based on predefined templates and tools for collaborative writing such as Google Docs.

Although the use of the tools we chose worked, the feedback from the participants also suggests that we could gain considerable benefits from choosing the right tools and using them properly. The use of different types of tools in collaborative processes such as CCeD is also considered very interesting for future research. A secure online workspace for cooperation purposes might consist of a combination of standard tools, customized standard tools and specialized tools that together constitute a portfolio of tools that meets the need. Later in the doctoral project tools for distributed cooperation were also studied more thoroughly and this is discussed in P5 which constitutes part of C4.

The Facility

The concurrent design facility was realized as a physical room with the necessary technical equipment. Details about the room itself and the tools used to conduct concurrent design activities in this room are described in SP2, SP3, and P3. It was very fortunate for me and my doctoral project that the department I belong to established a specialized room for concurrent design, when I was in the startup phase of the project. This room made it possible to test a concurrent design approach to the design of customized corporate e-Learning at our institution. If we are to conduct co-located concurrent design I think it is a great advantage to establish a physical environment that supports this appropriately. The room, which was established by HiST/AITeL was actually directly inspired by the Jet Propulsion Laboratory (JPL) in California. This is because Dr. Oxnevad worked with concurrent design at JPL from 1996 to 2005 (Simtano, 2012) and he was also involved in influencing how the room (the concurrent design facility) should be designed at HiST/AITeL.

As mentioned, it was very positive that such a room was established but the room's design has also provided guidance regarding how the work and cooperation should be conducted, and this is not necessarily optimal. Part of the reason why we chose four specialist areas (the instructional model team, the knowledge model team, the technical delivery model team, and the business model team) was that the room was designed with four desks, where the various participants were to cooperate and that we initially chose placing experts in one area at the same desk. This was not necessarily the best solution, and consequently we tried alternative placement of the participants, besides switching to smaller screens. This contributed to easier communication at the various desks, since it was easier to communicate across the desks when physical barriers such as large screens were removed.

Design of physical environments for cooperation is something that several researchers have worked with. In this context I would refer to Mittleman (2009) who presents a five-step process in relation to the design of computer supported collaboration spaces. In connection with this process, 97 questions are presented and these deal with topics that also have a high degree of relevance if we are to establish a concurrent design facility. An example from a more general study in relation to designing spaces to support knowledge work is Peponis et al. (2007) who discuss how both formal and informal processes can contribute to organizational productivity, and that design and layout of the workplace affect this. This suggests that studies regarding the design of the physical working environment for intensive cooperation also are interesting topics for further research, especially if we are to conduct distributed and synchronous cooperation by means of modern ICT solutions. This was also partly affected later in my doctoral project, in connection with P5 which forms a part of C4.

The Infrastructure

The infrastructure is in this context a secure online workspace for the exchange of project information, documentation, and other resources. First we established a Microsoft SharePoint Server to meet this objective, but since Mindjet Catalyst also provides a secure online work spaces, we decided to use this. As mentioned the web-based tool we used to co-edit mind maps was also based on Mindjet Catalyst. We had no particular problems with the SharePoint solution, but decided to use the Mindjet Catalyst solution, to reduce the number of solutions for the project participants. Several of the project participants stated that they felt comfortable working in the clouds, and that it was very beneficial to have easy access to what the other project participants have produced.

We have concluded that it is very important to establish an infrastructure that supports the project activities when the cooperation switches between synchronous and asynchronous activities with co-located or distributed participants. The infrastructure was also identified as very important in connection with the work performed later in the doctoral project, i.e. the work on RQ3 and C4, which was materialized in the form of P5 and P6.

Summary of Contribution 2
There is a demand to develop e-learning solutions in HEIs. These solutions should be based on a variety of needs that are balanced to form comprehensive and sustainable training services for the students. When using the concurrent e-learning design approach we want to involve the customer in the design process and to elicit the customer's needs. Furthermore, we want to deal with as many relevant requirements as possible, already in the design phase, in order to avoid major surprises later in the project. This means that participants such as domain experts, educationalists, technical experts, business people, and people from the administration must be represented in the design phase. Our aim is to contribute to the development of holistic e-learning designs, which cover all relevant requirements. We want to do this on a time and cost effective manner and simultaneously produce high quality results. The challenges we face in this context have much in common with those related to computer-supported cooperative work in general, i.e. how do we get synchronous and interdisciplinary cooperation, with a high degree of hardware and software support, to function optimally?

The CCeD Method covers only the analysis and the design phases of a project. We decided to drop project phases such as implementation, production, delivery, and maintenance, to concentrate on the early analysis and design phases. I believe this made sense within the scope of my doctoral project. Thus I conclude that the CCeD method, as we described it, gave us the opportunity to test a concurrent design approach to the design of customized corporate e-learning in a good way. How the actual testing went is the subject of the next section.

5.3.3 Evaluation of Contribution 3

C3 consists of experience from using action research as a means of introducing new artifacts at higher education institutions. The CCeD Method is an artifact which can also be considered a prescriptive and conceptual framework. Design science research guidelines from Hevner et al. (2004) were used when they were developed, but Guideline 3 concerning design evaluation and Guideline 5 concerning research rigors, required artifact to be implemented and tested in the target organization. This was the motivation behind using the principles of canonical action research from Davison et al. (2004), when the CCeD Method was introduced at HiST/AITeL. Experience gained from these action research studies resulted in updates of the material that constitute C2, i.e. SP2, SP3, and P3. However, it is P4 which in its entirety constitutes C3, since the experience from using action research as a means of introducing the CCeD Method at HiST/AITeL is thoroughly documented and discussed in P4.

Action research brings the research and the use of research results together in a process where external scientific observers are not necessarily present, since the researcher usually is an active participant in the research program. Action research is a systematic and reflective study of some actions and the effect of these actions on the organization. The researcher examines the ongoing work and looks for possible improvement opportunities as well as searching for evidence from several sources as a tool to analyze the actions carried out. The researcher acknowledges his/her own subjective view, but seeks to develop an understanding of the events based on multiple perspectives, thus using and rendering the collected data in a way that it can be shared with the participants. In turn, this forms the basis for a reflective phase where new plans in relation to actions, activities, and measurements for the next implementation cycle are designed. Action research is a method where practice learning by working through a set of reflective phases, contributes to the development of personal customized expertise. Over time, a deeper understanding in areas such as organizational processes, stakeholder collaboration, and utilization of models, methods and tools is developed and forms the basis for new improvements (Susman & Evered 1978; Baskerville & Pries-Heje 1999; Davison et al. 2004). In this way, I consider action research to be an extension to the design science process, and an aid in relation to evaluation and improvements of new artifacts like the CCeD Method.

During this study I concluded that action research is well suited when new artifacts such as the CCeD Method are to be introduced and adapted into an HEI such as HiST/AITeL. The use of action research contributes to systematized and structured planning, implementation, and evaluation in which both the process and results become more thoroughly and rigorously. The experience I had with the use of action research in connection with the projects where the CCeD Method was implemented was considered both relevant and significant. This is why C3 (i.e. experience from using action research as a means of introducing new artifacts at higher education institutions) is presented as a separate contribution in this thesis. Furthermore, I consider that a grounded action research approach as described in Baskerville & Pries-Heje (1999) will contribute with added rigor and reliability in the action research theory formulation process. Therefore, this is regarded as a natural extension of C3 in connection with future projects where new artifacts are to be introduced at our institution.

5.3.4 Evaluation of Contribution 4

C4 consists of requirements and guidelines for concurrent design of customized corporate e-learning. This can be considered as a conceptual framework or a prescriptive framework, but it is less prescriptive than C2. This is because our studies revealed that a concurrent design approach should be flexible and adaptable to varying situations and changing needs, and that we do not have sufficient experience to define in advance and in detail how this should be done. C4 is a twofold contribution, which on the one hand focuses on co-located concurrent e-learning design while it on the other hand focuses on a distributed approach to this. The following sections evaluate these two separate parts of the contribution, before concluding by discussing the contribution on a comprehensive level.

The Co-located Approach
Concurrent design is interdisciplinary and intensive cooperation among participants who are co-located in a specially designed room, called a concurrent design facility.

This was also the approach that I mainly worked with and in P6 it is described in terms of 16 principles of concurrent e-learning design.

P6 is basically a summary regarding how concurrent e-learning design can take place, when the cooperation sessions are conducted in a concurrent design facility with the participants physically present. P6 and C4 are actually a direct continuation of P3 and C2, but P6 is to a greater extent based on personal experience and primary data collected in connection with the studies that make up C3, i.e. the action research projects in which the CCeD Method were implemented, tested, and evaluated.

In the study behind P6 16 principles in relation to concurrent e-learning design were identified and in my attempt to present these principles, I chose to categorize them. Five categories were identified and as stated in Fig. 12 (Section 4.1.4), these categories can be presented as a wheel. The principles of *Adaption to the Surroundings*, which refers to the issues that must be considered for every new project, were placed on the outermost level of this wheel. This is where the method meets the environment and where customizations have to be performed. On the next level of the wheel, in the external surroundings come *Stakeholders*, *Activities*, and *Infrastructure*, which constitute the framework in concurrent e-learning design. The integration and interaction of these elements and their adaptation to the external surroundings form the foundation that will produce the results of the design process. In the center of the wheel we have the *Results*, meaning that results (project deliverables) lie at the core of concurrent e-learning design and several principles are connected to the results that the projects are meant to produce.

I believe that the wheel of principle categories for concurrent e-learning design helps to convey the key aspects of this approach in a general way, while the relevant principles within each category provide important details. This wheel can also be seen as a continuation and an improvement of the PPT-Model developed by Oxnevad (see Section 2.4). This is because people, process, and tools are continued as, respectively stakeholders, activities, and infrastructure in this wheel. In addition, we have the outer part of the wheel (i.e. the tire which faces the surroundings), and the very core of the model (i.e. the hub or the kernel which symbolizes the reason we carry out the projects, and that is typically the results we aim to produce). Each of the five categories is thus an important constituent for a concurrent design approach to the design of customized corporate e-learning, especially when this should be carried out co-located and in a concurrent design facility. Furthermore, the principles work as prescriptive guidelines in each category and we can choose to study selected parts (e.g. the principle of expert tools) to make improvements and provide with significant contributions in selected parts of the model.

The Distributed Approach

A demand to make the CCeD Method available via the Internet (online and distributed) occurred since it could be both challenging and expensive to always meet physically and face-to-face. In this context it was appropriate to consider how to transfer a common information space from a co-located setting (the concurrent design facility at HiST/AITeL) to a distributed setting (Internet). This also corresponds to many of the issues that CSCW researchers have worked with and terms such as communication, collaboration, coordination, awareness, openness and closure, articulation work, common information spaces, and community of practice turned out to be relevant in this context (Gutwin & Greenberg, 2002; Bannon & Bødker, 1997; Girgensohn & Lee, 2002).

In the study behind P5 I worked to identify prescriptive approaches for distributed cooperation, and this methodological approach was based on experience from computer-supported cooperation and industrial concurrent design. On this basis the term distributed concurrent design was defined and P5 provides the following definition:

> *Distributed Concurrent Design is coordinated and multidisciplinary collaboration where different forms of communication are used to develop knowledge and make decisions regarding products under development. Optimal interactions between involved parties, activities, and the artifacts they utilize are important for this to work, and utilization of workspace awareness is important for optimal cooperation.*

When working on P5 it was discovered that successful distributed concurrent design has an overall need for communication, coordination, collaboration, and workspace awareness, to support the needed interactions between involved people, artifacts, and activities. P5 uses these four elements to build and to explain a platform of distributed concurrent design which also is depicted in Fig. 11 (see Section 4.1.4).

Experience with distributed concurrent design, as a part of the UnderstandIT project (see Section 3.2.1) revealed that communication, coordination, collaboration, and workspace awareness are very important elements that can be treated separately, but which also must be considered together. It is important to identify the needs within each of these four areas since these are guidelines with respect to needed infrastructure, activities to be performed, and who is to be involved in which roles. Furthermore, it is important to understand the connection between these areas, since a good interaction is necessary to achieve effective and efficient concurrent design with distributed participants. This is important to get started with distributed concurrent design, while each of these four elements also represents significant topics for future research and improvement.

Contribution 4 on a Comprehensive Level

The two preceding sections have discussed the requirements and guidelines for how the concurrent design of customized corporate e-learning can be divided into two approaches. Actually, these approaches show two different dimensions of concurrent e-learning design. One dimension deals with co-located concurrency and a set of principles, grouped into respective categories, is used to define and describe this dimension. The other dimension deals with distributed concurrency and a four-element platform for distributed cooperation is used to define and describe this dimension.

However, both these dimensions (i.e. the contributions in P5 and P6) have significance for effective and efficient concurrent design. This is also the reason why both P5 and P6 are part of C4, i.e. requirements and guidelines for concurrent design of customized corporate e-learning. On this basis it would be relevant to develop a new and general model for concurrent e-learning design, which takes up the contributions from P5 and P6 and let them melt together into a common model. This must possibly be considered for future work.

5.4 Evaluation of Trustworthiness

In this project, I have used different research methods (e.g. literature reviews, design science, action research, and qualitative data analysis) to answer various research questions (RQ1, RQ2, and RQ3). This has resulted in four contributions (C1, C2, C3, and C4) of which the most important one is C4, since the experience that is collected throughout the doctoral project to a great extent is gathered in C4. Thus C4 contributes to answer the main challenges of this thesis, i.e. how should concurrent design be conducted when the aim is to design e-learning deliverables adapted to the needs of corporate clients.

When I perform the evaluation of trustworthiness in relation to the work performed and the results produced in connection with this thesis, it is natural to ask questions in the following categories: (1) problem relevance and to what extent is there a need for the provided contributions, (2) utility and credibility which concerns whether the presented solutions works and what evidence I possibly can show, (3) novelty and whether the solutions are sufficiently original and innovative, and (4) generalizability and in what context the results of this work may be used in another context. In the remainder of this section, I discuss each of these question categories.

Problem Relevance

Problem relevance deals with what extent there is a need for the contributions provided in this thesis. My literature studies show that there is a need to improve ID processes. Modern e-learning deliverables are comprehensive and it is therefore natural to involve stakeholders representing different disciplines in these processes. Concurrent design is an approach that basically and in other contexts can demonstrate effective and efficient interdisciplinary cooperation, and it should therefore be relevant to test this in connection with the development of e-learning.

Furthermore, my literature studies and own experience (e.g. from the BITØK/EIK project and the CCeD project) show that corporate clients have needs for adapted training at college level, besides that this may be an important market for HEIs. It turns out that cooperation with corporate clients on e-learning creates a win-win situation. This is because employees are being trained while the HEIs get updated knowledge about what is relevant in today's market, i.e. state of the art knowledge concerning what is relevant in businesses nowadays. An example of such a win-win situation can be found in connection with the new course within service management, which was developed as part of the CCeD project. The course was primarily designed for employees at Telenor and two managers from Telenor participated in the CCeD project in which the course was designed. The final course had significantly more students than other comparable courses, so while Telenor conducted training for many employees HiST/AITeL got a useful and up-to-date course in service management in its portfolio.

Another argument for formalizing the ID processes and involving different experts when new courses are to be designed are the new and stricter government regulations. The new Norwegian Qualifications Framework (which was also discussed in Section 3.1.3), typically contribute so that the ID process must be formalized and the concurrent e-learning design approach is relevant in this context.

The arguments provided in this section suggest that the relevance of the issues raised in this thesis is considerable.

Utility and Credibility

Utility and credibility deal with issues related to whether the presented solutions actually work and what evidence can be presented. In connection with the qualitative research conducted in this doctoral project the evaluations are central to determine the utility and credibility. Therefore, it is natural to discuss how the evaluation has been carried out in the rest of this section.

First, design science was used when the new artifacts (e.g. the CCeD Method) was defined. In design science, evaluations take place continuously while the design work is in progress. The iteration between design activities and evaluation activities is considered as there is a significant different between design science research and natural science or theory driven behavioral science (Kuechler & Vaishnavi, 2008). However, the evaluations performed in the design science context were limited by the project participants' own experience and what we could find from relevant secondary data (i.e. literature reviews).

Second, while evaluations were an integrated part of the design science conducted when the new artifacts were defined it is questioned whether the action research projects contribute to additional evaluations. Evaluations are part of the cyclic model in action research and the stages of *Evaluation and Reflection* (Specifying Learning) have particular focus on this (Susman & Evered, 1978; Davison et al., 2004). In connection with the action research projects conducted, we performed oral evaluations among all participants after each concurrent design session, and this was followed up with online surveys later on. In addition, the project team of the CCeD project (me and five other participants) had specific meetings to reflect on the results achieved, specifying learning, and make modifications to the artifacts. These evaluations referred to both the process (e.g. the CCeD Method) and the products (e.g. different version of design documents for new e-learning course). When we conducted distributed concurrent design sessions in the UnderstandIT project, we did not fully use action research. However, oral evaluation after each session was followed up by online surveys to all participants in this project. One person had specific responsibilities for evaluation in this project; while I made sure the questions were in relation to the distributed concurrent design process.

Third, I claim that the research process used in this doctoral project is consistent with design-based research (see Section 3.1). Documentation and reflection to produce design principles is the fourth and last phase of design-based research, and this is about evaluating the collected data (see Section 3.1.4). Towards the end of the project I had a lot of qualitative data in different formats such as video clips, audio recordings, completed questionnaires, interview notes, project documents, training materials, design documents, and fully developed courses. These data were used in a qualitative data analysis and coding process and the procedures for assessing the trustworthiness of qualitative data analysis and coding should in accordance to Thomas (2006) include independent coding, coding consistency checks, and stakeholder checks. During the data analysis and coding process I unfortunately did not use independent coding (i.e. to using external and independent researchers to perform some coding) or coding consistency checks (i.e. to using external and independent researchers to categorize data based on samples of raw text which previously have been coded by the initial coder). However, stakeholder checks were conducted, in the sense that the creditability of the findings was enhanced since several research participants discussed the research findings, interpretations, and conclusions.

The experience we had and the data we collected indicate that the contributions of this thesis exist and are credible, i.e. a concurrent design approach to the design of customized corporate e-learning is a reasonable approach. However, we did not compare our results directly with other approaches used to solve similar problems and we have no evidence that a concurrent design approach is more effective or efficient than other approaches. Both the artifacts and the environment in which the artifacts are implemented are complex and the contributions provided in this thesis should be considered as extensions and refinements of instructional design, and concurrent design, rather than confirmation or disconfirmation of a theory. Such extensions and refinements is a natural consequence of design-based research (Kuechler & Vaishnavi, 2008).

The arguments provided in this section suggest that utility and credibility to a certain extent is taken care of in this thesis, and that there are sound reasons to build further on this work.

Novelty

The main contribution of this thesis is the concurrent design inspired methodological approach to the design of new e-learning solutions for corporate clients, which are customized to the current context and the project in question. The work is largely inspired by state of the art in instructional design, concurrent design, software engineering processes, and computer-supported cooperative work. Although this work to a great extent is inspired by existing knowledge, it also contributes with novelty due to the use of existing knowledge in new contexts. I cannot find others who have used concurrent design in this way and in connection with the design of e-learning deliverables and I have not found other ID approaches that have a similar focus on all aspects of the e-learning offerings, i.e. the interplay between factors such as academic content and learning outcomes, pedagogy and learning activities, various technologies, a sustainable business model that contributes to attractiveness for all stakeholders, and administrative matters.

Furthermore, the contributions in this thesis create a basis for further work and in that context it is interesting to study selected parts of these contributions in more detail. Therefore, I believe that this work has created a foundation for future research, in which new and exciting solutions in relation to the design of e-learning can be developed and studied more thoroughly.

The arguments provided in this section suggest that the contributions provided are original and innovative.

Generalizability

Generalizability is also known as external validity. The ability to generalize from the research sample to the population (external validity) is a key criterium for good quantitative research (Krefting, 1991). In qualitative research, however, the term transferability is used to describe the ability to transfer research results into new situations and this is the form of generalizability that is interesting for my contributions. Since C4 is a direct continuation of C2, whereas C1 mainly is based on secondary data (literature reviews), I choose to discuss the generalizability of C3 and C4 here.

C3 is experience from using action research as a means of introducing new artifacts in HEIs. Action research is itself a tool to be used when new artifacts are to be introduced in an organization. The experience of using action research in this doctoral project (i.e. C3) can be considered as a contribution in relation to how canonical action research could be implemented. This experience should certainly be transferrable to future projects where changes and new artifacts are to be introduced in an organization.

C4 is the requirements and guidelines for concurrent design of customized corporate e-learning. This is the most important contribution in this thesis, and when the generalizability is to be assessed, it is relevant to discuss whether this methodological approach can be used in other contexts. C4 consists largely of guidelines, principles, and prescriptive approaches. This means that I am not definitive in describing how things actually are and how they fit together, but rather provide informed advice regarding what to think about and consider. During this doctoral project flexibility is also identified as an important property of a methodical approach, since projects vary significantly and since these variations must be handled for the project at hand.

Thus it can be argued that generalizability to a large extent is taken care of in C4. We have strived to be generic and transferable to different situations when the prescriptive approaches for distributed cooperation (P5) and the principles of concurrent e-learning design (P6) were defined. It should for example be possible to implement projects with different infrastructures, tools, and resources, and it should be possible to use this methodological approach (concurrent design) to develop different results and deliverables.

On a general level both instructional design and concurrent design can be described as knowledge work, in which the knowledge of the workers is the true means of production. It requires both education and training to be able to generate, develop, and implement ideas which are innovative, sustainable, and adequately competitive. If more stakeholders are involved in the knowledge work, the coordination towards common objectives and goals becomes a central part of the work, i.e. articulation work. In this context it is natural to attempt to influence both the process and the use of appropriate tools, which typically are different ICT tools used for different purposes. Thus I claim that C4 provides general advice in relation to how this kind of modern knowledge work can be implemented. It applies for participants who alternate between being co-located and distributed, as well as participants who alternate between synchronous and asynchronous cooperation.

Finally, I would emphasize that the results of the research carried out in this project, have been disseminated as work has progressed. The results were presented both to academically-oriented audiences (i.e. peer-reviewed scientific papers) and management-oriented audiences (i.e. technical reports, method descriptions, and lectures on practical experience). Together with the other arguments provided in this section, this suggests that the generalizability is sufficiently high.

6. Conclusion

This chapter concludes this thesis. First, it sums up the main contributions, as well as the research questions and the research methods that led to these contributions. Then, some ideas in terms of future work are discussed, and finally, some concluding remarks are presented.

6.1 Contributions

The overall research aim of this thesis was to contribute with basic motivation, implementation experience, and requirements for practical realization, regarding methodological approaches for concurrent design of e-learning deliverables for corporate clients. This was conducted by answering three research questions and it resulted in four different contributions.

- The first research question (RQ1) referred to basic motivation and it questioned ***why*** this research should be carried out, i.e. why should HEIs apply a concurrent design approach when they aim to deliver e-learning to corporate clients? This research question was processed by means of literature review, questionnaires, and interviews and much of this work was conducted as part of the R&D project called BITØK/EIK. This work resulted in contribution 1 (C1), i.e. detected motivation and conditions for applying a concurrent design approach to the design of customized e-learning for corporate clients. P1, P2, and SP1 of this thesis constitute C1.
- The second research question (RQ2) referred to implementation experience and it questioned ***how*** a concurrent design approach for the development of customized e-learning for corporate clients should be materialized, i.e. how should this approach initially be described, and how should it eventually be tested and evaluated? This research question is twofold and it was answered by design science and action research. The design science research resulted in contribution 2 (C2), i.e. a description of the method in which concurrent design is used for the design of customized corporate e-learning. This method was named the CCeD Method and it is described in P3 and also in SP2 and SP3. The action research was used when the

CCeD Method was implemented, tested, and evaluated at HiST/AITeL, and the results from this research is considered a separate contribution 3 (C3) of this thesis. C3 is described as experience from using action research as a means of introducing new artifacts at higher education institutions and the fourth paper (P4) contains this contribution. Most of the work leading up to C2 and C3 was conducted as part of the R&D project called CCeD.

- The third research question (RQ3) referred to requirements for practical realization and it aimed to detect the ***key requirements*** for a concurrent design approach to the design of customized e-learning for corporate clients. This research question is also twofold since it on the one hand focuses on co-located concurrent e-learning design, while it on the other hand it focuses on a distributed approach to this. The research that concerns the co-located approach was conducted by means of qualitative data analysis and coding, and this was based on empirical data which also was a basis for C1, C2, C3, i.e. it was based on all empirical data gathered in the project at that time. This part of C4 is mainly covered by P6. The research that concerns the distributed approach was conducted by means of design science and empirical data from the R&D project called UnderstandIT. This part of C4 is mainly covered by P5 and SP4.

Design, development, and delivery of educational programs can be considered a huge and complicated subject that is constantly changing, and where there are many actors working to make improvements. Some of the challenges are general while others are more specific and depending on the context in which the educational program should operate. Conole offers the following insight concerning current state of the art within learning design: ”Learning design as a research field has emerged in the last five years, as a methodology for both articulating and representing the design process and providing tools and methods to help designers in their design process” (2010, p. 482). I consider this doctoral thesis as a contribution to this research since methods and tools to be used in the design process is developed, implemented, and evaluated.

Even though the methodological approach mainly focuses on concurrent design applied to the development of customized e-learning for corporate clients, this thesis also describes experience in computer-supported cooperative work on a more general level. This work (i.e. a concurrent design approach to the design of customized corporate e-learning) can be regarded as knowledge work in which the true means of production is the workers' knowledge (Reinhardt et al., 2011). It requires significant education and training to perform effective and efficient knowledge work, and computer-supported cooperation is an important instrument for modern knowledge workers. The main contribution of this thesis (C4) mainly concerns how to facilitate knowledge work for participants who alternate between being co-located and distributed, as well as participants who alternate between synchronous and asynchronous cooperation.

6.2 Future Work

This thesis provides recommendations and guidelines from which parties involved in design of e-learning deliverables can benefit. It focuses especially on a concurrent design approach to the design of customized corporate e-learning, and it is anticipated that this cooperation can switch between co-located and distributed contributors who alternate between synchronous and asynchronous participation. In general, I claim this has much in common with modern knowledge work and the recommendations presented can therefore be considered in connection with several different kinds of projects where new solutions are to be developed (Peponis et al., 2007; Reinhardt et al., 2011).

The contributions in this thesis can serve as a platform for a framework with detailed recommendations regarding the implementation of applicable concurrent cooperation where computer-supported cooperation is exploited. There are several interesting topics for future work within both the co-located and the distributed approach to concurrent cooperation. In the remainder of this section about future work I will discuss these two approaches separately, before I conclude with some thoughts about how this could be integrated.

The Co-located Approach

The principles of concurrent e-learning design as presented in P6 is divided into five categories and each of these categories in isolation, are candidates for future work.

First, the *adaptation to the surroundings* is very important, and we need more knowledge regarding how such collaborative projects should initially be planned to get the most sensible inception.

Second, the *stakeholders* are those who actually perform the project activities and we need more knowledge in relation to the allocation of roles and responsibilities so that the interaction between articulation work and real cooperative work functions optimally.

Third, the *activities* include what should be done, how it should be performed, who should be involved, and when different things should happen. This consists of an interaction between training and preparation, as well as real execution, and there are some activities that typically must be performed concurrently and synchronously, while others may take place sequentially and asynchronously. More knowledge about how different activities affect each other will help to ensure that the projects can be implemented more efficiently.

Fourth, the *infrastructure* is very crucial for optimal computer-supported cooperation and if I should point out an area within this category in relation to further work, I will emphasize the expert tools. The state of the art chapter in this thesis (e.g. Section 2.2.2) indicates that there is great potential in relation to better use of available standards and tools, and this is in accordance with my own experience from this doctoral project. However, this is generally challenging since the use of such tools (e.g. visual languages and tools for instructional design) requires experience from the project participants. In this project mainly general tools were used (e.g. Google Docs for collaborative writing or Mindjet Catalyst for collaborative mind mapping), since there were enough new things to deal with for the project participants. In future projects it is very tempting to try out alternative tools since this will give us expertise in terms of how existing tools can be utilized, besides what criteria and requirements we should define for different kinds of new tools.

Fifth, the *results* are in most cases the goal and the fundamental reason for performing the project. However, it turned out to be a challenge to perform concurrent cooperation right up until the final results are finalized. In this context, we need more knowledge and experience in relation to which results that can be expected after interdisciplinary and concurrent cooperation, besides the tasks individuals should finalize in retrospect. Furthermore, it is also relevant to gain experience in relation to the development of different deliverables, i.e. for which projects it may be appropriate to use a concurrent design approach and what results that can be expected in different contexts.

The Distributed Approach

The prescriptive approaches for distributed cooperation as presented in P5 defines a platform for distributed concurrent design which is based on communication, coordination, collaboration, and awareness. Each of these constituents can be considered independent candidates for future work.

When it comes to *communication* the experience from the UnderstandIT project states that it is a great potential to exploit video conferencing tools (e.g. Adobe Connect Pro) better. Such tools does for example offer several features which can be used to gain workspace awareness, e.g. Chat Pods that can be used to communicate with other participants without disturbing the session flow, and Attendee Statuses such as Raise Hand, Agree, Disagree, or Applause that can be used to invoke attention and convey simple viewpoints. There is great potential to exploit such opportunities better but this will require attention and training. Furthermore, the experience from the UnderstandIT project states that it is important to maintain good communication between all project participants, also between the distributed concurrent design sessions. This means that we should gain experience and learn to communicate more effectively when distributed cooperation is performed.

Coordination is largely conducted by the facilitator(s) in concurrent design. Facilitation is an activity that is challenging when co-located concurrent design sessions are conducted, and this is even more challenging when the sessions are distributed with online participants. Relevant issues in this regard are for instance how the facilitation should be performed, what tools that are needed, and what support a facilitator can get from other roles such as a session secretary or technical ICT-staff. To obtain more expertise and experience of facilitation is thus a relevant task for future work.

Collaboration is in this context the work itself, which eventually leads to project deliverables. This doctoral project found that knowledge work consists of conversation, in which knowledge is created, developed, assessed, and shared between the involved parties. It was decided to document the results of these conversations in general tools such as Google Docs (collaborative writing) or Mindjet Catalyst (collaborative mind mapping). However, there is a possibility to improve this process so that all project participants contribute in an efficient manner when results from conversations are to be documented. In this context, we can stick to the mentioned standard tools (i.e. Google Docs or Mindjet Catalyst), but it is also highly relevant to test tools that are specially developed for design activities. Such tools may foster creativity and enhance communication and this is regarded as two important keys for the quality of designs (Botturi, 2008).

When it comes to *awareness,* this is a well-known challenge in computer-supported cooperative work. In the UnderstandIT project it was pointed out that communication between the concurrent design sessions was not optimal. This was first discovered because it caused challenges in relation to awareness of project status among the participants, which in turn can affect both the coordination and the actual project collaboration. Informal communication can be important to maintain awareness when the participants are co-located (e.g. coffee machine conversations), but it is a challenge to encourage this type of informal communication when the participants are distributed. In this context it may for example be interesting to test whether the use of social media between distributed project participants, results in informal communication, which in turn contributes to improved awareness.

The Merged Approach

The distinction between a co-located approach and a distributed approach may be considered artificial. This is because modern knowledge work consists of computer-supported cooperation which naturally alternates between co-located and distributed participants, as well as synchronous and asynchronous cooperation. This is also the reason why C4 is described as a common contribution.

A challenge for future work can be to let the results presented in, respectively, P5 and P6 become a common framework for concurrent cooperation, i.e. to develop a new and general model for concurrent cooperation, which takes up the contributions from P5 and P6, and let these contributions melt together into a single model. In this context several problems and challenges must be considered. For example, what are the parameters that affect the requirements for an appropriate technical infrastructure to support this kind of computer-supported cooperation.

6.3 Concluding Remarks

This thesis deals with methodological approaches to cooperative design of e-learning solutions for corporate clients. I have presented the motivation behind the work; the research context and the R&D projects I have been involved in; state of the art for relevant fields in connection to this interdisciplinary research; the research questions I have been working with and the different research methods used to answer the research questions; the identified contributions of this theses; the evaluation of research questions, methods, and contributions; and six publications that make up the paper collection, besides four secondary papers which were not found relevant enough to be included in its entirety.

It is the instructional design process and the corporate use of e-learning that forms the basis for this doctoral project. However, I have discovered that many of the challenges regarding design, development, and delivery of e-learning to corporate clients, also are relevant to higher education and online education in general. Furthermore, these design activities are considered modern knowledge work, which of course is applied on a broader and more general basis, in the modern knowledge-based economy. This implies that the concurrent design approach to the design of customized corporate e-learning, as presented in this thesis, also to a large extent concerns computer-supported cooperative work. The thesis is thus a contribution in terms of how technological solutions should be used and what requirements should apply to new solutions for computer-supported cooperation. As mentioned in the state of the art chapter (Chapter 2) there are well-known researchers in cooperation technology who believe that the development and utilization of technologies for cooperative work practice has great potential, which only occasionally have been exploited, since we do not really understand what cooperative work and its coordination is about (Schmidt, 2010).

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Part II

Appendix A: Selected Papers

This appendix includes the complete text of the following six selected papers:

Paper 1 Strand, K.A. & Staupe, A. (2009). To Provide Online Distance Learning as a Portfolio of Services. In G. Siemens & C. Fulford (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2009 (pp. 4433-4442). Chesapeake, VA: AACE.

Paper 2 Strand, K. A. & Hjeltnes, T. A. (2009). Design of Customized Corporate E-Learning. Seminar.net - International journal of media, technology and lifelong learning, 5(2), 14.

Paper 3 Strand, K. A., & Staupe, A. (2010). The Concurrent E-Learning Design Method. In Z. Abas et al. (Eds.), Proceedings of Global Learn Asia Pacific 2010 (pp. 4067-4076). AACE.

Paper 4 Strand, K. A., & Staupe, A. (2010). Action Research Based Instructional Design Improvements. In Falmyr, T. (Eds.), Norsk konferanse for organisasjoners bruk av informasjonsteknologi, NOKOBIT 2010, (pp. 25-38). Gjøvik University College.

Paper 5 Strand, K. A., Staupe, A. & Maribu, G. M. (2012). Prescriptive Approaches for Distributed Cooperation. In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2012 (pp. 1011-1020). Chesapeake, VA: AACE.

Paper 6 Strand, K. A., Staupe, A., & Hjeltnes, T. A. (2013). Principles of Concurrent E-Learning Design. In K. Patel, & S. Vij (Eds.), Enterprise Resource Planning Models for the Education Sector: Applications and Methodologies (pp. 48-75). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-2193-0.ch004

Paper 1
To Provide Online Distance Learning as a Portfolio of Services

Authors: Knut Arne Strand and Arvid Staupe.

Full title: To Provide Online Distance Learning as a Portfolio of Services.

Published in: Proceedings of ED-MEDIA 2009, AACE.

To Provide Online Distance Learning as a Portfolio of Services

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Abstract: Despite the popularity of IT Service Management frameworks such as IT Infrastructure Library (ITIL) in the business world, there is little scholarly literature available on this topic in general, and even less when we consider the online education business. ITIL is known as "best practice" guidance and it is relevant for all types of organizations who provide IT based services to a business. Both online distance learning (ODL) literature and ITIL literature are reviewed in this study, and a need for supportive IT services in connection with competitive ODL programs are identified. Moreover, we find that few educational institutions have tried to manage their supportive IT services according to ITIL. Thus, it is assumed that ODL programs can benefit from adopting ITIL, and move to a service-centric lifecycle approach provided by ITIL version 3. This is comprehensive and we propose that educational institutions start out with an introduction of a service strategy in this context.

1. Introduction

1.1 Online Distance Learning Contributes to Lifelong Learning

Companies have an increasing need for employees with appropriate and updated skills. Some companies take the initiative and facilitates that employees should be able to acquire relevant skills. If the company is located far from universities and colleges, online distance learning (ODL) is perhaps the only option. To keep the company competitive, work-based learning can take place on different levels. In this article the focus is on higher education. "We understand work-based learning to be a learning process that focuses higher-education-level critical thinking upon work (paid or unpaid) in order to facilitate the recognition, acquisition and application of individual and collective knowledge, skills and abilities to achieve specific outcomes of significance to the learner, their work and the higher education institution" (Gibbs & Garnett 2007, p.410).

ODL is an important option if educational institutions are to provide training for employees. Companies can make agreements with educational institutions and their employees could have the opportunity to follow ODL programs. This article primarily use the term ODL but relevant information is also collected with the help of search terms such as e-learning, distance learning, distance education, online learning, web-based learning or blended learning. "The terms "distance education" or "distance learning" have been applied interchangeably by many different researchers to a great variety of programs, providers, audiences, and media" (Sherry 1995, p.338). ”E-learning is an integral part of distance learning” (Gunasekaran, McNeil & Shaul 2002, p.47). Blended learning could be used if you have a blended learning environment that mixes face to face elements with online and distance elements (Wills 2006).

1.2 Core Business with Appropriate Partners, Services and Processes

To establish an ODL program for work-based learning, cooperation between several parties must be established. Higher educational institutions and companies will have customer and supplier relations with respect to the education. It is also relevant to involve other organizations. These can for example establish agreements with the educational institution on behalf of several companies, helping manage the educational offer as a local provider, provide funding from local authorities and follow up the quality of the ODL program.

ODL is a business where the education is at the core, but related services are needed and there is a high degree of ICT support. It is a growing market that is changing rapidly and where customers increasingly set new requirements. Educational institutions also establish strategic partnerships with external suppliers such as learning designers, Learning Management System (LMS) providers, web-conference providers or suppliers of educational provision where the educational institution provide academic content.

Production of services with ICT support is also common within many other business areas. “Information technologies (IT) enable, enhance, and are embedded in a growing number of goods and services. They are connecting consumers and producers of services in ways previously not feasible, while contributing to the productivity of numerous sectors of the service industry such as financial services, communications, insurance and retail services. Government agencies, too, have experienced similar gains associated with the use of IT” (Taylor, Iqbal & Nieves 2007, p.3).

1.3 Can ODL Achieve Benefits with a Service-Centric Approach?

The purpose of this study is to consider whether ODL will have an advantage by utilizing the latest IT Infrastructure Library (ITIL) version. The study makes use of literature search in the traditional ODL literature to see if challenges that are also addressed by ITIL are discussed. We want to find out if ODL can be considered as a portfolio of services and whether we will have a positive effect if we plan, develop, maintain and deliver these services in accordance with ITIL. This can be particularly extensive, but this study is limited to a focus on the Service Strategy lifecycles of ITIL version 3. We also consider the other lifecycle phases with related processes relevant in a comprehensive ODL context, but we choose to do this restriction first, in order to start a discussion about ODL, as a portfolio of services, from a strategic and business oriented perspective. See section 3 of this article for a brief introduction to the ITIL framework.

1.4 Research Questions

Our study addresses the following research questions:

- Can ODL be seen as a portfolio of services to be delivered to customers?
- Will an educational institution achieve any benefits with respect to holistic and competitive ODL programs, if a Service Strategy is implemented?
- Can we better facilitate specific learning designs, based on independent learning objects, if it is part of an overall strategy to design new courses, for specific customers, based on smaller existing units.

This paper is organized into six main sections. Following this introduction, the next section describes the research methods and material. Section 3 is a brief introduction to IT Service Management (ITSM) and ITIL. Section 4 contains information from the research literature. The results are discussed in section 5, while a summary and conclusions comes in section 6.

2. Research Methods and Material

This study is based on a literature review. Basic information about ITIL is primarily taken from the five core ITIL framework publications that where first published in 2007. Research articles are primarily collected from electronic databases. We have searched the databases of SCOPUS, ACM Digital Library, IEEE Xplore and ISI Web of Science. First, we picked up a large amount of articles by combining search terms like: e-learning, online learning, distance learning, distance education, web-based learning and blended learning with OR in between. Then we searched in this result with ITSM terms like: ITIL, service management, ISO/IEC 20000, HP IT Service Management Reference Model, Microsoft Operations Framework and IBM System Management Solution Lifecycle with OR in between and the result was reduced to a few articles.

These sources can be grouped into the following four categories: (1) specific ITIL publications, (2) general ODL research literature and to what extent it implicitly refers to service management ideas, (3) ODL research literature that explicitly refers to service management ideas, and (4) general and ODL independent service management research literature with the primary focus on ITIL.

There are few research articles about ITIL in general and even fewer that combines ODL and ITIL. Because of this we have also searched for relevant information that is consistent with the service oriented approach and the research questions for this study, without an explicit focus on ITSM frameworks such as ITIL. It seems like the businesses that have a high degree of ICT support benefit from ITIL implementations. Even though there is little scholarly literature that confirms this, we can find success stories in the press and on the Internet. We have done searches in the research literature to examine whether these assumptions are processed by researchers.

3. IT Service Management

ITSM frameworks have evolved to meet some of the challenges within the ICT based business. ITIL is known as the most common of these frameworks, but we also have others like BS 15000 and ISO/IEC 20000 which is based on ITIL, and company based customizations such as HP IT Service Management Reference Model, Microsoft Operations Framework, and IBM's System Management Solution Lifecycle. "Service Management is a set of specialized organizational capabilities for providing value to the customer in the form of services. […] The capabilities represent a service organization's capacity, competency and confidence for action. The act of transforming resources into valuable services is at the core of service management. Without these capabilities, a service organization is merely a bundle of resources that by itself has relatively low intrinsic value for customers" (Taylor, Iqbal & Nieves 2007, p.15). "A service is a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risk" (Taylor, Iqbal & Nieves 2007, p.16).

3.1 IT Infrastructure Library

The ITIL history started in Great Britain during the eighties. The former Central Computer and Telecommunications Agency (CCTA) were instructed by the government to develop a standard approach for an efficient and effective delivery of ICT services. CCTA have since become the Office of Government Commerce (OGC) and they are the owners of the ITIL framework. ITIL version 3 was released in 2007. ITIL approaches service management from the lifecycle perspective of a service. The service lifecycle is an organizational model that provides insight into the way service management is structured, the way the various components are linked to each other, and the impact that changes in one component will have on other system components and on the entire system (Bon, Jong & Kolthof 2007).

The lifecycle model of ITIL version 3 consists of five lifecycle phases and there is one publication for each. The following list contains a brief description for each lifecycle phase.

- *Service Strategy (SS)* provides guidance on how to design, develop, and implement service management. It is central to figure out *why* something is to be done before thinking of *how*. The *why* is closer to the customer demand. Service Strategy expands the scope of the ITIL framework beyond the traditional audience of ITSM professionals. Service Strategy provides an additional focus on the interaction between ICT solutions, business processes, and service deliveries to the customers (Taylor, Iqbal & Nieves 2007).

- *Service Design (SD)* covers design principles and methods for converting strategic objectives into portfolios of new or changed services and service assets. It describes how to use the strategy to create designs and service specifications. Organizations are guided on development of design capabilities for service management (Taylor, Lloyd & Rudd 2007).

- *Service Transition (ST)* provides guidance regarding transitioning new and changed services into operations. These details how to get the specifications into the live production environment and how to manage the complexity related to changes to services (Taylor, Lacy & MacFarlane 2007).

- *Service Operations (SO)* defines how to best support the daily running of the service throughout its lifetime. Guidance is provided on supporting operations through new models and architectures. Knowledge regarding better decisions in areas such as managing the service availability, controlling demand, optimizing capacity utilization, scheduling of operations, and fixing problems is central (Taylor, Cannon & Wheeldon 2007).

- *Continual Service Improvement (CSI)* provides instrumental guidance in creating and maintaining value for customers through better design, introduction and operation of services. Organizations learn to realize incremental and large-scale improvements in service quality, operational efficiency, and business continuity. The 7-Step Improvement Process introduced in this lifecycle, spans the entire service lifecycle. This process covers measurements, data gathering, data processing, data analysis, use and presentation of the information, and implementation of corrective actions (Taylor, Case & Spalding 2007).

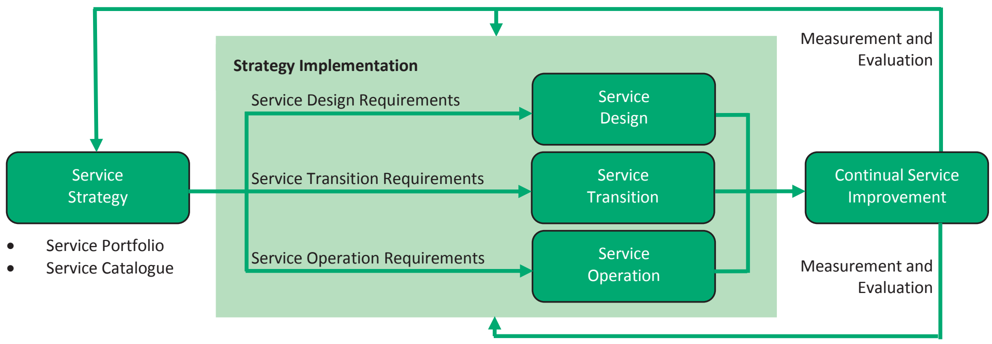

Figure 1. Closed-loop planning and control system for strategy.

Some of the interaction between the SS and the other ITIL lifecycles are illustrated in (Fig. 1), that is based on the SS volume (Taylor, Iqbal & Nieves 2007, p.163). The Service Portfolio represents all the resources presently engaged or being released in various phases of the service lifecycle. A Service Catalogue is a subset of the Service Portfolio visible to customers. It consists of presently active services and services approved to be offered to current or prospective customers (Taylor, Iqbal & Nieves 2007, p.74-75). The SS defines important and business oriented requirements for the SD, ST and SO lifecycles. CSI is responsible for the exercise of measurements and evaluations, and provide new and changing demands back to the other lifecycle phases. It is central to have service delivery systems where the ICT solutions support the business operations, so that these work together, and so that the business really benefits from the ICT solutions.

4. Results from the Research Literature

4.1 Implicit Service Management Ideas in the ODL Literature

(Levy 2003) points to a need in relation to additional services that must be offered in connection with ODL in order to have a comprehensive and sustainable offer for the students. Levy refers to the many authors who have written about how important it is to have a vision and a plan when ODL is implemented. This planning must have a relationship with administrative support structures, student services, technological support, and training for those who will work to provide ODL. All stakeholders should be involved when the purpose and goals are defined as it will contribute to less resistance to the changes that must inevitably come. Students need good access to a range of services, in addition to course content, if they are to be satisfied with the ODL offer. Campus students make use of a variety of services and you have to consider how they should be provided online. It's important to plan for the overall service spectrum needed when an ODL offer is developed. Levy points out that the students who have access to online services for training, guidance and advices are those who succeed best.

(Seeman & O'Hara 2006) highlights that the students are the customers in higher education and satisfaction with the education programs and services is central when they choose among several competing offers. To deal with these challenges (Seeman & O'Hara 2006) propose to introduce Customer Relationship Management (CRM) services. "Viewing students as customers provides a competitive advantage for higher education and enhances a college's ability to attract, retain and serve its customers" (Seeman & O'Hara 2006, p.32).

Several researchers have identified critical success factors for ODL. (Volery & Lord 2000) identified three critical success factors for ODL. The technical infrastructure must be reliable and work properly, the instructor must be able to utilize the technology, and the students must have basic technical skills. (Menchaca & Bekele 2008) groups the success factors from the ODL literature into five independent categories. They are related to technology, user characteristics, the course itself, learning approaches and support services.

(Hoppe & Breitner 2004) emphasize the importance of having sustainable business models for ODL and the authors describe how to combine three independent business models, into a common business model for ODL delivery. One of the three models is the *market model* where various actors, their roles, and the market structures are defined. It is considered useful to separate between the supply and the demand model, and to make statements about customer segments. The *activity model* defines activities that make up the deliveries and these are often associated with the value chain. Pricing of services in relation to the customer value is an important element in such a model. The *asset model* is a more traditional cost and revenue model where expenses are divided into fixed and variable costs, while the income sources can vary between various elements, such as a combination of grants, specific financial support for R&D projects, student fees, etc. The article also illustrates the connection between those who provide services in an ODL context, and the connection between activities provided by different providers in the ODL value chain. Even though this article does not mention ITIL explicitly, it contains many of the ideas from the SS lifecycle.

Other researchers have a more technical approach and propose how to develop a service oriented architecture (SOA) to support ODL. This technical approach is not within the scope of this study as we have decided to focus on the strategic perspective, but articles like (Wilson et al. 2005) provides insight into services relevant to consider. Wilson describes a framework where different user agents deliver services like portals, learning delivery systems, administrative interfaces, etc. to the students. Under this user interaction layer the framework groups the services into application services and common services, and these are dependent on the institutional infrastructure.

4.2 Explicit Service Management Focus in the ODL Literature

There is little explicit focus on ITIL in the ODL literature even though ITIL has become the most widely accepted approach to ITSM in the world (Taylor, Iqbal & Nieves 2007). However, if we broaden our search we find some examples where ITIL is considered in an ODL context.

(Morales 2008) shows the positive experience with the introduction of some ITIL processes related to distance learning at Louisiana State University. This report is a summary in connection with introduction of a Service

Desk function, the Service Level Management process and a new Service Catalog, and it concludes to continue this work.

(Zhen & Xin-yu 2007) focuses the use of ITIL at Chinese universities and this article deal with campus ICT systems and ITIL version 2. ITIL must be adapted by the organization and there are differences between an educational institution and a more traditional company that must be taken into account. The article also gets out the message that it is important to start with strategic planning before you plan ITSM that support the strategy.

(Haywood 2008) refers to ITIL as a key element when ICT strategies for supporting university research, teaching and administration are planned. ICT employees like to have expertise on current trends, technological developments and market moves. Moreover, they have competence regarding commercial ICT operations, how to protect digital assets, how to integrate services and how to have profitable operations in the long run. Educational institutions should therefore take advantage of the ICT expertise, and attempt to reconcile this with educational and administrative needs. Overall, this will constitute the business needs, and it is in relation to these the institutions have to ensure that appropriate services are offered.

There are several articles from the Technische Universität München (Knittl & Hommel 2007), (Bode, Borgeest & Pongratz 2007) where ITIL is implemented. The focus is on the core ITIL processes and functions like Service Desk, Incident Management and Configuration Management, and they were written before ITIL version 3 was released. These articles pinpoint several advantages that can be achieved, like for example improved service quality, improved customer satisfaction, improved productivity, integrated and centralized processes and verifiable performance indicators. As part of the ICT strategy they also have an e-learning project that aims for a thorough and sustainable implementation of ODL, and they expect positive effects when ODL is integrated into the ICT landscape.

4.3 General Service Management Research

Search for research articles on ITIL yields relatively few results. Scopus gave 131 hits when ITIL was used as a term against the title, abstract and keyword fields, IEEE Explore gave 45 hits for ITIL in all fields, ISI WEB of Science gave 34 hits for ITIL in the topic field and the ACM Digital Library gave 48 hits for ITIL.

There is a significant growth of ITSM practice in the industry but little scholarly work exists on this topic. More than 75% of the economies of industrialized nations are based on government and business services (GBS). ICT organizations are under extreme pressure to deliver ICT services in an effective and efficient manner to support GBS. A new and growing academic study called Services Science is evolving to address the demand for intellectual capital concerning GBS. ITSM is a subset of the Service Science discipline that focuses on ICT operations delivery and support. Plausible reasons for the lack of scholarly work on the ITSM topic could be because of its novelty, but the most probable reasons are its perceived limited universe and that the mainstream methods of conducting research are not suited for this research area (Galup et al. 2007).

(Peppard 2003) has adopted a service perspective on ICT and is concerned with the management of all services in and around the processing, provisioning and stewardship of information. An overall framework for information, system and technology (IST) services is presented. This framework can be used in structuring and developing IST services. It focuses the relationship between investment and value, and the mechanisms through which this value is created. Different operational and value enabling services are categorized with respect to the degree of service customization, and the degree of user involvement, in this article. ITIL services are categorized as having a low degree of service customization, and low intensity regarding user involvement. (Peppard 2003) was published before the ITIL version 3 was released, and the categorization of ITIL is therefore based on the core ITIL processes from version 2. The latest ITIL version has more focus on design of services that are suitable for the business, and in creating a strategy around this. We assume there is a high degree of compliance between the broad need of services that are presented in this article, and the service demand that the latest iteration of ITIL covers.

The general popularity of ITIL is confirmed by several researchers. One of the conclusions from (Cater-Steel & Tan 2005) is that public sector organizations and private companies has adopted ITIL and made good progress. Large organizations with a large dependence on ICT systems lead the way in this development. (Moura, Sauve &

Bartolini 2007) discusses business-driven ICT management (BDIM) and presents a BDIM model. The article confirms that ICT contribution to business value creation with the help of ITSM frameworks such as ITIL is central. ITSM decisions must be governed by business-oriented measures and objectives, if the ICT solutions should contribute to business goal achievement, and there are many potential research areas within this field. (Sahibudin, Sharifi & Ayat 2008) describes the importance of cost-effective ICT services that currently support the business. In this context ITIL is central in relation to definition of strategies, plans, and processes. Furthermore (Sahibudin, Sharifi & Ayat 2008) propose to combine ITIL with the Control Objectives for Information and related Technology (COBIT) and ISO/IEC 27002. COBIT is seen as better suited for metrics, benchmarks, and audits, while ISO/IEC 27002 is better for security related issues.

5. Discussion

Services constitute a large part of today's economy and ICT services are an important ingredient of the service production. For business and ICT solutions to cooperate properly, ITSM frameworks like ITIL have been developed. The ODL literature indicates that there is a large focus on services in this business area, and it has a high degree of ICT support. We have thus a high degree of implicit focus on ITSM in ODL. Although it is likely that ITIL can contribute positively to ODL, we find little research within this area. ODL is a growing market, with increased competition. It is apparent from the ODL literature that educational institutions must design comprehensive offers. To be competitive the offers must consist of additional services that contribute to good customer service. Educational institutions need to be conscious, consistent and have a strategy, to take part in this market.

Sustainable ODL offers must be based on a number of services that have value for customers, so that customers are willing to pay. Since a comprehensive ODL offer also consists of a number of additional services, it is obvious that we can achieve benefits if we plan, develop, deliver, and maintain these services according to ITIL. ITIL is big and extensive and it is recommended to introduce this framework in small steps. Many organizations have chosen to start with the Service Desk function and processes like Incident Management and Service Level Management, but this were basically based on ITIL version 2. In ITIL version 3 the SS lifecycle is at the core, and the other lifecycle phases depend on the service strategy. Consequently, it is appropriate to start with SS when ITIL is introduced, to support ODL services, in educational institutions.

If we are to implement the SS processes, we must define the market, develop the offerings, develop strategic assets, and prepare for the execution. Strategies will vary between different institutions, and this will ensure the organization's competitiveness and future. During the strategic development the institution must consider which customers they want, which subjects they wish to offer, what services they must provide, and what strategic partners they need. This in turn forms the basis for the strategic assets (resources and capabilities) they should develop over time. When it comes to the additional services we think the institution must consider services on an overall level first. Should the institution for instance offer CRM services, marketing services, live and real time lectures, live and real time guidance to students, asynchronous feedback to the students, electronic access to learning materials, administrative services like a service center for questions and problems, teaching and training plans, Web 2.0 services such as wikis, blogs, RSS feeds, social networks, etc. All services should support the strategy and they should be described in the Service Catalogue, including a suitable price model. Some services are implicit and standard parts of a course (such as access to standard learning material), while other services may have additional charges (such as web-conference based guidance to students in the evening). The possibilities in relation to this should be clearly presented to the customers as part of the Service Catalogue.

This study brings forward assumptions related to that ODL can be provided as a portfolio of services and benefit from “best practice” ITSM processes. We believe that a Service Strategy is central in this context and we have mentioned a few candidate services needed for a holistic and competitive ODL program. We also think customers will benefit from a service-centric perspective as they will better be able to select the services they want and negotiate about the service level. Moreover, this will serve as a tool for following up the quality, since measurements and evaluations is an integrated part of the CSI lifecycle.

5.1 Advantages, Disadvantages and Success Factors

Provided that an ITIL implementation performed by an educational institution achieves the benefits that are generally drawn up, at least the following are expected: (1) confidence-building and increased satisfaction among students and staff, (2) efficiency so that more services can be produced with fewer people, (3) increased service quality, (4) priority of services in accordance with the business needs, (5) appropriate coordination of service offerings, business processes and ICT systems, (6) improved agreements with customers and strategic partners, (7) better measurement criteria, (8) less chaos and “fire-fighting”, (9) predictable ICT costs which in time will also be reduced, and (10) increased value through higher productivity, better work morale and lower operating costs.

The challenges can be: (1) overestimated ambitions and expectations with respect to processes and tools, (2) resistance to changes, (3) lacking expertise to lead change processes, (4) reduced productivity in the initial phase, and (5) poor project management.

To succeed the following is central: (1) management must be involved and engaged, (2) the institution should focus on some selected areas that provide so-called "quick wins", (3) all stakeholders should be involved, (4) the institution should consider using external consultants for start-up assistance, and (5) it may be important to invest in tools that support the ITIL processes.

5.2 The Implementation Process

It is in accordance with ITIL recommendations to start out small with a few processes when ITIL is introduced in an organization, and we propose that educational institutions start with the SS processes. To make such an introduction we have to introduce various changes in the organization and since ITIL is large and complicated the researcher should acquire relevant competence and skills, and be involved in the implementation process. Therefore we propose to use the five principles of canonical action research (Davison, Martinsons & Kock 2004) as a research method and a guide for such a project. Action research is a growing post-positivist social scientific research method that is ideally suited to the study of technology in its human context (Baskerville & Wood-Harper 1996). “Action research embodies a strategy for studying change in organizations. This strategy involves the formulation of a theory, intervention and action-taking in order to introduce change into the study subject, and analysis of the ensuing change behavior of the study subject” (Baskerville & Pries-Heje 1999, p.1). The cyclical process of action research (Susman & Evered 1978) is in many ways similar with the quality improvement cycle of W. Edwards Deming. The Deming Cycle is generally used in connection with ITIL process improvements and particularly in connection to CSI (Taylor, Case & Spalding 2007). Thus, we believe that research on ITIL implementations, using action research, is consistent with the recommendations and “best practices” from the ITIL framework itself.

6. Conclusion

In this study, we have checked whether ODL can be offered as a portfolio of services, and whether this service production can be based on ITIL processes. Available literature concerning ODL shows that additional services are important for a comprehensive and sustainable ODL program. However, we find few examples that have exploited the ITIL framework in connection with ODL. Therefore we suggest that this is tested on a small scale and in this context we propose to start the implementation of a Service Strategy. Since this will involve various organizational changes we propose to use the action research method, and the researcher in an active role. If the institution is successful with this, we will probably move forward to implement ITIL more fully and consistently in the next turn. We believe that such a strategic approach will help the educational institutions in the following ways:

- Educational institutions will be better prepared to offer higher education provision that is in line with the needs of companies and students.

- Educational institutions will be able to offer a flexible delivery method that is adapted to the market need as they will be prepared for online services. Lectures, content distribution, training schemes, tutoring, exams and student administration must be considered in relation to online availability.

If the educational institutions introduce ITIL on a broader basis, they will probably also gain some advantages in relation to customers and the market. Companies sometimes want training packages that cuts across the traditional structures the educational institutions offer. Educational institutions will probably be better prepared to use learning objects from different courses or disciplines, when they do the learning design, if ITIL processes like Service Asset & Configuration Management, Service Knowledge Management, Service Catalogue Management and Change Management are implemented. In this context, it is also important to perform valuation of the individual course elements, and to implement a revenue model that is appropriate. Service valuation and Financial Management is part of the SS, and we believe it is easier to implement such component based learning design concepts, on a broader basis, if it is part of the overall strategy.

Companies however, will in some cases prefer training packages with a content that does not exist in the existing programs of study. Educational institutions or relevant partners will probably be better prepared to develop new and specially designed training packages for companies if ITIL processes from the SD lifecycle are implemented. In this context, the learning design methods and processes should be adapted to the overall strategy and integrated with the SD processes.

Focus on quality and improvements is central to any organization, and this work would have been systematized beneficially if we introduce processes for service analysis, service reporting, and service improvement, in accordance with the CSI lifecycle of ITIL version 3.

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Paper 2
Design of Customized Corporate E-Learning

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Design of Customized Corporate E-Learning

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Abstract

Today's educational institutions deal increasingly with external commercial organizations in connection with e-learning deliveries. Production and delivery of e-learning to corporations is different from both traditional campus education and online distance education for independent online students. This study discusses challenges related to e-learning production and delivery for corporate customers. Consequently we have identified appropriate guiding principles that should contribute to the specification of a model for design of customized corporate e-learning. We place particular emphasis on collaboration and stakeholder involvement, formative evaluation, utilization of technological opportunities, and relevant training for all parties involved. Moreover, we propose to benefit from concurrent design principles to achieve effective and efficient multidisciplinary collaboration in the design process. The study is based on primary data from two different projects where an educational institution offers e-learning for external corporate customers. In addition we collect secondary data from available research literature on e-learning and supplementary data from colleagues with long experience in this field.

Keywords: Online distance learning, corporate e-learning, e-learning design, concurrent instructional design, stakeholder involvement, formative evaluation.

Introduction

Corporate e-learning can occur in different forms and there are several challenges to consider. How do we ensure that our customers get the e-learning program they want? At the same time, how should we fulfill the requirements for effective and efficient production and delivery, where sharing and reuse are means to achieve benefits?

In the e-learning business there are several market domains with different providers and customers. The e-learning providers emphasized in this study could be categorized as academic research and development institutions. This means that the e-learning provider has a focus on effective and efficient use of e-learning technology for rather complex educational programs. This is in some contrast to commercial e-learning providers who have to focus more on making profit (Hoppe & Breitner, 2004). In this study, the academic institution emphasizes production and delivery of e-learning education ordered by external organizations. The customers are external companies and organizations who want approved academic courses giving credits, but also a certain degree of business customization. In one of the cases we focus on, the customer wants vocational training in a non-academic context, e.g. without student credit points.

We use the term corporate e-learning to indicate that the deliveries are ordered by external commercial organizations. In the following reading, the external commercial organization will also be called customer or client.

We have collected primary data from two projects which are carried out by our academic institutions. These projects are both in the category of corporate e-learning, but they are quite different with respect to the customers' requirements. The assignment from one customer was to deliver self-paced e-learning for vocational training. The other customer requested a customized higher educational program at bachelor level with student credit.

The purpose of this study is to highlight what should be considered when an educational institution develops a model for customized corporate e-learning production and delivery. The study is based on three categories of research data: Primary data was collected from two projects briefly described in the method and material section, secondary data was taken from the e-learning literature and supplementary data was gathered using general knowledge and skills required through earlier production and delivery of e-learning at the academic institutions.

The study is exploratory and the empirical data are meant to illustrate some challenges that must be considered in the context of customized corporate e-learning production and delivery. We place particular emphasis on the stakeholder involvement, formative evaluation, collaborative processes and possible support tools. In the future, we plan to further describe and practically test procedures and processes to get more firsthand knowledge regarding a new model for design of customized corporate e-learning.
In this article, we start by describing the research method and material used in the study. This section contains a brief description of the involved academic institutions and the two current projects, as well as data collection and data analysis methods used in the study. Then, we have one section concerning production issues and one section concerning delivery issues related to customized corporate e-learning. Finally, we discuss what we should emphasize when the goal is to develop a design model for customized corporate e-learning.

Method and Material

This study uses a mixed method approach which emphasize on qualitative data collection (Creswell, 2003). Primary data were collected from two specific projects. TISIP research foundation and Faculty of Informatics and e-Learning at Sør-Trøndelag University College were the educational providers in the projects.

- The TISIP foundation was established in 1985. TISIP performs educational research and development work. TISIP offers courses to corporations, public agencies and academic institutions. The foundation cooperates with the Faculty of Informatics and e-Learning at Sør-Trøndelag University College. TISIP is involved in several research projects regionally, nationally and internationally (TISIP, 2009).

- The Faculty of Informatics and e-Learning (AITeL) educates specialists within computer information technology. There are currently 475 students at the ordinary programs with 40 employees at the faculty level. AITeL is one of the largest Norwegian providers of distance learning university college courses via the Internet (Sør-Trøndelag University College, 2009).

Two Different Customized Corporate E-Learning Projects

Two projects (BITØK and ANIMALIA) are used as a basis to discuss challenges related to e-learning production and delivery in this study. These projects are very different when we consider what kind of e-learning solution the customers want. What they have in common is the fact that the customer is a commercial corporation or company who wants to buy customized e-learning from an academic institution.

- In the BITØK project the customer wanted the academic institution to develop and deliver eight customized e-learning courses. All eight courses had to be a part of an already existing bachelor degree, offered by the institution. It was also a demand from the customer that students who had completed all courses in the program should be able to continue on a full bachelor program afterwards. The idea behind customizing already existing bachelor courses was that this would help to make sure that the courses would be sustainable and reusable. The courses should be based on online synchronous lectures using web-conference software. The recordings of the lectures had to be available for streaming and downloading, together with text based training material and corresponding mandatory exercise work administrated by a learning management system (LMS). The LMS was used to present all learning material related to the courses. In addition the local corporate organizer had to set up an independent portal for administrative purposes. It was also important for the customer that the courses could be followed by the students in a flexible way, since most of the students were company employees with many job related tasks and limited spare time. The eight 7.5 credit courses were to be offered over a two year period, with two courses in parallel each semester.

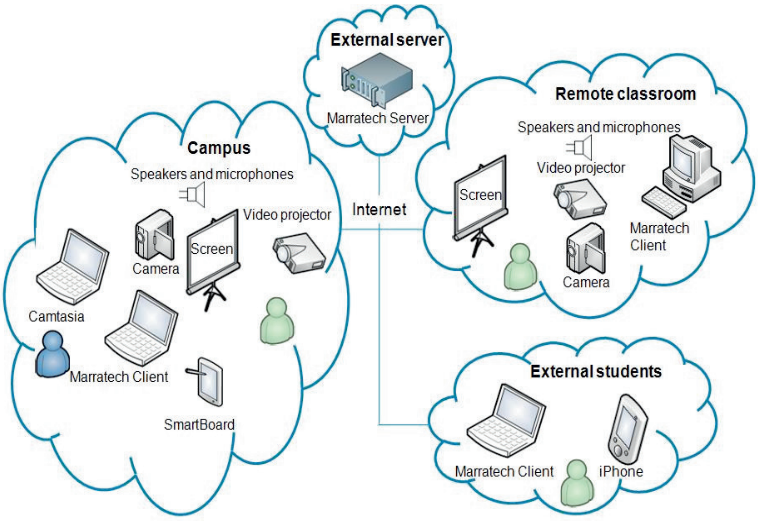

Fig. 1 – Infrastructure for lectures in the BITØK project.

- In the ANIMALIA project the assignment was to develop a self-paced e-learning course based on web pages containing, text materiel, oral presentations, video presentations and animations. The evaluation program in the course was based on multiple choice tests and the course participants received instant feedback on their answers. The subject domain area for this e-learning course was unknown to the educational provider, meaning that the customer had to contribute as a subject matter expert (SME), and therefore help to describe the content and develop a suitable knowledge model for the training course. The course, once developed, had to be reusable without involvement from the customer or the educational provider. The course was only meant for the customer's employees. This training course was in the area of vocational training for slaughterhouse workers.

Fig. 2 – A web page from the self-paced e-learning system developed in ANIMALIA.

The Qualitative Research Approach

Qualitative data were collected from the BITØK and the ANIMALIA project through, project documents, scheduled interviews with involved project participants, and analysis of open (free-response) questions from two questionnaires. In addition, we have conducted informal interviews with relevant project participants, and we have taken part in some of the project activities. Moreover, we have used external material such as books and research articles covering relevant topics for this study. This includes the article by Mikalsen, Klefstad, Horgen, & Hjeltnes (2008) which has previously been published from the ANIMALIA project.

The four instructors who lectured the first semester in the BITØK project, and the ICT-technician who was responsible for the technical equipments, were interviewed in semi-structured interviews. Each of these persons was interviewed once and the interviews took between 30 and 70 minutes. In these interviews, data were gathered about: (1) relevant background and experience, (2) preparations before the program started, (3) preparations before the net-based lectures, (4) problems or challenges faced the first semester, (5) positive experiences and what has worked well the first semester, (6) possible adjustments and improvements, (7) issues to be retained and reinforced, (8) fulfilment of the students' expectations, and (9) if the program had been sufficiently adapted and customized with respect to needs of the customers? All interviews were taped and transcribed into text protocols.

The Quantitative Research Approach

Two electronic questionnaires were given to the students who followed the two courses in the BITØK project in the first semester. These questionnaires were conducted primarily to get an indication of how the students perceived the overall quality in the courses. A mix between free-response questions, dichotomous questions, multiple-choice questions, checklists and rating questions with the Likert scale were used. The instrument designs for these questionnaires were based on Cooper & Schindler (2008, chap. 12 - 13). It was also used several free-response questions that have been used in the qualitative analyzes afterwards. The questionnaires were distributed to the students as part of the mandatory exercise program. All 33 students answered the first questionnaire and 29 students answered the second questionnaire. At the end of the semester 27 students took the final exam in one or two of the courses in the first semester of the BITØK project.

Summary of Research Method and Material

The research method used in this study collected data from three different sources.

- Primary data from the two projects carried out by the academic institutions. Mainly relevant project documents, interview protocols and questionnaires.
- Secondary data collected from the e-learning literature. A lot of research literature on e-learning in conjunction with higher education is available; and relevant elements in relation to e-learning and customization for corporations are drawn out in this study. The search strategy included electronic databases and hand searches of some published books on e-learning. We have used databases like ACM Digital Library, IEEE Xplore, ISI Web of Science and CiteSeerX. In addition, we have used Google Scholar that provides a simple way to broadly search for scholarly literature across many disciplines and sources (Google Scholar, 2009).

- Supplementary data taken from the academic institutions. They have both offered Internet-based distance education since 1994. This represents a lot of expertise and experience but it is also a challenge to take advantage of this knowledge in the research, since much of it is tacit knowledge among the employees (Leonard & Sensiper, 1998).

Production of Customized Corporate E-Learning

E-learning or distance education are terms that cover several very different techno-pedagogical realities. Technical media used in distance education can help to categorize the scheme (Williams, Nicholas, & Gunter, 2005), but we should also be concerned with the instructional needs of the students, rather than unambiguous focus on the technology itself (Sherry, 1995). Paquette (2004) defines six teaching model paradigms to help classify different e-learning or distance education schemes. If we categorize the projects in this study with the help of these categories we could define BITØK as a mix between a distributed classroom and an on-line training project and ANIMALIA as a mix between a performance support system and a hypermedia self-training project.

The distributed classroom in BITØK is realized with web-conference software and all participants are present at the same time, synchronously. In addition, video recordings of all lectures are made and transferred to the LMS. These can later be downloaded and played in the browser (AVI files) or with an iPhone (MP4 files). Learning events are presented live by the instructor and a variety of instruments such as sound and image transmission, slideshows, application sharing features and smart boards are utilized. The on-line training dimension covers the asynchronous mode and this part is mainly supported by services provided via the LMS.

ANIMALIA is a mix between a performance support system and a hypermedia self-training project. Individual and autonomous learning are central in ANIMALIA, and it focuses on competencies and skills that are directly related to the daily production at the workplace.

Educational designers are likely to have a different approach when they are in a university context with traditional students, compared to a more business oriented context with external organizations as clients. Nevertheless, they almost completely agree on central principles for educational design, and they claim it is important to start the design process from the needs of the learners in all cases (Kirschner, van Merrienboer, Sloep, & Carr, 2002). If you are to describe the needs of the learners you must have a close dialogue with the customer. Corporate customers are heterogeneous and their needs vary in the different corporations. A corporation must consider the individual needs and balance these needs up against the corporation's total needs. Corporations are also different from educational institutions as a learning arena, since they do not have learning as a primary objective. Learning in corporations aims to serve the goals and needs for the business and is a mean to achieve competitiveness, profit, efficiency, etc. (Welle-Strand & Thune, 2003). The production of sustainable e-learning programs adapted to corporations must therefore balance the different needs of the educational institution and the corporation on an organizational level. Moreover, it is important that we meet the needs of each individual and the organization as a whole.

The different stakeholders have to be involved sufficiently when e-learning is developed, and this applies increasingly for customized corporate e-learning. Designers of corporate e-learning (business designers) are much more client-oriented and emphasize the importance of client involvement in the process to a much greater degree than university designers (Kirschner et al., 2002). The importance of involving the stakeholders is also confirmed by several of the sixteen instructional design principles from Visscher-Voerman (1999), which is also referenced in Kirschner et al., (2002). The stakeholders receive special attention in principle three, six and seven.

- Principle three. “During the design process, designers should pay as much attention to creating ownership with clients and stakeholders, as to reaching theoretical or internal quality of the design.” (Kirschner et al., 2002, p. 97).
- Principle six. “Designers should not only ask clients and (future) users for content-related input, but should also give them the right to decide about the design itself.” (Kirschner et al., 2002, p. 97).
- Principle seven. “A useful means to help clients, partners, and other stakeholders to choose a solution and to formulate product specifications is by showing products from former projects.” (Kirschner et al., 2002, p. 97).

We aim to develop and deliver e-learning that meet the expectations and we need to involve all relevant stakeholders in this context. In addition, it is important to conduct evaluation activities early in the process, and to integrate this formative evaluation within the design and development process (Visscher-Voerman & Gustafson, 2004; Davidson-Shivers & Rasmussen, 2006). The Web-Based Instructional Design (WBID) Model by Davidson-Shivers & Rasmussen (2006) has special focus on evaluation. In the WBID Model both formative and summative evaluation is planned early in the project. Moreover, the formative evaluation is an integral part of the design and development process and it is important to determine whether the upcoming system actually meets the requirements and needs in the best possible way. This formative evaluation should be iterative and continue during the whole project period. Summative evaluation is conducted after full implementation, which is also common for traditional Analysis, Design, Development, Implementation, and Evaluation (ADDIE) models for instructional design. In the same way, as for the stakeholders, we also find the importance of making the evaluation embodied in several of the design principles from Visscher-Voerman (1999). Formative evaluation receives special attention in principle eight, ten and fourteen.

- Principle eight. “In order to clarify product specifications, designers should spend their time on carefully planned formative evaluations of early versions of a prototype, rather than on an elaborate preliminary analysis.” (Kirschner et al., 2002, p. 97).
- Principle ten. “For efficient and effective formative evaluations, several (about three) sources and several (about three) data gathering instruments should be used.” (Kirschner et al., 2002, p. 97).
- Principle fourteen. Designers should conduct formative evaluations themselves. (Kirschner et al., 2002, p. 97).

Our primary data from the BITØK and ANIMALIA projects also confirm that it is important but difficult to involve stakeholders in the project, and to conduct formative evaluation along the way. This is important because it is only the stakeholders who know what they actually want, and it is the stakeholders who ultimately determine whether the system have met their expectations.

Our experience, particularly from the ANIMALIA project, was that a lot of changes had to be performed late in the project. The reason was too little stakeholder involvement along the way and too little formative evaluation integrated into the design and development phases of the project. Necessary information and material with sufficient quality was not made available early enough. This led to major changes after the first delivery when the first summative evaluation was conducted (Mikalsen et al., 2008).

Some of the weaknesses in the BITØK project can also be traced back to low stakeholder involvement. Both students and lecturers in this project believe that there is a great potential for improvement of the customization of the e-learning courses, but this requires a closer dialogue and more involvement from the corporate employees.

Experience shows that it is difficult to involve the external stakeholders. This is especially the case with the stakeholders who have the adequate decision-making authority. It is therefore extremely important to utilize the available time well, when you are in dialogue with these stakeholders. It is important that the customers really understand the existing opportunities, so that they can better evaluate them against their actual needs, when decisions are to be made. Likewise, the provider needs to understand the subject domain, as well as customer requirements concerning the business, organizational needs, individual needs, technical factors, etc. "At a general and highly abstract level, the process of organizing and planning learning activities needs to take into account the following considerations and interrelationships: why learning activities are being planned; who the learners are; what is to be learnt; how it is being learnt; where and when the learning activities are taking place; and, what the effects are." (Welle-Strand & Thune, 2003, p. 186).

Delivery of Customized Corporate E-Learning

The challenges in relation to deliveries vary between e-learning projects in different categories. The ANIMALIA project deliveries were self-paced e-learning courses where the challenge by far is limited to technical matters, and requests for changes that occur after the system is put into production. The main focus when we describe the challenges in connection with delivery of e-learning in this section is related to the BITØK project category, which is a combination of distributed classroom and on-line training. Several researchers have described relevant success factors in connection with delivery of e-learning, online learning, distance learning, web-based learning, blended learning, etc., and this covers a very broad range of challenges. In this section, however we restrict ourselves primarily to challenges associated with distributed classroom and on-line training projects.

Based on a literature study, five independent categories of distance education success factors are identified by Menchaca & Bekele (2008). These are: (1) *technology-related factors* that represent the infrastructure and the tools used, and how the varied use of technology in different contexts affects the learning environment, (2) *user characteristics* and the importance of having experienced participants (instructors, facilitators, students, etc.) that can leverage the technology, (3) *course-related factors* that generally refers to quality issues, such as structured material, well formulated learning objectives and clearly defined expectations, (4) *learning approaches* that include pedagogical conditions as well as online collaboration and interactions between the participants, and (5) *support services* that include administrative and technical support for both students and instructors. Other researchers also discuss success factors for e-learning, and the five factors mentioned in Menchaca & Bekele (2008) are also mentioned by other researchers. Several researchers underline the importance of an optimal functioning technology. Involved parties must learn to master the technology and aim for varied technological usage during the course period (Webster & Hackley, 1997; Volery & Lord, 2000; Easton, 2003; O'Neill, Singh, & O'Donoghue, 2004). "The most important factor for successful distance learning is a caring, concerned teacher who is confident, experienced, at ease with the equipment, uses the media creatively, and maintains a high level of interactivity with the students." (Sherry, 1995, p. 343).

Moreover, it is interesting to observe that several researchers studying the instructor's role in online distance learning point to increased time and workload. Required work is significantly larger in an online and distributed classroom environment, compared to equivalent face-to-face teaching on campus (Smith, Ferguson, & Caris, 2002; Easton, 2003).

Primary data from the BITØK project confirms that the technology must work perfectly and that instructors need training in order to exploit the technology. The instructors use significantly more time in an online and distributed classroom environment, where customized e-learning is delivered to external customers, compared with corresponding lectures for traditional campus students.

In relation to the technological solutions, 100% online data feed availability while the lectures take place is crucial. It is important to install and use the technical equipment correctly and test the configuration in advance. Our study shows that sound quality is really important in a distribute classroom environment. The whole experience will be spoiled if the sound is not good enough. The image quality is also important and a means to achieve good communication with students. Large screens providing good image quality helps the participants in the interaction between the instructors and students, and this stimulates the communication. In addition, the instructor must be confident with technical equipments, such as the tools embedded in the web-conference software (slide presentation tools, application sharing features, smart board features, etc.), if they should be able to utilize the possibilities and vary the use in relation to pedagogical objectives.

Our study identified several factors leading to increased workload for instructors in a distributed classroom environment. First, the instructor must spend more time to organize the customization and find examples that are relevant for the companies' students. Secondly, the teaching method must be adapted to the technology and the pedagogical setting. It takes time to prepare the lecture, and it is extremely important to maintain a good flow through the whole lecture, when the students participate through distributed classrooms. Thirdly, the examples must be prepared in a different way. This may particularly be the case in practical subjects where it is natural to, send hardware components around the physical classroom or let the students physically configure software settings. Generally, this shows challenges concerning transference of constructivist teaching techniques from traditional classrooms, to distributed classroom environments. Last, but not least, the increased preparation time is related to the video recordings that will be distributed via the LMS. Filming leads to increased preparation time, since the instructors to a greater extent feel they must think through what to say in advance. This challenge increases further if there are requirements concerning reuse. Smaller recorded parts from a long lecture could function as an independent and reusable entity, and this requires thorough preparation.

In the same way as we need to be aware of the workload for instructors, we must also think of the students. Attending a course in addition to a full job is challenging. The BITØK project study showed that about 75% of the working students felt comfortable taking one course (7.5 credits) per semester, while this percentage dropped below 30% when we asked about two courses (15 credits) per semester.

Towards a Model for Design of Corporate E-Learning

Production and delivery of customized corporate e-learning can be a complex process and it requires the involvement of several different stakeholders (Sherry, 1995; Kirschner et al., 2002; Visscher-Voerman & Gustafson, 2004). Providers and customers should meet because the customer must understand the opportunities that exist, and the provider has to understand customers' requirements. It is only through a unified collaboration between these parties that a common understanding can be established. E-learning programs are sometimes very complicated and there are many different challenges that influence each other. Companies have business needs and financial constraints that act as overall guidelines. Moreover, they must consider organizational needs and the needs of the employees. Sometimes the stakeholders from companies are the only ones who know the relevant subject domain for the e-learning system. Companies also tend to have restrictions in relation to technological choices, adoption to existing technical infrastructure, security policy, etc. On the other hand, the educational provider must take responsibility to represent the knowledge, develop the pedagogical program, develop the learning material and arrange the delivery of the whole e-learning package to the customer.

In total this represents many different disciplines and we need to involve people in different roles in the cooperation. The clearest roles in this context are perhaps: (1) SMEs who are experts on the subject domain, (2) instructional designers who prepare the pedagogical program, (3) instructors who are responsible for course delivery, (4) students, (5) customer's decision-makers who may be responsible for various areas such as economy, the subject content, pedagogical guidelines and technological guidelines, (6) the provider's decision-makers, (7) developers and graphic designers, (8) engineers who are responsible for production, (9) quality assurance people who are responsible for ongoing formative and final summative evaluation, and (10) the project manager who is responsible for the project within the approved frame of time, cost and quality.

Several models for the production of e-learning are based on a problem-solving process with a series of defined phases like Analysis, Design, Development, Implementation, and Evaluation (ADDIE). Research shows that instructional designers have different approach to the ADDIE models. This depends on experience and background among the involved project participants, as well as the different kinds of products that are developed. Visscher-Voerman & Gustafson (2004) discusses how the approaches to ADDIE phases are for different instructional designers, and presents four different paradigms and rationalities related to ADDIE. Although the customers to some degree are involved in all these paradigms: (1) *Instrumental Paradigm*, (2) *Communicative Paradigm*, (3) *Pragmatic Paradigm*, and (4) *Artistic Paradigm*, we find the greatest degree of customer involvement in the *Communicative Paradigm*. Here the customer works as a co-designer and co-decider in addition to provide needed information. In this way, the customer is drawn deeply into the production process. "Ultimately, we believe that all of the paradigms and their accompanying perspectives, tools, and techniques can and do play useful roles in designing effective, efficient, relevant, and engaging instructional experiences. We believe that all practicing professionals should be aware of the value of each paradigm, and use the one that is most appropriate for the specific situation. To do less is to be less than a complete and competent practitioner.” (Visscher-Voerman & Gustafson, 2004, p. 87).

An organization that has worked with e-learning over time has a lot of tacit and implicit knowledge (Stenmark, 2001), concerning how e-learning programs should be developed and delivered. “[Designers] are influenced by their theoretical background or frame of reference.” (Kirschner et al., 2002, p. 101). When something customized for a specific audience is developed, the necessary domain expertise may be missing and it may be a challenge to extract this knowledge from the customer and have it represented in the e-learning system. These are knowledge acquisition challenges that knowledge engineers have worked with over decades and several techniques and tools are developed (Boose, 1989). We can also find such techniques and tools used in models for e-learning production. The instructional engineering model MISA contains a knowledge model to represent the knowledge and competencies to be developed in addition to the instructional model, the media or learning model and the delivery model. The MISA model is based on phases and has much in common with traditional ADDIE models. The four models (*Knowledge Model*, *Instructional Model*, *Media Model* and *Delivery Model*) are integrated and the different models evolve in parallel through the different phases (Paquette, 2004). Moreover, they have a focus on development tools related to the different models, such as the TELOS (TELelearning Operation System) Scenario Editor and the TELOS Ontology Editor that are discussed in connection with the conceptual framework TELOS (Paquette & Magnan, 2008).

The WBID Model by Davidson-Shivers & Rasmussen (2006) also explains that some stages are conjoined rather than isolated and must be performed in tandem. This is described as concurrent design, and indicates that the design, development, and formative evaluation tasks are conducted simultaneously. “With many web-based instruction projects, especially complex ones, it is not possible to complete all of the design activities for the entire project before starting development. Constraints of resources, time, and money, and the desire to be responsive to the customer suggest that concurrent design may be a good approach. Concurrent design also permits unforeseen technical difficulties to be resolved well before the final web-based instruction is completed.” (Davidson-Shivers & Rasmussen, 2006, p. 172-173).

In other engineering disciplines, we also find concepts like concurrent engineering and concurrent design. This has been a research area for a long time within space technology institutions such as the European Space Agency (ESA) and the National Aeronautics and Space Administration (NASA). “Concurrent Engineering is a systematic approach to integrated product development that emphasises the response to customer expectations. It embodies team values of co-operation, trust and sharing in such a manner that decision making is by consensus, involving all perspectives in parallel, from the beginning of the product life-cycle.” (Bandecchi, Melton, Gardini, & Ongaro, 2000, p. 329). Concurrent Design is the early phases of the concurrent engineering process where multifunctional teams, possibly distributed in time and space, work together for designing some product (Lonchamp, 2000). ESA established a Concurrent Design Facility in 1998 and the key elements on which the implementation was based on were a process, a multidisciplinary team, an integrated design model, a facility, and an infrastructure (Bandecchi et al., 2000).

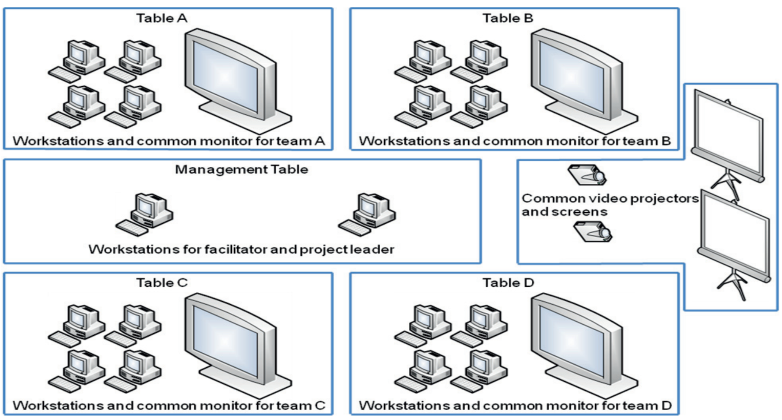

Fig. 3 – Drawing of AITeL’s room where collaborative design of customized corporate e-learning is to be implemented.

Conclusion and Further Work

In this study, we have discussed some challenges related to customized corporate e-learning. When an academic institution develops and delivers e-learning for external customers, it is extra important to involve all stakeholders, and to ensure that evaluation is carried out continuously through the process. Furthermore, it is important to utilize technological opportunities, and to ensure that all involved parties receive enough training in this context. Our findings from two specific projects confirm these challenges and these findings are consistent with the e-learning research literature. However, we find little documentation on how this should be done, and this forms the basis for our further work.

We will work further to develop a new model for design of corporate e-learning. In connection with this work, it will be important to leverage existing instructional design models, but also to utilize collaborative and multidisciplinary principles from concurrent design. We will focus on: (1) the preparation of processes for customized corporate e-learning design, (2) definition of relevant roles that involves all stakeholders in the design process, (3) specification of needed sub-models that constitute a whole and integrated model for the e-learning system, (4) establishment of a facility, including software tools and hardware equipments, where the team of specialists meets to conduct design sessions, and (5) specification of an infrastructure for exchange of information between working environments at the customers site, the providers site and the customized facility.

Fig. 4 – Picture from AITeL's room where a team practices on the Concurrent Design method.

It will be important to draw on the experiences that we have described in this article. The technology must be exploited in the best possible way, we need a continuous evaluation process, we must ensure that all involved parties receive the necessary training, both in terms of the production and delivery phase, and we must find and utilize tools that are suitable in certain situations for all participants.

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Paper 3
The Concurrent E-Learning Design Method

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The Concurrent E-Learning Design Method

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Abstract: Educational institutions face several tasks and challenges when they aim to develop e-learning courses for corporate clients. Instructional designers, subject matter experts, instructors and IT experts do not always have the necessary insights and knowledge with respect to particular areas of the industry. Hence, the educational institutions must involve experts from the corporations and collaborate closely to develop quality courses that satisfy all parties. In this article we present a new method for the design of customized corporate e-learning. This method approaches e-learning design as an integrated and iterative process and encourage interdisciplinary cooperation between all involved stakeholders. The method builds on key elements from the concurrent design methodology as well as several instructional design models that are already well proven in connection with e-learning design. We describe the method in detail, and outline a plan for future evaluation.

1. Introduction

E-learning design is the process of instructional design with the aim of developing online learning deliveries. This process is especially challenging if educational institutions develops and deliver customized e-learning for corporate clients. Indeed, it is necessary to involve relevant stakeholders and stimulate cooperation between the educational institution and the corporate client. It is appropriate to design main part of the e-learning delivery together so that all needs and requirements are addressed, and to establish evaluation processes (formative evaluation) that involves the relevant decision makers during the design process (Strand & Hjeltnes, 2009).

There exist numerous models that aim to describe how e-learning design should be carried out and several of these comes in the Analysis, Design, Development, Implementation and Evaluation (ADDIE) category (Peterson, 2003; Visscher-Voerman & Gustafson, 2004). Since these models are widespread there also exist several studies on how different practitioners utilize them (Kirschner, van Merrienboer, Sloep, & Carr, 2002; Visscher-Voerman & Gustafson, 2004). Some of the current e-learning design models emphasize collaboration between involved stakeholders. The approach to the design is integrated and model driven, where several parts of the upcoming e-learning delivery is represented in distinct models which are developed in parallel (Paquette, 2004; Davidson-Shivers & Rasmussen, 2006). This integrated approach is also referred to as concurrent design, and we can find some examples where the concept of concurrent design is used in conjunction with e-learning design (Wakefield, Frasciello, Tatnall, & Conover, 2001; Sims & Jones, 2002; Davidson-Shivers & Rasmussen, 2006).

Concurrent design is originally the early phases of the concurrent engineering process (Lonchamp, 2000), and this methodology have been developed to solve complex and interdisciplinary issues within space technology institutions such as the European Space Agency (ESA) and the National Aeronautics and Space Administration (NASA). Results from concurrent design implementations shows reduced time consumption, improved quality, satisfied customers and satisfied participants who can contribute more effectively, interactively and transparently to the evolution of the complete system design, as compared with more traditional approaches (Bandecchi, Melton, Gardini, & Ongaro, 2000). These positive results have contributed to different implementations by different institutions. They are all based on the basic concept of a facility (a room to conduct design sessions), where all design team members from different disciplines meet, utilize appropriate modeling and simulation tools and communicate regarding various aspects of the system design (Osburg & Mavris, 2005).

Since the design of customized corporate e-learning is an integrated process where different stakeholders (e.g. instructional designers, subject matter experts, technicians, business managers and customer representatives) must contribute to the upcoming e-learning delivery, we want to find out if the e-learning design process can be based on the concept of concurrent design. We want to study whether the positive effects from other concurrent design implementations (e.g. improved quality, more satisfied project participants and reduced time consumption) also appears when the principles of concurrent design is applied to design of customized corporate e-learning. To test this thoroughly, we first have to develop and describe a method for concurrent e-learning design and this is the main purpose of this study.

We use the design science research method (Hevner, March, Park, & Ram, 2004) to develop a new e-learning design method. The working name of the new method is ConCurrent e-learning Design (CCeD), and it is based on experiences from both concurrent design implementations and traditional instructional design models.

This article attempts to provide an overview of the CCeD method and how to implement the method when new customized corporate e-learning deliveries are to be developed. The first part is a background and motivation section where we explain why we want to mix instructional design and concurrent design. Second, the research questions, methods and material section describe how the research has been conducted. Then we have the main part of the article where an overview of the current CCeD method is presented, and finally we present some concluding remarks and our proposals for further work.

2. Background and Motivation

The challenges practitioners in different disciplines (e.g. industrial design, software design and instructional design) face when designing new solutions appear to have many similarities. For instance the concurrent design approach for industrial design (Oxnevad, 2000) and the agile manifesto for software design (Fowler & Highsmith, 2001), handle similar challenges to the ones faced in customized corporate e-learning design. It is important to satisfy the customer through meaningful deliveries, to build the projects around motivated individuals, to stimulate for integrated collaboration between all involved parties, to convey information through face-to-face conversation, and to base decisions on the overall needs and experts' competence.

To deal with this in connection to e-learning design we developed a new e-learning design method, designed for e-learning development projects where higher educational institutions develop and deliver e-learning for corporate clients. CCeD is based on a merger between two different disciplines, e-learning design and concurrent design. In this section we first choose to describe the background from each of the two disciplines separately, and finally we give the motivation for the new CCeD method that integrates these different disciplines.

2.1 Related work in E-Learning Design

E-learning design is based on instructional design which has its origin in the early twentieth century, and many researchers have helped to develop models and theories (Paquette, De La Teja, Léonard, Lundgren-Cayrol, & Marino, 2005). Today, instructional design models and tools are renewed to support the development of modern distributed learning systems, which to a great extent utilize modern information and communication technology solutions (Paquette et al., 2005). Even though the ADDIE models for instructional design are based on a series of sequential phases, the practitioners nowadays often follow an iterative cycle and develop several items in parallel (Kirschner et al., 2002; Peterson, 2003). An example of this is found in the MISA instructional engineering method where the different models (Knowledge Model, Instructional Model, Media Model, and Delivery Model) evolve in parallel through the different phases (Paquette, 2004). The MISA instructional engineering method is based on a mix between software engineering, knowledge engineering and instructional design, and Paquette (2004, p. 56) defines instructional engineering as: “A method that supports the analysis, the creation, the production, and the delivery planning of a learning system, integrating the concepts, the processes, and the principles of instructional design, software engineering, and knowledge engineering.”

The Web-Based Instructional Design (WBID) Model (Davidson-Shivers & Rasmussen, 2006) is another example of an iterative e-learning design model where the different parts of the e-learning solution are designed concurrently. The term concurrent design is used in connection with the WBID Model to emphasize how important it is that design, development and evaluation activities are carried out in tandem, and this is especially true for large projects involving many stakeholders.

2.2 Our approach to the Concurrent Design Methodology

Concurrent design has been a research area for a long time within space technology institutions such as ESA and NASA, and the method has in recent years also been applied in other business areas. One company behind this is Simtano™ (Simtano, 2009) and their chief executive officer (CEO) dr. Knut I Oxnevad. Oxnevad has a background from the Jet Propulsion Laboratory (JPL), a NASA laboratory (JPL, 2009), and he is recognized as one of the leading pioneers and innovators of concurrent design. Simtano have now applied concurrent design successfully to the oil and gas industry in the North Sea, and they also see a great potential for this methodology within other business areas (Simtano, 2009). Our professional communities have been visionary enough to collaborate with Simtano and Oxnevad recently, and this collaboration has, among other experiences, inspired us to adapt the concurrent design methodology to the development of corporate e-learning, as presented in this article.

2.3 Motivation for the Concurrent E-Learning Design Method

We have learned that it is challenging to develop new e-learning and this is especially true if the offer should be adapted to external corporate clients. The e-learning development process consists of interdisciplinary work that involves several different disciplines and we are dependent on several and smart decisions along the way. Concurrent design should by means of appropriate computer tools and interdisciplinary cooperation contribute to an efficient and effective design process. There are currently several concurrent design implementations and the most important findings we want to adopt in our CCeD method is similar to the key elements on which the ESA Concurrent Design Facility were based, in 1998 (Bandecchi et al., 2000). Thus, we will focus on: (1) the preparation of processes for customized corporate e-learning design, (2) the definition of relevant roles that involves all stakeholders in the design process, (3) the specification of needed sub-models that constitute a whole and integrated model for the e-learning delivery, (4) the establishment of a facility, including software tools and hardware equipments, where the team of specialists meets to conduct design sessions, and (5) the specification of an infrastructure for exchange of information between working environments at the customers site, the providers site and the customized facility where design sessions are conducted.

3. Research Questions, Methods and Material

Given the background and motivation presented in the previous section, we defined the following overall research question for this study: *How should we run concurrent e-learning design projects for corporate clients, to make effective e-learning deliverables efficiently?*

This overall research question have contributed to several challenges that we had to deal with in order to define the CCeD method: (1) to what extent can we draw on existing instructional design methods and what adjustment do we need to do, (2) to what extent can we draw on existing concurrent design experiences and what adjustment do we need to do, (3) how should we organize and define the CCeD process, (4) which roles do we need in a CCeD project, (4) which design-models that together constitute an overall model for the entire e-learning offer should we develop, (5) which software tools could we utilize when these models are developed, (6) how should we organize the facility (the room with needed hardware and software tools where concurrent e-learning design sessions are conducted), (7) how should we facilitate the work and stimulate to an inclusive team environment that contributes to productivity, and (8) how should we define an infrastructure for collaboration and information sharing between all the involved project participants?

In order to answer these questions we have reviewed relevant literature within the fields of e-learning design and concurrent design. Furthermore we have exploited the experiences our project participants have in relation to e-learning. This work started in the late eighties and our institutions have offered Internet-based distance education since 1992, as participants in the JITOL project (Lewis, Goodyear, & Boder, 1992). In addition, we have brought in external expertise (dr. Oxnevad) with regard to concurrent design. Oxnevad has worked with concurrent design at JPL from 1996 to 2005 (Simtano, 2009). Besides the traditional literature search, we have used both audio and video recordings to collect and store data during the project. Our project meetings have been recorded on audio-files and parts of this material are later transcribed into text protocols. Several activities conducted in our concurrent design facility has been video-taped and this includes the four days of concurrent design team and facilitator training Simtano and Oxnevad provided us with, in May 2009. These audio and video recordings were later used as input when various aspects of the CCeD method were described.

"Research methods are tools, and tools should only be selected once goals and tasks are clear." (Reeves, 2000, p. 8). Our goals and tasks are related to the above-mentioned research question and the establishment of the new CCeD method. On this basis, we have based our research on the method of design science (Hevner et al., 2004). The design science approach is also considered relevant by several other researchers within the field of instructional design. Reeves (2000) describe a development research process based on principles of design science. This iterative research process is further detailed in (Ma & Harmon, 2009), where each step in the process is more thoroughly described. Our approach to the design science research method has been to use the seven design science research guidelines from (Hevner et al., 2004), and the following shows our approach to these principles:

- First, we design as an artifact since we produce a method to solve important organizational challenges related to customized corporate e-learning design. Our main artifact is the CCeD method including process descriptions, templates for several e-learning design sub-models, a facility for the implementation of design sessions, and an infrastructure to support the project.
- Second, the problem relevance is thoroughly recognized both within our own institutions and more broadly as described in several research articles. Development of high quality corporate e-learning is challenging and appropriate stakeholder involvement, which is one of the challenges we treat in this project, is considered a key factor in this context.
- Third, design evaluation is on the agenda and the utility, quality and efficacy of the CCeD method was continuously evaluated during the first development phases, and the method will be further evaluated as it is implemented and tested more thoroughly on real cases.
- Fourth, the research contribution has a great potential and will be significant if we succeed in achieving results like they have documented for concurrent design implementations at space technology institutions (Bandecchi et al., 2000). Our goal is that the CCeD method should contribute to improved quality, reduced costs and reduced time consumption when new e-learning are designed and delivered to corporate clients.

- Fifth, research rigor is ensured by the fact that we base the research on the method of design science, and that we evaluate the CCeD method thoroughly and in several iterations before the final version is distributed to a wider audience.
- Sixth, we design as a search process since we make use of available theories within the two subject areas, e-learning design and concurrent design. Based on this, we compose new solutions that meet our needs and satisfy the guidelines we are bound by. This is an iterative and search-based design process where we investigate a broad base of alternative solutions, which are further reviewed, and adapted to our requirements in terms of utility, efficiency and effectiveness.
- Seventh, communication of research is dealt with and the results will be presented both to academically-oriented as well as management-oriented audiences. Our funding partner (Norway Opening Universities) has a web site where overall information about the project is posted (NOU, 2010), and the CCeD method with associated documentation will be distributed and made freely available from the project's web site (CCeD, 2010). Moreover, we intend to publish several scientific articles that go in depth on different aspects of the application of CCeD. This article, that aims to describe the CCeD on an overall level, is the first contribution in this context.

4. The Concurrent E-Learning Design Method

The purpose of this section is to give an overall description of the current version of the CCeD method, and to mention some of the challenges faced during the method design process. The project has lasted for several months to reach the current status, but nevertheless we expect adjustments ahead, as we now implement the method and use it for the development of real e-learning deliveries for corporate clients. Central method elements that we will describe in this section are: (1) the process that defines how the projects should be run from start to end, (2) the different roles involved in the CCeD sessions, and the tasks they are responsible for, (3) the different sub-models to be developed, which together make up the entire design-model for the e-learning delivery, (4) the tools that the various experts use when their sub-models are developed, and (5) the facility and the infrastructure which should contribute to efficient multidisciplinary collaboration (concurrent design) throughout the project. The following descriptions must necessarily be at a high level and we refer to the project's web site (CCeD, 2010) for more detailed information on these topics.

4.1 The CCeD Process

The CCeD process is documented as a process document containing descriptive text and graphical representations based on the Business Process Modeling Notation (BPMN) (White, 2004).The current process document contains: (1) an overview of the CCeD method where the process itself is one of the key components, (2) the purpose of the process, (3) an overview of the process that is graphically designed with BPMN, (4) a description of the process which includes a description of the operational roles and functions, decision points, collaborative teams, sub-models to be developed when the process is used, and the sub-processes included in the process, (5) an overview of the infrastructure at the facility where the CCeD sessions are to be conducted, (6) input and entry criteria required to start the process, (7) output and exit criteria describing the deliveries from the process, (8) an overview of all sub-processes where each sub-process is graphically designed with BPMN, in addition to a list of activities, tasks, guidelines, roles, expected output, and available templates and tools, (9) a checklist for the process, (10) an overview of process evaluation activities, (11) appropriate tools that can be used in conjunction with the process, (12) documents and templates related to the process, (13) control and ownership for the process, (14) specific guidelines that will apply in certain situations, and (15) important competences and training guidelines related to the process. We will come back to some of the above mentioned elements of the business process in paragraphs 4.2 to 4.5 in this article, and first we choose to simply describe the three phases of the CCeD process on an overall level.

First, we have the *Preparation* phase including initial contact between the educational institution and the corporate client. The input to this phase is the project directive document which represents the formal permission to start the project planning. It contains background information for the project, objectives, needed resources, scope for the project planning period and a sign-off from authorized representatives of the educational institution and the corporate client. The output from this phase is a project plan containing the project's frame of time, cost and quality, which must be approved before the project can proceed.

Second, we have the *Execution* phase. This phase is regarded as the core of the CCeD method, since concurrent e-learning design sessions are planned and executed here. The session schedule will vary between different projects, but we have chosen to define a directive schedule, containing a session plan, which includes five sessions with approximately 3.5 hours duration and a minimum of one week intervals between them. In each of these sessions different aspects of the four sub-models (*Instructional Model, Knowledge Model, Technical Delivery Model and Business Model*) evolves in parallel. The following list shows the area of focus for each of the sessions:

- *Session I – What is the situation;* A situation analysis about the current situation in relation to instructional schemes (*Instructional Model*), knowledge aspects (*Knowledge Model*), technological aspect (*Technical Delivery Model*), and financial and administrative issues (*Business Model*).
- *Session II – What possibilities exist;* A study of possibilities in relation to each of the four sub-models where the purpose is to describe a wide range of possible solutions for the e-learning design.
- *Session III – Selection of solutions;* An evaluation of the possibilities and selection of solutions for each sub-model, which we choose to bring forward and use in the current upcoming e-learning delivery.
- *Session IV – How the solution should be designed;* A detailed preparation of the e-learning design where the delivery is organized, e.g. in what order instructional activities will be carried out (*Instructional Model*), in what order appropriate learning material will be presented (*Knowledge Model*), how the different technical solutions should be designed (*Technical Delivery Model*), and how economic models and administrative solutions should be implemented (*Business Model*).
- *Session V - Completion and implementation planning;* To complete the design model for the entire e-learning delivery and make plans with respect to the development and delivery, e.g. who should do what, when will it be done and what resources are needed.

The output from the *Execution* phase is the design document for the entire e-learning delivery. This document is composed of the four above-mentioned sub-models and it is regarded as the main deliverable from a CCeD project.

Third, we have the *Conclusion* phase where the final evaluation of the project is undertaken, the design document is completed and the project's final report is prepared and submitted for approval.

Regarding the work of this process it was especially difficult to describe the *Execution* phase, to set the number of sessions and the content or focus area for each session. Our proposal for five sessions should be considered as a guideline and not as an absolute requirement, and it will be appropriate to consider adjustments for new projects.

4.2 Roles

The following roles were identified and must be represented when CCeD projects are to be implemented: (1) the *project manager* having traditional project management responsibilities in relation to leadership and management throughout the project, (2) the *facilitator* who will lead all sessions and contribute to relevant interdisciplinary cooperation between all participants, (3) the *session secretary* who will assist the *facilitator* with respect to the technical implementation of the sessions, (4) *instructional designer(s)* responsible for instructional strategies, learning activities, etc. that are to be documented in the *Instructional Model,* (5) the *subject matter expert(s)* who is responsible for the development of the *Knowledge Model* that contains information about competencies to be developed, learning needs and subject content, (6) *technical delivery expert(s)* documenting the technical matters such as selection of technical platforms, infrastructure, solutions and tools, in the *Technical Delivery Model, (7) business expert(s)* who should take care of business related issues and administrative needs, and document these in the *Business Model,* and (8) several other optional roles such as instructors, students and customer representatives who will cooperate with the above-mentioned roles, depending on the their own competence background, experiences and interests. One challenge with this is perhaps that it seems large and extensive with many roles. However, we will also test the method in a down-scaled version, where one person typically can take responsibility for several roles simultaneously.

4.3 Models

The main delivery from a CCeD project is a design document which is composed of the following four sub-models:

1. *The Instructional Model* – detailing pedagogical activities or learning events that students and instructor(s) should conduct in connection with the course and relevant resources in this context.
2. *The Knowledge Model* – that contains the learning content and objectives, i.e. the kind of knowledge, skills and attitudes the students should acquire.
3. *The Technical Delivery Model* – containing an overview of how the technical delivery will take place, and what technologies and tools that will be used in connection with the deliveries.
4. *The Business Model* – that describes economic conditions, i.e. costs and incomes, intellectual property rights (IPR), any agreements that must be entered into, administrative guidelines and requirements in relation to the delivery timing, needed resources, etc., for the upcoming e-learning delivery.

It has been challenging to decide what to focus on for each of the four sub-models since several aspects are relevant to several of the models. Nevertheless, our opinion is that such a division will help us to focus on all aspects of the e-learning delivery and contribute to a comprehensive design document that totally contains all the necessary aspects. Furthermore, it might be needed to modify the focus area for each model, but we will decide on this when we have collected more empirical data from specific test cases.

4.4 Tools

There are many tools that are designed to describe teaching-learning processes in a formal way, and some of these tools (e.g. the *ReCourse Learning Design Editor*) are based on formal pedagogical standards such as the IMS Learning Design (Koper & Tattersall, 2005). Our choice of tools has been inspired by the TELOS (TELelearning Operation System) Scenario Editor and the TELOS Ontology Editor (Paquette & Magnan, 2008), since these seems to support multidisciplinary collaboration and model driven development where various aspects of the e-learning design is represented in different but integrated models. However, we have decided to use general tools that are not specifically designed to describe teaching-learning processes, in the first place. Our selection is mind mapping software (MindManager® from Mindjet®) and the new powerful collaboration solution (Mindjet Catalyst™). Mindjet Catalyst combines secure online workspaces, web conferencing and a best-in-class visual productivity application (mind mapping), and teams can visually connect and share ideas and information during the design process (Mindjet, 2009).

In order to offer powerful tool support for the participants and to avoid a large overlap between the four evolving models we decided to make predefined templates for each model. These templates are realized as MindManager templates and new sub-models (Instructional Models, Knowledge Models, Technical Delivery Models and Business Models) are based on the respective template when they are created. The templates contain detailed information regarding the questions different designers should consider, in each of the sessions, during the *Execution* phase of a CCeD project. After the last session (*Session V*), we will merge the four models and create one common model representing the entire e-learning design. To make a final e-learning design document which is independent of the development tools, we will typically take advantage of the *Export to Microsoft Word* feature in MindManager.

It has been challenging to determine what should be represented in the various templates, and also to decide when and in what order one should focus on specific elements during the design process. Therefore, we also expect to make adjustments to the templates, based on empirical data collected from specific test cases. One of the advantages of using general tools such as MindManager, is that it probably is easier to get started for all parties involved, as compared with specialist tools for instructional design. However, it might be a disadvantage that the participants do not get the same support as with the help of tools that are specifically designed for instructional design purposes. Therefore, we will evaluate how well mind maps works in relation to instructional design and we will also consider taking advantage of more specialized instructional design tools in future CCeD implementations.

4.5 The Facility and the Infrastructure

Our institution established a concurrent design facility as part of a project where several engineering disciplines (electrical engineering, mechanical engineering, materials engineering, logistics and software engineering) aimed to test the concurrent design methodology, as we know it from space technology institutions. This concurrent design facility is realized as a room with the necessary technical equipment, and this room is also used when CCeD sessions are conducted. The room is equipped as follows:

- Four tables (working table A-D), each with four workstations (computers) and one common large screen for that table. The common large screen is primarily used to present the desktop of one of the workstations on the same table, but it is also possible to present the desktop of one of the other workstations in the room. Each of the four sub-models (*Instructional Model*, *Knowledge Model*, *Technical Delivery Model* and *Business Model*) is developed at one of the four tables when CCeD sessions are carried out in this room, meaning that we have room for four participants on each sub-model.
- A management table where workstations for the *facilitator* and the *session secretary* are placed. This table is placed centrally between working table A-D, so that the *facilitator* and the *session secretary* have a good overview and can stimulate to cooperation between the working groups in the sessions.
- Two video projectors that are primarily used when the facilitators wants to convey something to the whole group. The desktop from each of the sixteen workstations on the four working tables and the two workstations on the management table can be presented through these video projectors.

One of the biggest challenges faced when this facility was established, was to find a solution to switch any workstation desktop to any screen or video projector. There exist video splitters (hardware) to do this, but since these are relatively expensive we decided to use a software based solution. Our choice was the NetSupport School software from NetSupport Ltd, since this software covered our basic needs regarding the presentation of any workstation desktop to any screen (NetSupport, 2009).

The infrastructure is in this context an arena for exchange of information, documentation and other resources among project participants. It should be easily available for everyone during the whole project so that everyone can take advantage of relevant material. First we established a Microsoft SharePoint Server to meet this objective, but since Mindjet Catalyst also provides a secure online work spaces, we decided to use this. We had no particular problems with the SharePoint solution, but decided to use the Mindjet Catalyst solution, just to reduce the number of solutions for the project participants. Several of the project participants have expressed that they feel comfortable *working in the clouds,* and that it is very beneficial to have easy access to what the other project participants have made.

4.6 Concurrent E-Learning Design Sessions

The above-mentioned components (section 4.1 – 4.5) are considered necessary ingredients when CCeD projects are implemented. Nevertheless, it is the establishment of an integrated and interdisciplinary collaborative environment (concurrent design environment), we really should benefit from, when new e-learning deliveries are developed. Since practitioners representing different functions and disciplines meet for concurrent e-learning design sessions, we will to a greater extent be able to utilize everyone's skills and experience, taking all aspects of the e-learning delivery into account, as well as basing decisions on available expertise and sufficient authority. The facilitator is very central in terms of success with this, and we know from other concurrent design implementations that it takes a long time (several years) to become a skilled facilitator. We look forward to getting more first-hand experience with this.

5. Concluding Remarks and Further Work

In this article we have presented a new method (CCeD) to be used when customized corporate e-learning deliveries are designed. The method is based on experience from traditional instructional design as well as the concurrent design methodology, and it is developed to help us make effective e-learning deliverables efficiently. Our research is based on the method of design science and the main purpose of this article is to describe the produced artifacts. We define a concept that describes how concurrent e-learning design should be implemented and we base this concept on experiences which also is documented in the research literature. However, in accordance with the design sciences research method: "The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods." (Hevner et al., 2004, p. 12). When we still choose to publish the results of this research, without any scientific evidences regarding how the concept actually works, it is because we need to define the concept thoroughly before we can test it out and make evaluations.

5.1 Future Evaluation Considerations

Recently, we have presented this concept for three different groups and we have so far received very positive feedback and a strong belief that the concept will actually work. This would not have been possible without a thorough description of the concept, as described in this article. We now have the opportunity to carry out three different CCeD projects, with different stakeholders and different goals. When these specific projects are carried out we will collect empirical data through interviews and questionnaires. In this way, we aim to identify what works well and should remain the same, what works less well and should be improved, and what does not actually work and should be discarded. When we have been through the first implementations, and depending on the results we achieve, we will consider going more in depth on specific issues. Relevant issues in this context may include: (1) how does the mind map tools work for e-learning design, (2) how does it work to separate the design model into several (four) sub-models, and (3) what is needed to encourage good collaboration between all parties involved in the e-learning design process?

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Paper 4
Action Research Based Instructional Design Improvements

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ACTION RESEARCH BASED INSTRUCTIONAL DESIGN IMPROVEMENTS

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Abstract

The introduction of a new instructional design method can be a tedious and complicated process, and a new method must be tested thoroughly before it can be determined if it works properly. In this article we are studying the use of action research when a new instructional design method is implemented and tested in the target organization. The background for this work is a new method for the design of customized corporate e-learning. The method is developed and described in advance, and the purpose of this article is to focus on the organizational introduction by using the principles of canonical action research. We explain how the action research was conducted based on the principles of: (1) researcher-client agreement, (2) cyclical process model, (3) theory, (4) change through action, and (5) learning through reflection. Then we discuss the implementation followed by a conclusion and some suggestions regarding future action research projects and some thoughts regarding further work to improve the e-learning design method under development.

Keywords: action research, concurrent e-learning design, instructional design methods

1. INTRODUCTION

Implementation of changes and new artifacts within an organization are both time-consuming and challenging (Mantovani 1996) and this also applies if new methods for instructional design are introduced within higher educational institutions. It is challenging to develop new methods and to involve the institution's employees, clients, students and other stakeholders and have them adapt to the new approaches. These challenges are further strengthened if the work is undertaken on a research-based manner and the results are to be scientifically documented. Research within the field of instructional design is sometimes criticized for being of poor quality, for not being relevant, or for not making a real contribution to the subject (Reeves 2000, Reeves & Herrington & Oliver 2005). One possible improvement strategy is to base instructional design research on design research.

Design research is sometimes referred to as development research, and it requires a long-term perspective. This includes a proven relation to the objectives and the use of research methods suitable for the tasks to be performed. "[Design researchers] focus on broad-based, complex problems critical to human learning and performance. This type of research agenda requires intensive collaboration among researchers and practitioners. Rather than sticking to one preferred method, development researchers select methods as tools to accomplish specific tasks, and they engage in continual refinement of research protocols. Development researchers are also committed to constructing design principles and producing explanations that can be widely shared. Instructional technologists engaged in development research are above all reflective and humble, cognizant that their designs and conclusions are tentative in even the best of situations" (Reeves 2000, p. 11).

The purpose of this paper is to share experiences from an instructional design method development project. The focus is on research methods and particularly the action research conducted when the new instructional design method was implemented and evaluated in the target organization. We aim to demonstrate how action research (Baskerville & Myers 2004) can help to make the implementation and evaluation stages more rigorous and credible. Following this introduction is a research in progress section where we explain the work performed prior to the implementation and evaluation phase, which is the main focus of this article. The next section investigates the materials and methods; the methodological approach used in this research is explained. Additionally, we describe how the use of action research fits into this context. Next, results from the cyclical action research process are first presented in Section 4 (how the action research was conducted) and further discussed in Section 5 (how the action research worked). Then we present some impacts on the method and finally, we have the conclusions and additional work section where conclusions and proposals for future work are presented.

2. RESEARCH IN PROGRESS

Although several instructional design methods exist, there is still need for improvement (Gagné & Wager & Golas & Keller 2005). The method developed in our project targets the design of customized e-learning for corporate clients and the use of concurrent design principles (Bandecchi & Melton & Gardini & Ongaro 2000) in this context. We claim that design research (Reeves et al. 2005) is utilized since we have a long-term project (several years), use different research methods to suit the needs of the work toward different objectives, and have a focused attention on dissemination. In this research in progress section, we intend to briefly summarize the work conducted before the introduction of the action research based implementation and evaluation, which is the main focus of this paper.

Initially, we used a mixed method approach (Creswell 2003) and conducted both qualitative and quantitative analysis in relation to two specific e-learning projects. This revealed the need and initialized the development of a new method for the design of customized corporate e-learning, which could leverage existing instructional design methods as well as the principles of multidisciplinary collaboration from the concurrent design methodology (Strand & Hjeltnes 2009).

Next, we conducted design science (Hevner & March & Park & Ram 2004) and developed the first version of the new Concurrent E-Learning Design (CCeD) method, as the main artifact. The CCeD method was described along six dimensions. These dimensions were: (1) the process which is materialized as a process-document indicating the focus as CCeD-projects progresses, (2) the roles materialized as a list of needed roles with corresponding responsibilities, (3) the models including the instructional model, the knowledge model, the technical delivery model and the business model, which together make up an integrated model for the e-learning design, (4) the tools including mind-map templates for each model and a secure online workspaces for collaboration purposes, (5) the facility which is realized as a physical room with necessary technical equipment, and (6) the infrastructure that includes a secure online workspace for the exchange of project information, documentation and other resources among project participants (Strand & Staupe 2010).

We then started the research design processes for the implementation and evaluation stages of the CCeD method. All seven design-science research guidelines from Hevner et al. (2004) were considered when the CCeD method was developed. However, Guideline 3 concerning design evaluation and Guideline 5 concerning research rigors, required the artifact to be implemented and tested in its intended environment. It was in this context we wanted to take advantage of action research and in particular the principles of canonical action research from Davison & Martinsons & Kock (2004). Design science has much in common with action research, and this was confirmed by the similarities in the fundamental characteristics of action research and design science as highlighted in Järvinen (2007). However, we also experienced they complement each other well in terms of using action research for evaluating the utility, quality, and efficacy of the artifacts that are developed and described during the design science process.

3. MATERIALS AND METHODS

The development of the CCeD method was carried out by a project team of six people. This was two assistant professors and one associate professor from the Faculty of Informatics and E-Learning at Sør-Trøndelag University College, one associate professor and one PhD-candidate from the Department of Computer and Information Science at Norwegian University of Science and Technology and one associate professor from the research foundation TISIP. The project's funding partner was the Norway Opening Universities (NOU 2010) and there were several companies (see Section 3.1) that worked as partners when the new CCeD method was tested and evaluated in specific projects. All the six who participated to the CCeD method development have extensive experience with development and delivery of educational deliveries and e-learning, and this project team began by developing and documenting the new CCeD method. This was manifested by a process description for the development of customized corporate e-learning designs, the definition of appropriate roles with associated responsibilities and authority for the e-learning design process, the specification of templates for the sub-models that together made up the entire e-learning design, the establishment of a facility containing needed software tools and hardware equipments for the design sessions, and the specification of an infrastructure for collaboration and information sharing between all project stakeholders (Strand et al. 2010). On the basis of this manifest the project team started to spread information about the CCeD method. The aim was to enter into an agreement on specific test projects so that the CCeD method could be used, evaluated, and improved based on real experiences.

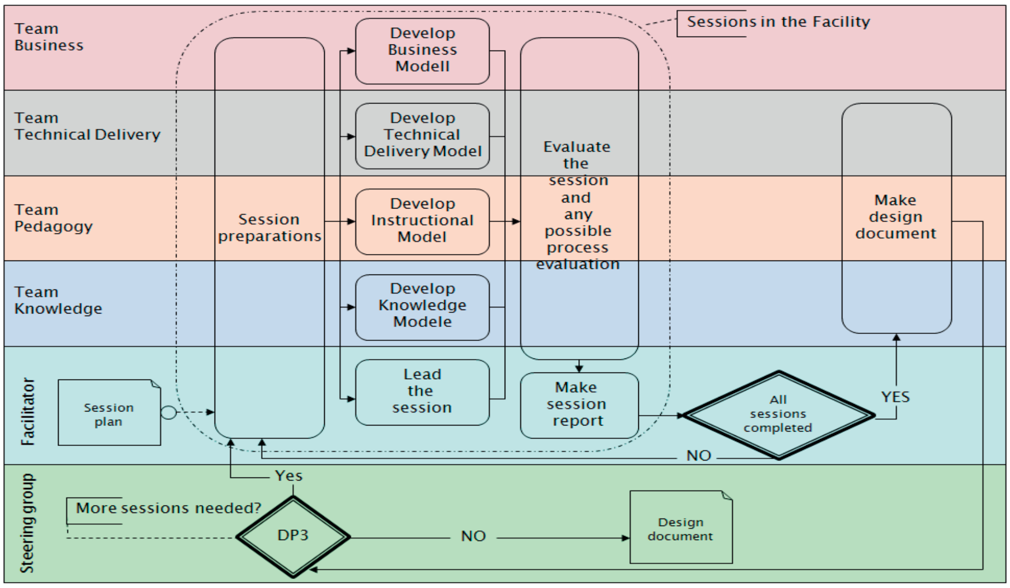

Fig. 1 – The execution phase of the CCeD process

Figure 1 explains some key aspects of the CCeD method at a general level. The figure shows the execution phase of the process and Strand et al. (2010, p. 4072) has following explanation to the execution phase: This phase is regarded as the core of the CCeD method, since concurrent e-learning design sessions are planned and executed here. The session schedule will vary between different projects, but we have chosen to define a directive schedule, containing a session plan, which includes five sessions with approximately 3.5 hours duration and a minimum of one week intervals between them. In each of these sessions different aspects of the four sub-models (*Instructional Model, Knowledge Model, Technical Delivery Model and Business Model*) evolves in parallel. The following list shows the area of focus for each of these five sessions:

- *Session I – What is the situation;* A situation analysis about the current situation in relation to instructional schemes (*Instructional Model*), knowledge aspects (*Knowledge Model*), technological aspect (*Technical Delivery Model*), and financial and administrative issues (*Business Model*).

- *Session II – What possibilities exist;* A study of possibilities in relation to each of the four sub-models where the purpose is to describe a wide range of possible solutions for the e-learning design.
- *Session III – Selection of solutions;* An evaluation of the possibilities and selection of solutions for each sub-model, which we choose to bring forward and use in the current upcoming e-learning delivery.
- *Session IV – How the solution should be designed;* A detailed preparation of the e-learning design where the delivery is organized, e.g. in what order instructional activities will be carried out (*Instructional Model*), in what order appropriate learning material will be presented (*Knowledge Model*), how the different technical solutions should be designed (*Technical Delivery Model*), and how economic models and administrative solutions should be implemented (*Business Model*).
- *Session V - Completion and implementation planning;* To complete the design model for the entire e-learning delivery and make plans with respect to the development and delivery, e.g. who should do what, when will it be done and what resources are needed.

Figure 1 also shows that design documents developed in CCeD projects consists of four sub-models. It is essential that these cover different areas and that they are developed in parallel. In Strand et al. (2010, p. 4073) we find the following information about these sub-models:

1. *The Instructional Model* – detailing pedagogical activities or learning events that students and instructor(s) should conduct in connection with the course and relevant resources in this context.
2. *The Knowledge Model* – that contains the learning content and objectives, i.e. the kind of knowledge, skills and attitudes the students should acquire.
3. *The Technical Delivery Model* – containing an overview of how the technical delivery will take place, and what technologies and tools that will be used in connection with the deliveries.
4. *The Business Model* – that describes economic conditions, i.e. costs and incomes, intellectual property rights (IPR), any agreements that must be entered into, administrative guidelines and requirements in relation to the delivery timing, needed resources, etc., for the upcoming e-learning delivery.

3.1 Implementation and Evaluation through Three Different Projects

To test the CCeD method thoroughly and form a basis for improvements, we entered into agreements with three different projects. These projects aimed to develop new educational deliveries and eventually use the CCeD method in this context. At the same time, it was also important that the objectives and the size of these projects were different, because it enabled us to test various aspects of the CCeD method.

The objective of the first project was to design a new subject within computer supported cooperative work for bachelor level students on campus. Five people from the CCeD method project team had mentoring roles in this project and collaborated with five colleagues from Sør-Trøndelag University College. These five participants were three associate professors and two assistant professors and they were challenged to play the following roles in the project: (1) pedagogical expert – one associate professors that worked with the Instructional Model , (2) expert on computer supported collaborative work – one associate professors that worked with the Knowledge Model , (3) technical delivery experts – two assistant professors that collaborated about the Technical Delivery Model, and (4) business expert – one associate professor that worked with the Business Model. This means that a total of ten people completed five CCeD sessions as part of the first project.

The objective of the second project was to design a new subject within the area of service management for some selected companies in the Ytre Namdal region in Norway. These companies were Norsk e-læring, a division of Ytre Namdal upper secondary school and the five partners; Telenor, Gothia, Aktiv Kapital, Manpower and Lindorff. Six people from the CCeD method project collaborated with three customer representatives in this project. Two of those came from Telenor and the third came from Norsk e-læring. Together these customer representatives covered the project's needs and contributed to the development of both the Knowledge Model, the Instructional Model, the Technical Delivery Model and the Business Model. A total of four sessions was conducted in the CCeD facility, and we had to conduct one morning and one afternoon session on the same day to reduce participants' traveling time. The fifth final session was not conducted in the CCeD facility, but replaced with traditional meetings to complete the models and the final learning design. This was planned from the start of the project to reduce the participants' travel.

The objective of the third project was to design a new course regarding the Framework for ICT Technical Support (FITS). FITS was owned by Becta, which led the national drive in the UK to inspire and lead the effective and innovative use of technology throughout learning (Becta 2010). However, while our project was ongoing the British government decided to close down Becta, and FITS was transferred into a self-funded model called The FITS Foundation (FITS 2010). In this project we have collaborated with the Norwegian *Senter for IKT i utdanningen,* who have the rights to spread FITS in the Norwegian market. We were five people from the CCeD method project that collaborated with eleven client and customer representatives, meaning that a total of sixteen people were involved. The reason the number of people expanded was that several representatives from the client (*Senter for IKT i utdanningen*) and the client's customers (one municipality and one county) wanted to participate. The CCeD method is flexible in relation to the number of participants, and this project would also have worked well with a few people, given the necessary competencies. In this project we also experienced changing objectives and, consequently, a need for adaptive adjustments. The first three sessions went more or less as planned, and then some adjustments were made because we gained access to various materials from The FITS Foundation that could be adapted and reused in the new course. This meant that the focus changed from designing a complete new e-learning course to adapting an existing classroom based course, and additional CCeD sessions were thus not required.

3.2 To Complete Design Science Artifacts with Action Research

Design science principles (Hevner et al. 2004) were used when the CCeD method was developed, but, as mentioned above, we could not vouch for the method's utility, quality and efficacy, since we had not tested the method in real projects. Introduction of a new method such as CCeD at an educational institution is somewhat of an organizational change where action research might fit the purpose.

Action research brings the research and the use of research results together in a process where external scientific observers are not necessarily present, since the researcher usually is an active participant in the research program. Action research is a systematic and reflective study of some actions and the effect of these actions on the organization. The researcher examines the ongoing work and looks for possible improvement opportunities as well as searching for evidence from several sources as a tool to analyze the actions carried out. The researcher acknowledges his own subjective view, but seeks to develop an understanding of the events based on multiple perspectives. They use and render the collected data in a way so that it can be shared with the participants. In turn, this forms the basis for a reflective phase where new plans in relation to actions, activities, and measurements for the next implementation cycle are designed. Action research is a methodological approach where practice learning by working through a set of reflective phases, contributes to the development of personal customized expertise. Over time, a deeper understanding within areas such as organizational processes, stakeholder collaboration, and utilization of models, methods and tools is developed and forms the basis for new improvements (Susman & Evered 1978, Baskerville & Pries-Heje 1999, Davison et al. 2004). In this way, action research can be considered as an extension to the design science process, and an aid in relation to evaluation and improvements of new artifacts like the CCeD method.

3.3 Techniques for Data Collection

A well-known cyclical process of action research was first described in Susman et al. (1978) and the following steps are central in this process:

1. Diagnosing – To make a diagnosis in relation to the organizational situation and determine the nature of the problem.

2. Action planning – To plan what actions one should perform and how the problem should be solved.
3. Action taking – To carry out certain real actions as planned so that the consequences can be checked.
4. Evaluating – To study the consequences by evaluating the consequences of certain actions.
5. Specifying learning – To identify and specify general findings and general learning for future implementation.

In the cyclical process model used in our project up to five working sessions for each project were carried out. For each of these the action planning, action taking and evaluation steps were conducted. This means that we first planned what to do and which deliveries to produce for each session. Next the sessions were conducted in relation to the plan, and finally the end of each session was used to evaluate the results in plenary. All these steps are considered as important data collecting activities and we used audio recordings (Dictaphone) to store these data for future investigations. Furthermore, we used questionnaires with a mix of free-response questions, checklists and rated questions using the Likert scale. These questionnaires were conducted online, and the results were processed and distributed to all project participants as text documents. The results of these questionnaires thus acted as important input when the six persons of the CCeD method team conducted evaluation meetings and specified learning that led to method changes and updates. The CCeD method team conducted short evaluation meetings, lasting for a few hours after each session. In addition two full-day workshops were conducted to specify learning and make decisions regarding final method modifications and updates. Participants' own experiences and the results of surveys were extended with the e-learning design models under development. These models always contain the latest documented information with respect to knowledge, pedagogy, technology and business related conditions. In fact, it is the content of these models that ultimately shows how well the CCeD method works, because these models will constitute the final design document for the new e-learning delivery.

4. HOW THE ACTION RESEARCH WAS CONDUCTED

The principles of canonical action research as described in Davison et al. (2004) are intended to be practical and measurable and the associated criteria help assess if the principles are being upheld. The principles and the associated criteria need not be followed strictly, but rather, they should be adapted to the situation. Our approach has been to use these principles as a guide, and in this section we use them as a basis for explaining our results regarding how the action research has been conducted. Therefore, this section consists of a sub-section for each of the five principles from Davison et al. (2004), i.e. the principles of: (1) researcher-client agreement, (2) the cyclical process model, (3) theory, (4) change through action, and (5) learning through reflection.

4.1 Agreements

Formal agreements were established between the action researchers (those who developed the CCeD method) and the clients, which in all three cases wanted a new learning design developed. The objectives were twofold in these test projects since the client's main goal in all cases was to arrive at a good design document while the action researchers also focused on experience and collection of data to help improve the CCeD method. The CCeD method development team was open in that the method was under development and that action research was used to evaluate the method in parallel to the development of the client's learning design document. We relate to the twofold objectives by focusing on both the method and the new product during the evaluation process. Such twofold evaluations were conducted at the end of each working session as well as in online questionnaires answered by participants afterwards. We learned that clients are willing to describe observations regarding the method or process that leads to the new product as long as attention is also directed at the product itself.

We believe the client should know what is expected when an action research project is to be carried out to the greatest extent possible. For the three relevant projects, this includes the following:

- First, the client is made aware of the project's focus in that we are clear on expected input (project directive), the process to be followed (preparation, execution and conclusion phases) and the requirements of the final project delivery (the e-learning design document).
- Second, the project schedule is clearly defined with a series of working sessions where intermediate objectives and intermediate deliveries are defined. In the three current projects we have recommended a session plan with five sessions, each lasting approximately 3.5 hours. The focus areas for these sessions are respectively: (1) situation analysis, (2) study of possibilities, (3) evaluation of the possibilities and selection of solutions, (4) solution design, and (5) completion and implementation planning.
- Third, the roles and the associated responsibilities and authority were defined in advance so that all participants knew what would be expected of them during the working sessions. In the current projects the client's roles were related to: (1) the content (subject matter experts), (2) the pedagogy (instructional designers), (3) the technology (technical delivery experts), and (4) business matters (business experts). Specialized roles such as facilitator, session secretary and project manager were conducted by participants of the CCeD method development team.
- Fourth, all participants need access to the project infrastructure and necessary tools while the project is in progress. In this context, we used cloud computing services (Mindjet Catalyst™) where necessary tools and produced data were always available over the Internet. This worked technically well both in and between the working sessions, but we also discovered that our mind map templates were not optimal and consequently that it is appropriate to consider alternative tools in this context.
- Fifth, the customer must be aware that they are part of a research project and therefore realize the importance of formative and summative evaluation. It is always important to perform formative evaluation for products under development. Likewise, it is equally important to evaluate the process and the method used to develop the product in an action research context. Even if the customer has no interest beyond the product itself, they must contribute to the method and process evaluation, when participating in an action research project. The client must know that research is part of the program and that surveys in connection with each session and possible follow-up interviews, therefore, must be expected. Our impression is that this goes well if it is on the agenda from the beginning and expressed in writing in the contract or other steering documents.

4.2 The Cyclical Process Model

Although the cyclical process model of action research from Susman et al. (1978) can serve as a good guide, justified deviations could also be made. Challenges with respect to the twofold objectives are also well known among other action researchers. These challenges include customers who are concerned with the product while the researchers also are concerned about the process and method that leads to the product. In McKay & Marshall (2001) this is referred to as the dual imperatives of action research and a dual cycle process for action research is presented. In this dual approach the problem solving interests (about the product) and research interests (the method and the process) are depicted as two processes operating in tandem with one another. Nevertheless, the following figure (Fig. 2) focuses on the action research used to improve the CCeD method, and the figure contains little information about the product (the new e-learning design) under development.

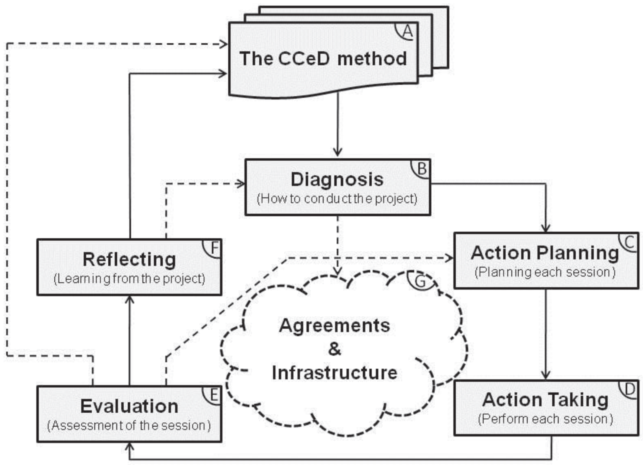

Fig. 2 – The cyclical process model used

The purpose of Figure 2 is to form a basis for the explanation of the cyclic process model approach in our project. The boxes in the figure are marked with letters that are repeated in the following text:

The CCeD method (A) is an artifact from a design science project, and one of the main aims of the action research project was to test this artifact in an organizational context. In this way the CCeD method (A) works as a central input to the project. Furthermore, the method is updated based on evaluation activities that take place after each session (E) and reflecting activities (F) that are intended to specify learning based upon extracted lessons from experiences. This means that an updated and improved CCeD method (A) results from the project together with the product developed, i.e. the new e-learning design document.

Diagnosis (B) to identify or define the problem is traditionally the start and the first phase of action research projects. In our project this phase becomes somewhat special, because the new method was described and about to be tested, and much of the diagnosis had been made as part of this preparatory work. However, we must make diagnoses in relation to the project we intend to start. Typically, this is about the establishment of a dialogue with the client, to get a common understanding of the requirements such as purposes and objectives plus scope, time, and cost constraints. In turn, this is used to establish formal project documents (project plans, contract agreements, etc.) and an appropriate infrastructure for the project.

Our action planning (C) mainly consisted of preparation for the working sessions. In accordance to the CCeD method, each session was planned with: (1) time, place and participants, (2) overall objective of the session, (3) the preparatory work, (4) deliverables to be produced, and (5) the tasks to be performed in the session. These tasks vary in relation to the roles (subject matter experts, instructional designers, technical delivery experts and business experts) and the different templates indicate which questions are to be answered by the respective roles and as part of the model they are working on.

Action taking (D) in this context describes the carrying out of each session with all parties involved. The facilitator is particularly important when CCeD sessions are conducted since this person coordinates the work performed by the other resources. The facilitator should strive for a balance between plenary activities and group activities with the aim of reaching good interdisciplinary solutions that take all needs into account. Moreover, the session secretary also fills an important role during these sessions. This person will typically ensure that all decision points and all actual decisions are recorded and made available for the rest of the project.

The evaluation (E) that takes place after the action taking step (D) is twofold. First, the end of each session is used for plenary evaluation. Here the achieved results are presented while both the processes and the product are discussed and evaluated. Secondly, online questionnaires were developed for each session, and all participants had the opportunity to answer these. Although the results of the evaluation phase most often is input to the reflecting phase (solid arrow), we also had examples where these evaluation results directly affected the action planning for the next session or caused a direct update of the CCeD method (dashed arrows). In this way the entire project team including client representatives, is involved in making changes and improvements that are implemented and tested by the first and best opportunity.

The reflecting phase (F) can be regarded as a more thorough evaluation where learning is specified and the model is updated (solid arrow). We conducted workshops in the CCeD project team (clients did not participate), and the main purpose was to generalize on the basis of gained experience and to update the CCeD method on this basis. Input to this reflecting phase can be the results of surveys or evaluation notes, but also the design document under development. Evaluations regarding strengths and weaknesses of the produced design can typically help to get a more appropriate focus for the next project implementations. Although the results of the reflecting stage can influence an ongoing project (dashed arrow to the diagnosis), it is the update of the CCeD method that has been most important for us.

Agreements and infrastructure (G) are regarded as a central core in canonical action research projects, and this was also true for our project. It symbolizes the client agreements as well as the equipment and infrastructure needed to perform the project. Consequently, this supports all phases (B to F) that the projects must go through. The first principle of canonical action research, i.e. the principle of researcher-client agreement (see Section 4.1), is also devoted to this topic.

The questionnaires used in the three projects are not directly stated in Figure 2, but they have contributed substantially to the data collection. The questionnaires have mainly been threefold with questions concerning: (1) how the session preparations worked (action planning), (2) how the session implementations actually went (action taking), and (3) how the session conclusion worked (evaluation). Within each of these three question categories, the respondents had to answer some closed questions with alternatives and some open questions where free-response was demanded. In this way we obtained the respondents views in relation to some selected areas (e.g. how the different templates work in a specific session) while we also captured their general opinions by the use of free-response questions. In addition to the threefold division, we also asked questions that helped categorize the participants and this was the first part of the first questionnaire. For the first project ten people responded to this survey, and through these responses, we received relevant information about the respondents. For example, 90% had more than five years of experience in educational activities and teaching, 80% had previously been involved in the development of four or more educational programs, 90% were in complete agreement that they had good experiences with the development of online courses, and this increased to 100% when we asked about the development of campus courses.

4.3 Theory

In accordance with the principle of theory, action researchers should rely on existing theories to guide and focus their activities. In our project, much of the theoretical foundation was incorporated into the CCeD method which was developed in advance. The CCeD method is actually a mix of instructional design and concurrent design, and hence it includes theories from these two disciplines. For example, different learning theories exist (such as behaviorism, cognitivism or constructivism) that affects how learning designs are created and implemented. These and other theoretical foundations are integrated into the CCeD method, mainly in two ways: First, the process itself is described on the basis of available theories of instructional design and concurrent design processes. This helps us focus right through the project and it helps to get things done in an appropriate order. Second, the templates contributes that theoretical considerations from the relevant disciplines are covered. Here are a few examples from each of the four sub-models: (1) The instructional model template contains information about learning activities, formative assessment and summative assessment, (2) the knowledge model template contains information about learning outcomes and classification systems to be used in this context, (i.e. the categories of learning by Robert M. Gagné), (3) the technical delivery model template contains some best practices in relation to technical delivery, (i.e. principles for selection of media, media types, etc), and (4) the business model template contains elements from the Business Model Generation by Alexander Osterwalder and Yves Pigneur. These theoretical foundations were also an integrated part of the discussion when the evaluation and reflecting activities took place.

4.4 Change through Action

In connection with the change through action principle, we understand that both the action researcher and the client must be motivated to improve the situation. This means that they must agree on what actions to be performed, when it should happen and what results they are trying to achieve.

In our test projects, we absolutely had changes through actions. First, the project itself, where we aim to implement and test a new e-learning design method, is about introduction of changes through actions. Second, we attempted to modify and improve the working sessions as the project progressed. An example of this was the increased attention to decisions. It emerged that decisions should be lifted during the working sessions, discussed in plenary, and documented in project documents available for all participants. However, we did not particularly involve the client when such modifications were discussed. This is due to the twofold objectives in our test projects. We experienced that the client was concerned with the product under development, while these changes (change through action) in the first place cover the method or process (CCeD) with which the action researchers are most concerned.

4.5 Learning through Reflection

Learning through reflection by explicitly specifying the learning achieved is regarded as one of the most critical activities in action research (Davison et al. 2004). This can be achieved if the researcher conveys status along the way, and if achieved learning is immediately specified when it occurs during the project.

In our test projects we have addressed this issue, but it can certainly be improved. At the end of each session the team performed evaluations and each participant was given the opportunity to reflect on achieved results by answering online questionnaires. Furthermore, we have more deeply specified learning by conducting workshops where the purpose was to reflect in relation to gained experiences and to make CCeD method updates based on this. In this way, we claim that we have made reflections and collected data, but, unfortunately, we have not described what we actually have learned and should build upon sufficiently and we have not always communicated the learning to all relevant stakeholders. The results of the surveys have been communicated to everyone, but in raw data form. This means that the main points and the achieved learning have not always been extracted and specified explicitly during the projects.

5. HOW THE ACTION RESEARCH WORKED

The action research has primarily contributed to the formalism and served as a guideline in relation to how the work was planned and performed in our projects. In this section we discuss how action research works when a new artifact such as the CCeD method is introduced in an organization.

The first principle of canonical action research by Davison et al. (2004) deals with the agreement between the researcher(s) and client(s). These agreements should provide a basis for the project work and collaboration between the different stakeholders. We also experienced that this is important and there are especially two aspects we want to highlight in this context. First, all parties involved must be informed that they are participating in an action research project and that this includes the use of time on the research process. Activities such as answering questionnaires, participating in evaluation meetings, and being interviewed are necessary, and such activities should definitely be agreed upon in advance. Second, it is good to know as much as possible regarding the customer's requirements and expectations before the project starts. The more that is agreed upon in advance and the more thoroughly it is described, the easier it is to implement the project. Therefore, the project directive or similar documents should always be filled out as thoroughly as possible in the beginning of the action research project.

We consider the second principle of canonical action research (the cyclical process model) from Davison et al. (2004) as the most important principle. This is also a direct continuation of the cyclical process model first presented in Susman et al. (1978), and we would argue that this principle actually contains more of the other principles. This is because the researcher-client agreement is in the center of the cyclical process model, change through action is partly covered by the action planning, and action taking stages while learning through reflection are partly covered by the evaluation and reflection stages. This means that only the principles of theory are not directly related to the cyclical process model. However, since the actions should also be supported by well-known theories, one can argue that the principle of theory is also included in the cyclical process model.

In our project the cyclical process model has worked well with some minor adjustments. Much of the diagnostic work was done in advance when the CCeD method was developed, but still we had an initial diagnosis phase in connection with each project agreement signed with various clients. Thus, the diagnostic work primarily focused on the new product to be made. Furthermore, client representatives received an introduction to the process and the method (CCeD) to be used. This was perceived as positive, and most participants reported that they were reasonably well prepared for the first sessions.

The three steps: (1) action planning, (2) action taking, and (3) evaluation proved to fit very well with the working sessions in the CCeD method since these sessions had to be planned, implemented and evaluated in turn. This might mean that the CCeD method was particularly well suited to be introduced by using action research. Our experience with the planning, execution, and evaluation of sessions was reasonably positive in this project, and we would argue that our consciousness about action research has been of great help in this context. The fact that we plan what to do, implements in accordance to this plan, and conduct evaluations afterwards, implies that we have gained a solid foundation for assessing what works well and what does not work well. This is in turn a solid basis for identifying general findings and specifying learning.

Specific workshops were organized with the aim of specifying learning and in turn updating the CCeD method. In these workshops, we were able to reflect on the projects (what has happened so far, what is produced, what feedback is given by the participants, etc.) and to compare these reflections to the CCeD method and relevant theories. We found that the group quickly reached consensus in some areas, but also that there were agreement difficulties in other areas. In this context we believe action research can be of great help. It is sometimes easier to agree on a few new actions to be tried out rather than to agree on final changes in a method. When these new actions have been through parts of the cycle (action planning, action taking, and evaluation) we will typically have a better basis for making permanent changes in the method.

Collection of data is relevant in any research project, and it is appropriate to use different techniques to collect the most pertinent information. The cyclical nature of action research results in much data, and it is important to document most of this while the project is ongoing in order to avoid oversights. In our projects we should have documented more in writing than we actually did and also used more time to write down the main points from the recorded audio files along the way. However, we are pleased with the use of online questionnaires and we especially recommend using some open questions to help collect information that might be otherwise impossible to collect. Through the use of open questions we raised issues regarding, for example, who should arrange for coffee, meals, etc. during the working sessions and this would probably not have been caught using other style questioning. This example may not sound particularly relevant; however, it is really important to have access to food since the working sessions are intensive and last for approximately 3.5 hours. It is important to work intensively and without common breaks in these sessions, and each participant should be able to replenish energy as needed.

Some of the most important things we have learned in this project are that we must deal with the changes that occur, and, consequently, we must expect to adjust our action research plans as the project progresses. As mentioned above, we tested the CCeD method in three different projects. The first project was accomplished without any major deviation from the original plans, while some significant changes were undertaken for the last two projects. This tells us that e-learning design methods must be dynamic and flexible so that they can function even if the conditions change. Moreover, it indicates that the research approach must be adapted and adjusted as the project progresses. For action research projects this is about planning how to do something, before actually doing it. Sometimes this planning occurs just before or perhaps simultaneously with the execution. In such situations, one can easily implement changes even if they are not planned and documented, but this is not recommended. Our experience shows that it is more difficult to evaluate and specify learning if we are not thorough enough in documenting plans from the onset. This means that we must be prepared to re-plan the actions during the project.

6. IMPACTS ON THE CCED METHOD

Although the main focus of this article is to convey how the action research has worked, it is also natural to discuss how this work has impacted on the method. In Strand et al. (2010) the CCeD method is presented with the following six elements: (1) The CCeD process, (2) roles, (3) models, (4) tools, (5) the facility and the infrastructure, and (6) the concurrent e-learning design sessions. By carrying out the three projects we discuss in this article, we have gained experience with all of these six elements. Some of these experiences have led to direct changes and updates in the method, while other experiences have made us aware of conditions that we should consider to improve at a later time. Here are some of our observations in relation to the mentioned elements:

- The CCeD process has generally worked well and we believe that we only need to adjust the session plan and what should be the focus area of each working session, when session plans for new projects are established. The biggest change we have implemented in relation to the process is that much more work must be done between the sessions and the participants must devote more time to prepare well before each session.
- A challenge we have experienced in relation to the roles is that we have not always had experts for each model (*Instructional Model, Knowledge Model, Technical Delivery Model and Business Model*), but several participants with some experience within several domains. However, in one particular project the customer represented expertise both within the business area (*Business Model*), the subject domain (*Knowledge Model*) and technical delivery *(Technical Delivery Model*). These experiences have taught us that we should cultivate the roles and specialized competence, also in future projects, since it is important to have real experts which are responsible for the decisions regarding each sub-model.
- The models and the tools interfere with each other since the models are realized with templates developed in the tool (MindManager© from Mindjet®). It was within this area we made the most significant changes during the project. The structures of the models were altered so that participants could more easily gain insight into other sub-models (the contribution from the other project participants). As an example of this we changed from using one template for each of the four sub-models into a single template that contained all models. Furthermore, we started to identify general requirements for new tools, specially designed to support the concurrent e-learning design method. In this context it is challenging to determine which theoretical models we should incorporate, how the system should be organized, how to support collaboration in and between working sessions in a best possible way, etc., and further work is necessary to deal with this. Furthermore, the importance of each model varying from project to project, which also affects how the projects are staffed. For example in some projects the business model or the technical delivery model are defined in advance so that we need minimal time to ascertain how it should be, while in other projects we need to develop these models from scratch.

- The facility and the infrastructure were basically kept unchanged through the three mentioned projects, but still we identified a need for changes and improvements. This was small things like for example placement of people in the room, furniture design (it should be possible to look above the screens over the table), the usability of technical devices that must be good so that the facilitator for example easily can show any computer desktop on any screen in the room and so that participants can easily find relevant project information. All these elements should contribute to improved cooperation and communication among the participants, both in and between the working sessions.
- The concurrent e-learning design sessions are very important since this is where the interdisciplinary cooperation takes place. The facilitator plays a central role as a session leader that contributes to the exchange of necessary information between all parties involved. In addition, the session secretary has an important role, responsible for documentation of decisions accomplished during the session. During the three mentioned projects we have completed twelve CCeD sessions in our concurrent design facility and this has given us a good basis for describing how such sessions should be conducted.

7. CONCLUSIONS AND ADDITIONAL WORK

The principles of canonical action research have been helpful in our project. Even though we argue that most of the principles actually are covered by the cyclical process model we will argue that the division into five principles, like we have seen in Davison et al. (2004), helps us to focus properly. Therefore, we believe we can continue to use action research in this manner when new artifacts like methods, processes or the similar are introduced and adapted into an organization.

The principles of canonical action research act as a good guideline when projects are to be planned, but we must also take upcoming changes into account. We must be prepared for changed plans and we must be able to continue working with both research and product development, even if some assumptions are changed. Furthermore, we should use several techniques to collect data while the projects are running. Our experiences with the online questionnaires are good since they provided us with useful data. Nevertheless, we should have done more in terms of documenting what occurs during evaluation meetings, utilizing the audio files, preparing reports that summarize the experience gained thus far, and following up with interviews of the participants.

We should have done more to systematically collect data during the project, and, in addition, we could have done more to analyze the collected data. In this context we believe grounded action research (Baskerville et al. 1999) is suitable. It is especially true when evaluating and specifying learning that the principles from grounded action research might be appropriate. Data from questionnaires, surveys, observations, interviews, etc. may then be encoded in accordance with the coding procedures called open, axial and selective coding. “Integrating grounded theory techniques into action research […] involves integrating certain grounded theory activities in the phases of action research primarily in two ways. First, grounded theory notation (e.g. memos and diagrams) is used to represent the theory-data during the action research cycle. Second, grounded theory coding becomes the essence of the evaluating, learning and diagnosis phases of action research” (Baskerville et al. 1999, p. 8).

In summary, we want to use canonical action research in similar projects in the future. In addition, we must take into account changes in the project. Additionally, we should utilize several data collecting techniques and try out how grounded action research can be of help in relation to data analysis, evaluating, and specifying learning. Furthermore, it is natural to mention that an improved method for the design of e-learning is our main objectives and not the action research in itself. Research methods and the use of action research when the CCeD method is introduced in its target organization is the main focus of this article, but a smaller part of the CCeD method development project. In our further work we will typically improve selected aspects of the CCeD method. Can we for example better involve the customer via net-meetings and how should we finalize a complete e-learning design that includes all four sub-models most effectively? To deal with such questions we are considering a study of how the use of different software tools can help improve the CCeD method, so that e-learning designs of good quality could be developed effectively and efficiently.

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Paper 5
Prescriptive Approaches for Distributed Cooperation

Authors: Knut Arne Strand, Arvid Staupe and Geir Magne Maribu.

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Prescriptive Approaches for Distributed Cooperation

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Abstract: Today, there exists a wide range of computer tools that can be used to facilitate distributed cooperation across organizations and countries. In this article we present prescriptive approaches for a kind of distributed cooperation which we choose to call distributed concurrent design. This approach is based on industrial concurrent design and computer-supported cooperative work, and we draw particularly on communication, collaboration, coordination, and awareness as key components and a platform for applicable distributed cooperation. We argue that cooperation is made up of communication, collaboration, and coordination, and that awareness is important for the interaction between these components. We describe these four components in detail and outline a plan for the development of a framework for establishment of such distributed environments. The article is based on an ongoing R&D project in which distributed cooperation among several European partner institutions is a key issue.

1. Introduction

Those who succeed with efficient and productive computer-supported cooperation will create results that are not independently obtainable, since synergy usually arises when people with different, complementary skills cooperate. The research field of Computer-Supported Cooperative Work (CSCW) emerged from Irene Greif's and Paul Cashman's workshop in 1984 (Crabtree, Rodden & Benford, 2005). CSCW was based on computer-mediated communication and technologies, such as the time-sharing operating systems that were developed in the 1960s and the experimental ARPANET developed in 1969, which was also the platform for the very first version of the network-based email designs we use nowadays (Schmidt 2009). The research field of CSCW has since become large and extensive, and it covers great many aspects of computer-supported cooperation. During the last decade we have seen organizations emerge which are based to a large degree on cooperation technologies. Virtual organizations, networked organizations, and extended enterprises are examples of common working environments where the utilization of different forms of cooperation technology is of crucial importance. These environments can manifest as large cooperative projects, such as the development of Wikipedia, or joint development of software within a group of peers, such as Open-Source Software (OSS) development projects. Within such projects, thousands of participants practice truly distributed cooperation with solid requirements for cooperation technology and project organization. Benkler's Commons-Based Peer Production (CBPP) framework (2002) is an important contribution in terms of explaining how the creative energy of a large number of participants is coordinated into cooperative projects which are often without traditional hierarchical organization and common financial compensation (Hilgers, Müller-Seitz & Piller, 2010).

Despite their widespread use, well-known CSCW researchers like Kjeld Schmidt (2010) claim that the great potential for development and utilization of cooperative work technologies has only occasionally been exploited, and that the reason is we do not really understand what cooperative work and its coordination are all about. The motivation behind this article is to outline an approach to distributed cooperation in which a few selected academic organizations provide resources to common projects, with the support of appropriate cooperation technologies. We refer specifically to a traditional EU project: an R&D project with support from the European Union. The project joins seven partner institutions in six European countries with a total of 19 participants, and the schedule indicates that the project team will work together for approximately two years. This means that this particular project is relatively small and manageable. However, there are numerous projects that are comparable in terms of budget, staffing, duration, and results, and it is very likely that these projects can achieve great benefits from efficient and productive computer-supported cooperation.

Nowadays, cooperation technology (i.e., hardware and software solutions that facilitate teams working together over geographic distances toward common goals) is widely used, and both commercial and free solutions are available. A wide range of tools can be used to support various forms of interaction between participants who are spread across organizations and countries. A wide variety of cloud computing services (Armbrust et al., 2009) are available; several of these help us to create arenas easily for different kinds of distributed cooperation between actors which can be located anyplace where Internet access is available. Although we have good access to various forms of cooperation technology, it is not obvious how this technology should be used. It might be challenging to figure out which tools are best suited for diverse purposes, how cooperation processes should be organized, and how different participants should interact within the communities that are established.

In this article we present prescriptive approaches, i.e., recommendations and guidelines, regarding how such projects should be conducted. We base these recommendations on documented research in CSCW, as well as our own research and experience with the application of concurrent design of customized e-learning for corporate clients (Strand & Staupe, 2010). Furthermore, these recommendations are adapted to suit the parameters of the above-mentioned EU project in order to come up with a design document to adapt an existing e-learning course to four new countries and a business model that define the possibilities and constraints within the respective countries.

Following this introduction is the research methods and materials section, where we briefly explain how data was collected and how we relate it to specific research guidelines. Then we have a literature review section that highlights relevant themes from the CSCW field that we should take into account when we aim to identify prescriptive approaches for distributed cooperation. Next is a section that briefly explains how concurrent design might be realized. Then, the prescriptive approaches for distributed cooperation are presented as recommendations and guidelines that are grounded in communication, coordination, collaboration, and workspace awareness. Finally, we have the concluding remarks section, which presents conclusions and suggestions for further work.

2. Research Methods and Materials

The motivation behind this study is to figure out how today's easily available cooperation technology can be used to implement distributed synchronous and asynchronous cooperation across organizations and countries. We want to provide recommendations and guidelines from which all parties can benefit when an environment for this kind of distributed cooperation is to be established. In turn, this can serve as a platform for a framework with detailed recommendations regarding the implementation of applicable distributed cooperation, as well as requirements for new cooperation technology solutions. Our project used distributed cooperation to identify and describe different requirements regarding e-learning delivery. However, we believe this has much in common with modern knowledge work in general and that the recommendations we present can therefore be used in many different projects.

The methodological approach used is qualitative, with data collected from two different source categories.

- Primary data were collected from the UnderstandIT project. UnderstandIT is an EU project that belongs to the Leonardo da Vinci Transfer of Innovation program. It is a part of the European Commission's Lifelong

Learning Programme and involves 19 participants from seven partner institutions and six different countries. Currently there have been performed four distributed cooperation sessions in which the whole project team has participated, in addition to some technical sessions in which some participants have focused on testing technical equipment. All of this has given us valuable primary data.

- Secondary data is based on a literature review focused mainly on selected parts of the CSCW research area, in which some of our selected sources are among the most cited researchers.

Design science research guidelines are used in this project; we consider this article to be a report from an ongoing design science project (Hevner, March, Park & Ram, 2004) for the following reasons. First, we aim to produce a viable artifact (i.e., prescriptive approaches which may eventually become a framework for distributed cooperation). Second, we believe this is relevant since the streamlining of distributed cooperation can provide benefits for a lot of projects. Third, the results are evaluated as part of the UnderstandIT project, where computer supported cooperation is a key issue. For example, as part of the UnderstandIT project, we collected oral feedback and online questionnaires after completing each of the four distributed and synchronous cooperation sessions. Fourth, collected data from the UnderstandIT project confirms that the form of distributed cooperation as described and tested in this project works well. Even though we do not consider this to be proof that it makes us more efficient and productive, we take it as an indication that we should continue this work. Fifth, our work is largely based on existing research results (the CSCW literature), while our new contributions (human approaches and technological configurations) are tested and evaluated as part of an ongoing EU project. Finally, we are ensuring the dissemination of results while the work is in progress.

3. The Research Field of Computer-Supported Cooperative Work

Cooperative work is distributed in principle (Schmidt, 2009). It consists of communication, collaboration, and coordination, three functional aspects of cooperation (Fitzpatrick, 2003). In addition, awareness is both important and challenging for cooperative work. It is important when we work co-located, and an additional challenge when we work distributed (Erickson & Kellogg, 2000; Gutwin & Greenberg, 2002; Schmidt, 2002).

The cooperation in which we aim to identify prescriptive approaches is distributed (including participants from several European organizations and countries), with a mixture of synchronous and asynchronous activities. However, we focus mainly on synchronous activities, since we are inspired by concurrent design sessions which are very intensive and in which everyone's presence is essential. In this section we examine whether the CSCW research literature provides experiences that can also serve as recommendations and guidelines for our approach to distributed cooperation. For the sake of space, we will emphasize: (1) communication, (2) collaboration, (3) coordination, and (4) awareness. These four concepts are very important in the CSCW literature and we claim that they are of crucial importance for our distributed cooperation approach. Thus, they are prioritized before other interesting concepts such as shared-context and context-aware computing, common ground, trust, mobility, ubiquitous computing, or social computing. In the remainder of this section, we discuss communication, collaboration, coordination, and awareness in detail.

3.1 Communication

A central part of CSCW deals with computer-based communication between distributed people, with the aim of designing systems that support deep, coherent, and productive communication (Erickson & Kellogg, 2000). It is also important to support informal and spontaneous communication when groups are geographically distributed (Schmidt, 2002). Much communication is informal; creativity often flourishes in informal communication. For communication to work, the systems must offer implicit social translucence and the kind of indirect awareness that we can get from others when we are co-located. To achieve social translucence we need (1) visibility—so that significant information is visible, (2) awareness—so that information about others and what they are doing is available, and (3) accountability—meaning that we understand that we are held responsible for the actions we perform (Erickson & Kellogg, 2000).

A large part of the communication that takes place among knowledge workers is conversation, in which knowledge is created, developed, assessed, and shared between the involved parties. This form of communication is also used as a medium for decision making. Through conversation, we establish a common ground, exchange experiences, interpret what is being said, check that we have been understood correctly, provide new contributions, and make decisions. Furthermore, we should strive to make the knowledge that emerges from conversations reusable. In this way the conversation may be a product that others can use and analyze retrospectively (Erickson & Kellogg, 2000).

It is also important to be aware of implicit versus explicit communication when designing systems for computer-mediated communication (Pipek & Kahler, 2006). Communication is not just a separate activity but also an integrated part of doing the work (Schmidt, 2009). Systems must therefore be designed to support implicit communication, and the participants must utilize the possibilities so that communication becomes a direct contribution to the final product.

3.2 Collaboration

Collaboration is, according to the *Oxford English Dictionary*, the action of working with someone to produce something. Work that involves several people and contributes to the products being developed is therefore essential and the central aspect of collaboration. To carry out this work, computer tools must be used in a way that allows various geographically distributed experts to interact synchronously or asynchronously to produce a joint and comprehensive product. There are a number of collaborative software tools that can be used. Some are specific to particular disciplines, such as computer-aided design tools for product design or editors for instructional design, while others are general and support activities such as collaborative writing and collaborative mind-mapping. It is important to emphasize that the tools we focus on under the collaboration umbrella are not necessarily the ones that will be used for communication and coordination, but rather the tools we use to produce the final product.

Knowledge production takes best place in smaller forums where participants feel safe and want to contribute. On the other hand, we also want to share knowledge at a broader level of the organization. Erickson & Kellogg offer the following insight about this duality: "One resolution to this tension between privacy and visibility is to support an organizational space within which semiautonomous knowledge communities can exist, each community exercising control over the ways and means through which its knowledge is shared with the larger organization" (2000, p. 69).

Many tools can be used to cooperate to reach a common target. When specific products are selected they may be implemented, configured and used in very different ways. The process of customizing tools to a specific situation is often called tailoring (Pipek & Kahler, 2006). The tools must primarily be adapted to different and changing work contexts. Moreover, tailoring can be done jointly to get the tools to suit a particular situation in the best possible way. Collaborative tailoring can contribute positively to the tools that are used, but this assumes that tailoring mechanisms are available and that a culture for tailoring is established in the project organization (Pipek & Kahler, 2006).

3.3 Coordination

Coordination can be defined as interdependent activities or tasks that must be performed by several actors working together in order to achieve a goal. Coordination is regarded as articulation work; this work does not contribute to the final product, but is part of the process that must be followed to arrive at the final product (Schmidt & Simone, 1996).

The work of coordination is to determine the order in which different tasks should be performed, who should perform them, when they need to be done, and so on. Coordination is needed to achieve a productive workflow. Coordination is also tightly connected with awareness of the ongoing activities that constitute a cooperative effort. We become aware of what has happened, what is happening, what should happen, and to what extent this affects us and the tasks we should perform. Actors who are performing interdependent work need to coordinate and integrate their various actions (Schmidt, 2002).

Schmidt (2002) also highlights monitoring and displaying as two complementary aspects of coordination. We monitor our colleagues by observing, listening, and so on, so that we get an overview and are able to adjust our own work and make it fit in with that of others. In addition, we display what we are doing so that our colleagues can become aware of what is being done, how it is done, etc., and use this information to coordinate their own work.

3.4 Awareness

The concept of awareness is very central and important in CSCW research. From the very earliest days of CSCW research, researchers have been concerned with how computer systems can support awareness. Today, however, the concept of awareness is both ambiguous and diluted. Researchers do often use adjectives in front of "awareness" to handle this (Schmidt, 2002). In this study we have done so by focusing on workspace awareness (Gutwin & Greenberg, 2002) which concerns awareness among project participants working in a shared environment or a shared workspace.

The concept of awareness is in itself so liquefied that it is only when we refer to a person's awareness of something that the concept makes sense. Awareness should therefore be regarded as an integral part of the tasks or activities being carried out, so that we know what the actors actually are aware of. The challenge for the actors will be to capture what happens around them and to exploit this in their cooperation (Schmidt, 2002).

Some studies of awareness point out that awareness does not necessarily consist of passively acquired information, but is rather the result of active and conscious actions on the parts of both the observer and those being observed (Schmidt, 2002). The term "social awareness" is used to describe mechanisms which help people adjust their own activities to those of others who are co-located with them. Social awareness is often mediated by the use of social artifacts in a distributed setting (Bardram & Hansen, 2004). This suggests that acts of contribution to and utilization of workspace awareness are skills that can be learned and developed to achieve more efficient and productive cooperation. If we do not manage to take advantage of this, the result is a lack of workspace awareness which in turn is a problem, since the consequences are that we do not know what to do and that cooperation will suffer.

Constraints on the shared workspace are also an important phenomenon. This awareness helps us to exploit the situation in the best possible way within the constraints that exist for us as individuals, for other participants, and for the whole group. It is not obvious which constraints exist in a digital shared workspace, nor how diverse constraints affect different participants. Although this might be a matter of course in face-to-face physical environments, it is not obvious in a shared digital workspace, since equipment and infrastructure can vary between the different sites and participants (Erickson & Kellogg, 2000).

4. Key Contributions Inspired by Concurrent Design

The approach to distributed cooperation for which we aim to provide recommendations and guidelines is twofold. On one hand, our approach is based on theoretical CSCW findings, as presented in the previous section; on the other hand, it is also based on the practical concurrent design experiences we describe in this section.

Our approach to concurrent design is based on the experiences we have had in terms of adapting this methodology to the development of customized e-learning for corporate clients. This means that e-learning deliveries are designed through a set of concurrent design sessions, i.e., cooperation sessions where relevant stakeholders (such as the project managers, facilitators, session secretaries, instructional designers, subject matter experts, technical delivery experts, business experts, customer representatives, etc.) meet for multidisciplinary cooperation sessions in a specially designed room (a concurrent design facility). These sessions are conducted by a facilitator who also contributes to the progression of the projects by ensuring that relevant multidisciplinary discussions are highlighted and necessary decisions are made. Furthermore, the various experts use their computer tools to design sub-models (such as instructional, knowledge, technical delivery, and business models) which in turn are integrated into a unified design model for the entire system (Strand & Staupe 2010).

Very simplified, the practical experiences to which we are referring consist of three main types of work and interactions. These are: (1) project administration and the establishment of a technical infrastructure for cooperation, (2) implementation of specific cooperation sessions with dedicated goals, and (3) preparations and follow-up regarding cooperation sessions. These three aspects of concurrent design are discussed in the following sub-sections.

4.1 Project Administration and Technical Infrastructure for Distributed Cooperation

Project administration will typically involve the project manager and a few selected people from the project team who are responsible for planning how the project should be implemented. This involves determining the project deliveries and their composition as well as decided which experts are needed and which roles they should play so that the expected results can be produced. Furthermore, one must decide when the project participants should meet for cooperation sessions and what the expectations and goals of each session will be. Relevant information for these sessions should be summed up and collected in a session plan that will consequently be important for project coordination.

During the project startup phase, the technological platforms and technological tools to be used in the project must be considered. Once these choices are made, some rules must be defined for how the tools are to be used in the project, and these rules should be communicated to all project participants. Project administrative activities are very important in the project startup phase, and it is important to focus on these coordination activities along the way in order to adjust the project direction and ensure that the team is heading towards the right goals.

4.2 Distributed Sessions

What really distinguishes concurrent design from other forms of cooperation is the implementation of the cooperation sessions. This is a set of synchronous and multidisciplinary sessions conducted by a facilitator where the project participants use selected and customized computer tools to achieve the best possible cooperation. Initially, we experienced traditional concurrent design sessions, in which the participants are co-located in a concurrent design facility and where the necessary equipment is available and suitably located.

In contrast, a challenge and one of the key questions we aim to answer in this study is how these sessions can be made distributed. In this context we have to consider tools that are suited for diverse purposes, how cooperation processes should be organized, and how different participants should interact within the communities that are established.

4.3 Session Preparations and Follow-Up

Although the implementation of cooperation sessions distinguishes concurrent design–inspired approaches from more traditional CSCW approaches, we must also take into account the work that takes place between these sessions. It is when we are preparing for or following up on a session that we really are building the foundation for effective cooperation within the session. Sessions should ideally consist of important and multidisciplinary conversations which lead to decisions that will ensure comprehensive solutions that meet stakeholder needs. To get the correct focus and an adequate level of cooperation, the participants must be well prepared and have the opportunity to familiarize themselves with the themes and issues that are on the agenda for the current session. This means that important coordination work takes place between the sessions, just to be able to exploit the situation when experts actually meet for cooperative sessions.

5. Prescriptive Approaches for Distributed Cooperation

In this study, we have worked to identify prescriptive approaches for distributed cooperation. This methodological approach builds on experiences from computer-supported cooperation and industrial concurrent design. On this basis, we choose to define the term *distributed concurrent design* and put forward the following definition:

> *Distributed Concurrent Design (DCD) is coordinated and multidisciplinary collaboration where different forms of communication are used to develop knowledge and make decisions regarding products under development. Optimal interactions between involved parties, activities, and the artifacts they utilize are important for this to work, and utilization of workspace awareness is important for optimal cooperation.*

Successful DCD has an overall need for communication, coordination, collaboration, and workspace awareness to support the needed interactions between involved people, artifacts, and activities. When we present the prescriptive approaches for DCD in this section, we use separate sub-sections to address these overall needs.

5.1 Guidelines for Applicable Communication

Communication is perhaps the most important element of DCD. Formal communication must be supported so that we can convey formal information about ongoing work, while informal communication must be supported so participants can meet by chance and exchange information spontaneously. Synchronous communication must be supported so that participants can converse during the cooperation sessions and work simultaneously on the same product, while asynchronous communication must be supported so that participants can work on tasks over time. Communications in multiple channels must be supported so that participants can discuss things in common (the whole project team) or in smaller expert groups, whichever is needed. Explicit communication should be supported so that parties can exchange information directly, while implicit communication should be supported to make the communication directly affect the product under development. Implicit communication, such as describing design ideas that occur directly in the design document which all work together to develop, is an effective way to communicate. The communication must support both the work that actually leads to a product and the coordination work which is done to optimize the cooperation.

We need to establish a shared workspace that consists of multiple communication channels to support all these communication needs. The products currently under development must always be available so that participants can contribute to the development at any time and thus communicate implicitly. Moreover, the process itself affords important communication in relation to coordination and workspace awareness. As part of the process, we have tools such as session plans, action lists, and decision lists which can also be considered boundary objects (Star & Griesemer, 1989), and these objects support shared understanding and coordination of work across the project team. It is important that the experts understand each other and that everyone understands the common goals. Communication is an important means to achieving this understanding.

In the EU project we refer to, we chose to use the Adobe Connect Pro web conferencing tool (a trademark of Adobe Systems Incorporated) as a communication platform and Google Docs (a trademark of Google Inc.) as a platform for document sharing and both synchronous and asynchronous collaborative writing. In order to encourage maximum participation from all parties involved, we recommend two monitors with extended display, so that the communication platform (Adobe Connect Pro) can run on one monitor while the collaborative writing tool (Google Docs) runs on the other monitor. In addition, we recommend a headset with speakers and microphone (as an alternative to the built-in microphone and speaker) as well as a web camera of good quality. The tools we chose turned out to satisfy our needs, but we do see great potential in terms of utilizing these tools to improve the cooperation process. There are many similar tools available nowadays. We recommend focusing mostly on work processes and how the selected tools should be utilized for efficient and productive computer-supported cooperation. We consider this to be tailoring and customization to get the best possible environment for communication, collaboration, coordination and workspace awareness.

5.2 Guidelines for Applicable Coordination

Coordination is very essential in DCD, since multidisciplinary solutions depend on various experts' needs and these needs must be treated in coordination.

The facilitator plays a central role with respect to coordination. The facilitator's most important role is actually to lead cooperation sessions so that relevant discussions are conducted and decisions are made. In practice, this means to coordinate the session participants as effectively as possible through the session. In addition, the facilitator and/or project manager is also involved in the session planning phase. Session planning can be regarded as coordination of all project participants, so that they get the chance to become well-prepared for the sessions, where the actual work should be performed.

The facilitator has an additional role in relation to coordination in DCD, but distributed coordination is generally an important part of cooperative work of which all participants must be aware (Crabtree, Rodden & Benford, 2005). In DCD, it is particularly important that the various experts are aware of what other experts have produced, so that new solutions can be built on a joint decision and a common platform that takes the team’s overall needs into account. We chose to divide the experts into two groups in our EU project, with each group responsible for its respective deliveries: a business model and a design document for an e-learning course. Furthermore, we chose to use two facilitators, each with special responsibility for his or her respective group. The facilitators led the sessions and contributed to the best possible cooperation. Parts of a cooperation session take place among all participants, while other parts only support conversations between participants in a specific group, in this case either the business model group or the design document group. This shift from collaboration among some experts to collaboration among the entire group is very important in achieving comprehensive solutions; one of the main challenges for the facilitators is to ensure that this coordination happens in a sensible way.

A cooperation session lasts for approximately three to four hours, so it may be appropriate to schedule the session before or after lunch. Before the session starts, the video conferencing platform has to be established so that participants can join up and so that all participants can check that everything is working properly. In this context it is also important to check each participant’s access to necessary resources in the workspace. When all participants are connected and the session starts, the facilitator typically makes an introduction to convey the objectives of the current session, and then the cooperation starts. While this cooperation is in progress, the facilitators will ensure a balance between cooperation across the whole group and cooperation within the small groups, using common sessions and breakout session. Towards the end of a session, the facilitator typically conducts a session evaluation. This may be an oral evaluation where all participants contribute, followed up with an online questionnaire.

5.3 Guidelines for Applicable Collaboration

The "double level nature of work" is a concept used to make a distinction between core work activities and work about the work (Fitzpatrick, 2003). In this section we will discuss collaboration concerning the core work activities. DCD must facilitate collaboration concerning the core work activities, and this is also the main aim of the cooperation sessions.

During these sessions the experts work together to produce results that will be part of the project deliveries. Collaboration is therefore synonymous with production of results, and we need tools that support both synchronous and asynchronous collaboration to deal with this. Our experience shows that conversations are actually important work in this context, and that the tools therefore must allow the possibility of storing the main results of these conversations while the work takes place. The use of Google Docs as a platform for document sharing and collaborative writing turns out to work very well in this context. Furthermore, we had a positive experience using the same tool for session preparation activities, i.e., to fill out current issues and topics in the collaborative tool (Google Docs) in order to give all participants the opportunity to become prepared for the conversation that will actually take place in the cooperation sessions. Sensible conversation about current topics and challenges are of greatest importance. This should make us able to handle important decisions that take into account the needs of the whole and of all relevant parties.

It is very important that everyone always has access to the collaboration tools, so that results can be documented when they are produced and so that all participants have easy access to everything that is created at any given time. The tools must support both synchronous and asynchronous cooperation between co-located and distributed actors. In this context Google Docs worked very well for us, but there are also many other suitable collaboration tools available.

5.4 Workspace Awareness in Distributed Concurrent Design

We are particularly interested in workspace awareness in connection with DCD, which means that participants know what is going on and what others contribute in the shared workspace.

When it comes to gathering workspace awareness, we consider part two of Gutwin and Greenberg's framework (2002) relevant. Our workspace should support consequential and intentional communication by demanding a separate screen dedicated to video conferencing. In addition, the participants need to have the necessary equipment (web camera, headset, etc.), so that they are able to sense to the greatest extent possible what is going on at the different sites. Likewise, feedthrough from the artifacts is found to be an important source for awareness. The fact that all participants always have the opportunity to see what the others have contributed, through public and shared documents, is perhaps the most important instrument to coordinate activities and arrive at comprehensive solutions.

The facilitator has a special part to play in relation to awareness, since the facilitator's role actually is to be aware of contributions from the different participants so that the interaction between plenum discussions and discussions in small groups can be balanced for the benefit of all. The facilitator uses consequential and intentional communication from the participants as a source to determine when work should take place in small groups and when it must be lifted up in the plenary. Furthermore, the participants themselves are dependent on knowing and understanding what others have contributed, so that their own work and contributions can be coordinated with the others. In this context the feedthrough from artifacts (e.g., Google Docs and Adobe Connect Pro) is a very important source of awareness.

Adobe Connect Pro offer several features which can be used to gain workspace awareness. For example, Chat Pods can be used to communicate with other participants without disturbing the session flow; Attendee Statuses such as Raise Hand, Agree, Disagree, or Applause can be used to invoke attention and convey simple viewpoints. We believe there is great potential to exploit such opportunities better; this will require attention and training.

5.5 The Platform of Distributed Concurrent Design

Figure 1 shows distributed concurrent design as a platform which stands on three legs (*Communication*, *Coordination* and *Collaboration*) and where the whole construction is surrounded by a cloud of *Awareness*. This is intended as a summary regarding the prescriptive approaches for distributed cooperation which are identified in this study.

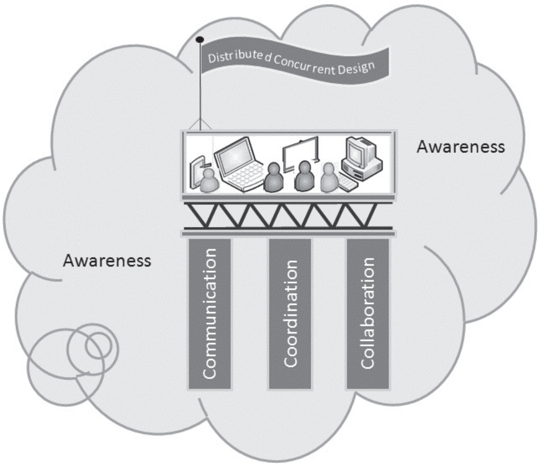

Figure 1. The Platform of Distributed Concurrent Design.

6. Concluding Remarks and Suggestions for Further Work

We need to understand cooperative work so that we can implement it better (Schmidt, 2009). DCD is cooperative work, and in this study we built understanding in two ways. On one hand, we conducted practical testing, while on the other hand, we carried out literature studies to better understand challenges that others have worked with and how they dealt with them. CSCW research is essential in this context, since several articles in the field of CSCW deal with issues that are relevant for DCD. In this study we have found that communication, coordination, collaboration, and awareness are very important elements and that understanding and utilization of these elements can be important for efficient and productive DCD.

We choose to focus on some selected areas (communication, coordination, collaboration, and awareness) to avoid embracing too much in a single study, but we may well expand this later on. We believe the prescriptive approaches discussed in this article can serve as a starting point and a platform for a more sophisticated framework for distributed cooperation. Such a framework should provide specific recommendations in relation to applicable communication, coordination, collaboration, and workspace awareness for involved parties, aligned in relation to the activities they carry out and the artifacts they use. Furthermore, it is probably appropriate to extend the platform for such a framework. Several CSCW topics are relevant in this context. For example:

- Can the work on collaboration readiness and collaboration technology readiness by Olson and Olson (2000) provide insight regarding the human and technological factors that must be present to achieve applicable computer-supported cooperation, and can this insight eventually be incorporated into this kind of framework?

- Can lessons learned from research concerning Spaces (the opportunity) and Places (the understood reality) and experiences with War Room Meetings (Bjørn, 2011) contribute to knowledge regarding how a distributed workspace should be established?

We are sure that DCD has a lot to learn from CSCW. We believe that the experiences gained from DCD will also contribute to the cumulative production of CSCW research results. This means there are several areas of specialization which will benefit from further work.

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Principles of Concurrent E-Learning Design

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Applications and Methodologies

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Chapter 4
Principles of Concurrent E-Learning Design

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ABSTRACT

Instructional design is a process that in many cases requires multidisciplinary collaboration among several stakeholders. Domain experts, pedagogues, technical experts, economists, administrative personnel, customer representatives, instructors, and learners may have very different preferences, and sometimes it is a great challenge to coordinate them all. In this chapter, the authors present the principles of concurrent e-learning design. Concurrent e-learning design is a novel approach to computer supported and cooperative instructional design where several stakeholders actively participate in the design process. The results from a concurrent e-learning design project can typically be a comprehensive design document containing details regarding how higher education e-learning courses should be developed and delivered. The authors have worked to codify this methodological approach for several years and conducted a qualitative analysis of data collected during this period. This analysis has yielded sixteen principles, which are grouped into five categories and presented in this chapter. The chapter describes each principle in detail, discusses whether ERP systems can be of assistance in the instructional design process, and outlines a plan for testing ERP systems in connection with the concurrent e-learning design approach.

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Principles of Concurrent E-Learning Design

INTRODUCTION

Educational institutions must increasingly deal with changes, adapt to new competitive situations, and deliver a range of services that together make up complete educational offers for the students. Today, these services are largely based on Information and Communications Technology (ICT), and they are important contributions to the total business of the institutions. E-learning deliveries constitute an important part of this business, since e-learning comprises all forms of ICT supported learning and teaching and varies from e-learning courses for formal higher education to self-paced e-learning systems for informal training.

Corporate institutions create value through activities such as trading, logistics, financial services, or human resource services, and Enterprise Resource Planning (ERP) systems provide important support for these processes, since they are utilized to manage the internal and external resources needed to run the business. Educational institutions also need to design and manage their core resources (e.g. academic courses) so that they satisfy the expectations of students and other stakeholders. The reason for this book is the great potential inherent in educational institutions' use of ERP systems to support design, development, and delivery of academic resource and educational deliveries. The objective is to provide applications, methodologies, and framework suggestions for the use of ERP systems within the education sector. This approach intends to help improve the effectiveness and efficiency of learning and teaching processes and enhance the service level for all stakeholders.

The main aim of this chapter is to present the concurrent e-learning design method (i.e. the sixteen principles of concurrent e-learning design), and to discuss possible links between this method and the use of ERP systems in the education sector. Concurrent e-learning design is as a methodological approach where the objective is to produce holistic designs for e-learning deliveries, i.e. to produce comprehensive descriptions regarding arrangement of ICT-based resources and procedures to promote learning. Such designs must cover aspects such as learning outcomes (what to learn), learning activities (how to learn), technical production and delivery (different learning environments that should be supported), and financial constraints (how to finance the development and delivery). The concurrent e-learning design approach can be used to design various forms of e-learning deliveries which in all cases consist of a complicated design process that involves several stakeholders, requires a multidisciplinary focus, and necessitates information access that can largely be obtained through ERP systems.

The concurrent e-learning design method was initially developed to achieve effective and efficient design and development of e-learning for corporate clients, i.e. to manage and coordinate multidisciplinary requirements so that corporate clients, educational institutions, and other stakeholders could agree upon complex requirements and arrive at mutually agreed solutions. This study is largely based on data from two specific projects where a higher education institution developed formal education for bachelor level students, i.e. instructional design of approved academic courses giving credits. One of these courses was based on an internal initiative and intended for students on campus, while the other was based on initiatives from a corporate client. Consequently, the second e-learning course had to be designed for blended learning (i.e. a mix of different learning environments) and take into account a certain degree of business customization.

In this chapter we present the main principles for successful concurrent e-learning design, which typically can be used when formal e-learning courses are developed at higher education institutions. We believe these principles are useful and should be considered when instructional design activities are to be performed, even if a total concurrent e-learning design approach is not adopted. Involving the client in an interaction with design team experts from different disciplines allows for the design of holistic solutions that take everyone's needs into account. Furthermore, we discuss how the use of ERP systems can help improve the concurrent e-learning design process. To do so, we point out common objectives and discuss how ERP can be used in the concurrent e-learning design process when new academic resources are being developed.

Following this introduction is a background section in which we explain how our research in connection to the concurrent e-learning design method has been conducted and how we have achieved the results presented in this chapter. Next, we present the principles of concurrent e-learning design – this study's main contribution. The next section is a discussion of the usefulness of ERP systems in this context. The chapter closes with a conclusion section summarizing the overall coverage of the chapter and presenting some evaluation-related matters.

BACKGROUND

Design, development and delivery of e-learning can be a huge and complicated practice that undergoes constant change. Several actors with different approaches are working to make improvements in selected parts of this area. Some of the challenges are more general and universal while others are more specific and dependent on the e-learning delivery context. It is typically challenging to define the learning outcomes, identify the relevant subject content, and select appropriate assessment practices in addition to identifying learning activities, methods and teaching strategies that fit the purpose. Furthermore, it might be challenging to select and utilize appropriate technological solutions for development and delivery of the educational environment that also satisfy administrative needs, at the same time limiting spending on the total e-learning delivery within a prudent budget.

These challenges are likely to be strengthened if the e-learning delivery is customized for corporate clients, and this applies independent of whether the client wants formal e-learning courses providing credits or self-paced e-learning systems intended for informal training. In both of these cases the client would like to ensure that the education is in accordance with formal and defined requirements while it also satisfies general and more informal expectations, e.g. suitable technical delivery, sustainable economy, adapted academic content, and a pedagogy that suits the target audience. Satisfied clients are always essential for renewed confidence and the long-term cooperation needed to grow the business and involvement in the design phase is essential to achieve this.

The process that aims to produce new e-learning deliveries is often called instructional design. A number of approaches exist: "It will be a mistake to think that there is a single best model of instructional design. In actuality, there are as many models as there are designers and design situations" (Gagné, Wager, Golas, & Keller, 2005, p. 2). The ADDIE model of instructional design is considered fundamental and generic and the five phases (Analysis, Design, Development, Implementation and Evaluation) deal with topics that we find in several other models.

Challenges in the design of customized e-learning for corporate clients and the methodological approach employed to deal with those challenges have formed the background of the study presented in this chapter. We developed, implemented, and gained some experience in using a new method called concurrent e-learning design. Concurrent e-learning design can be regarded as a situated model (Gagné et al., 2005, p. 39-40) that mainly focuses the first phases of the ADDIE model. It is based on models for instructional design (Kirschner, van Merrienboer, Sloep, & Carr, 2002; Peterson, 2003; Visscher-Voerman & Gustafson, 2004), with a special focus on models where the forthcoming e-learning delivery is represented in distinct models that are developed in parallel (Paquette, 2004; Davidson-Shivers & Rasmussen, 2006). In addition we utilize principles from the field of industrial concurrent design. This means that the design team meets for cooperative sessions in a specially designed facility where appropriate computer tools are utilized and work is conducted by a facilitator. The concept of concurrent design developed as an early phase of the concurrent engineering process; it was originally developed to solve complex and multidisciplinary issues within the space technology institutions (Lonchamp, 2000; Bandecchi, Melton, Gardini, & Ongaro, 2000; Osburg & Mavris, 2005).

The concurrent e-learning design approach includes the client in the design process, so that we are able to fully elicit the client's needs. Furthermore, it is desirable to deal with as many requirements as possible early on in the design phase, in order to avoid major surprises later in the project. This means that stakeholders such as domain experts, pedagogues, technical experts, economists, administrative personnel, customer representatives, instructors and learners should cooperate in the design phase. This multidisciplinary cooperation should contribute to the development of holistic instructional designs that are appealing and cover all relevant requirements. The use of concurrent design should help us do this in a time and cost effective way while simultaneously producing high quality results. This study grew out of an examination of e-learning customized for corporate clients, and we have discovered that many of the challenges faced in this context also are relevant to higher education and educational programs in general. This is because competitive formal education depends on the interplay between factors such as the following:

1. Academic content and learning outcomes;
2. Pedagogy and learning activities;
3. Various technologies that support a range of activities relevant for learning, teaching, coaching, assessments, administration, and evaluations;
4. Flexibility so that students have the possibility to participate anytime and at any place; and
5. A sustainable business model that contributes to attractiveness for all stakeholders.

We have found that these factors should be considered, although some factors (e.g. technical delivery platform or economic constraints) to some extent are given in advance when higher education institutions design internal courses.

Materials from a Method Engineering Project

The concurrent e-learning design method was developed as a collaborative project between several Norwegian institutions: the Faculty of Informatics and E-Learning at Sør-Trøndelag University College; the Department of Computer and Information Science at Norwegian University of Science and Technology; the research foundation TISIP; and five internationally-operating companies within the telecommunications industry. The project received external funding from the Norway Opening Universities from spring 2009 till spring 2011.

At the moment the method is undergoing further development in an EU-project that belongs to the Leonardo da Vinci Transfer of Innovation program. A part of the Lifelong Learning Programme, the project involves 19 participants from 6 different European countries.

The principles of concurrent e-learning design presented in this chapter constitute a method engineering project: "Method engineering is the engineering discipline to design, construct and adapt methods, techniques and tools for the development of information systems" (Brinkkemper, 1996, p. 276). We consider the concurrent e-learning design method a situational method in which it is essential to adapt the method to the situation of the project at hand. We must consider the goals of the project we are undertaking, and what results we want to produce, each time the method is used for a new project. Furthermore, it is reasonable to note that the result we wish to achieve is usually not an information system in the traditional sense, but rather a design for an e-learning delivery, offering guidelines for learning outcomes, subject content, assessment practices, learning activities, teaching strategies, technological choices for development and delivery, administrative needs, economic constraints, intellectual property right issues, etc.

Reeves, Herrington, & Oliver (2005) offer the concept of design research, a research methodology similar to the one used in the method engineering project we are referring to in this chapter. We claim to employ design research because we have a project that:

1. Develops over several years (the project started three years ago and is still ongoing),
2. Includes cooperation between a number of people (six actors participated in the method engineering project and a dozen were involved in testing and evaluation),
3. Utilizes various research methods (e.g. literature review, design science, action research, and qualitative data analysis) that are suitable to answer the research questions we face as the project progresses,
4. Reveals design principles that can be further developed and used in other contexts (the main focus of this chapter), and
5. Maintains a dissemination agenda.

First, the need for a new method for design of e-learning deliveries was uncovered in a research project where two different e-learning deliveries were studied, i.e. the need for the method was uncovered through qualitative analysis of data from e-learning projects that have been implemented at the higher education institution we belong to (Strand & Hjeltnes, 2009). Then, the concurrent e-learning design method was developed and documented as part of a project where the design science research method was used (Strand & Staupe, 2010a). Next, the method was tested, evaluated, and improved as part of an action research project in which the method was put into practice (Strand & Staupe, 2010b).

In this chapter we draw on the research data from several projects and use these data to identify and describe the main principles of concurrent e-learning design. We aim to answer the following main research questions:

- **RQ1:** What are the most important principles of concurrent e-learning design?
- **RQ2:** How might designers benefit from these principles?

In order to answer these research questions we have employed a qualitative data analysis and coding of qualitative data in different formats (e.g. video clips, audio recordings, surveys, interview notes, project documents, training materials, design documents, and fully developed courses).

Since we had quite a lot of data in different formats we decided to handle our data using the NVivo 9[1]. Our approach to the coding process was inspired by Bazeley (2007) and Saldaña (2009), in that we carried out iterative coding in three cycles. In the first cycle we used descriptive initial coding to name the ideas in the data and represented them as nodes in NVivo 9. We identified a total of 74 nodes; each node refers to ideas and works to help us aggregate extensive and varied raw data into a brief summary format. In the second cycle we did axial coding to extend the analytic work from the first cycle. During this process all the nodes from the first cycle were categorized in relation to what each node actually concerned. After completing this cycle we had five categories (i.e. adaption to the surroundings, stakeholders, activities, infrastructure, and results) containing their respective nodes. In the third cycle the nodes were reduced to a total of sixteen principles (i.e.

our response to RQ1), and we used data associated with the different nodes to describe each of the sixteen principles (i.e. our response to RQ2).

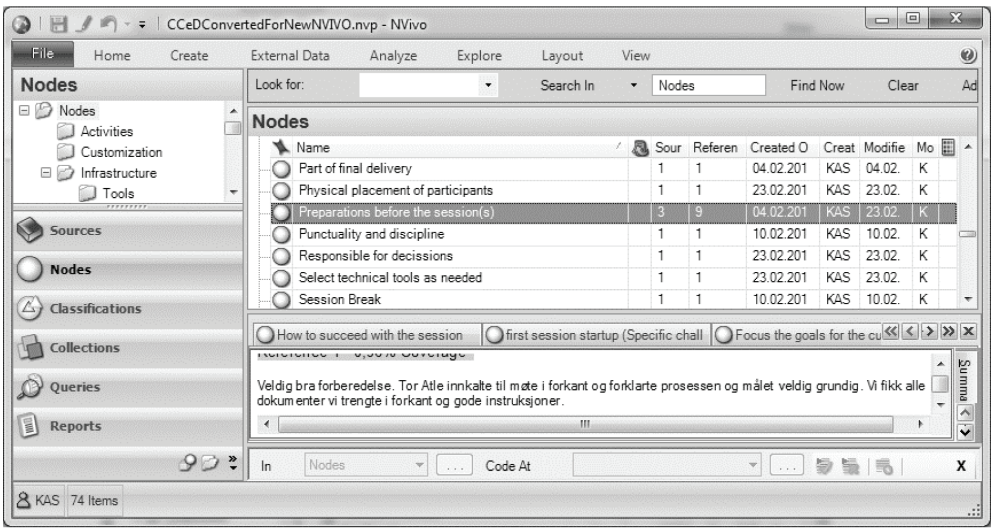
Figure 1 shows a screen dump from this project where NVivo 9 is used for qualitative data analysis and coding. In this case the node Preparations before the session(s) is selected in the List View, while the Norwegian text in the Detail View below, which is resulting from a survey carried out during the project, states the importance of preparing participants for cooperation sessions (in this context and through this chapter, the term cooperation is used to describe activities that consist of communication, collaboration, and coordination). The principle of training and preparation and the corresponding category (Activities) was later identified based on this node. This example shows that training and preparation is one of several key activities in concurrent e-learning design and it is intended to explain how we worked to answer the main research questions, i.e. how we identified, categorized, and described the principles of concurrent e-learning design.

To summarize this section about research materials and methods, we have conducted a qualitative analysis of data collected over several years in order to identify the principal characteristics of concurrent e-learning design. These principles are grouped into five categories; details of each principle are presented in the next section. Following the enumeration of principles is a discussion of whether ERP systems can be of assistance in the design process – we regard decision support as a crucial potential benefit in this context.

THE PRINCIPLES OF CONCURRENT E-LEARNING DESIGN

This section is regarded as this study's main contribution in which the resulting principles of concurrent e-learning design are presented. In a slightly simplified way we can say that concurrent e-learning design is a method to be used when several stakeholders representing different com-

Figure 1. Use of NVivo 9 for qualitative data analysis and coding



petencies meet to design e-learning courses. This section serves as a guide for the implementation of concurrent e-learning design projects (in this context and through this chapter, the term project includes all the work that must be performed when the method is used to design a specific e-learning course).

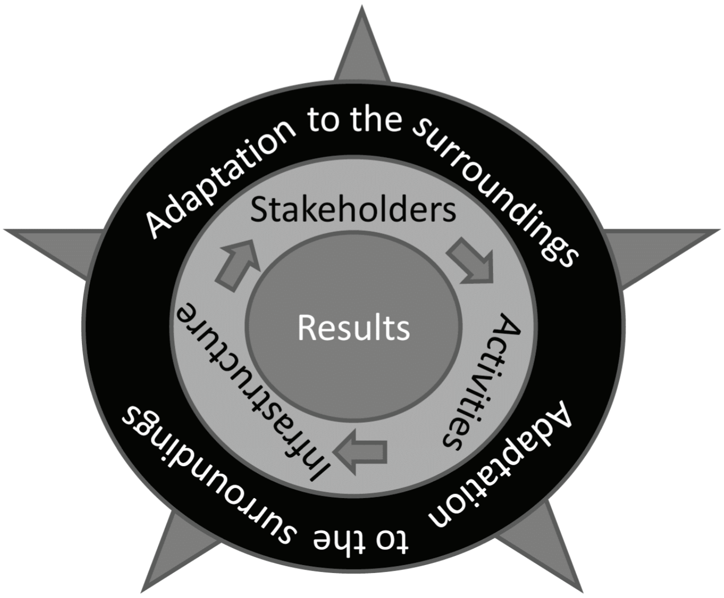
We have identified several principles in relation to concurrent e-learning design; in our attempt to present these principles appropriately, we have chosen to categorize them. Figure 2 shows these categories as a wheel. We have placed the principles of adaption to surroundings, which refers to the things that must be considered for every new project, on the outermost level of this wheel. This is where the method meets the environment and where customizations have to be performed. On the next level of the wheel within the external surroundings come stakeholders, activities, and infrastructure, which constitute the framework in concurrent e-learning design. The integration and interaction of these elements and their adaptation to the external surroundings forms the foundation that will produce the results of the design process. In the center of this wheel we have the results, meaning that results (project deliverables) lie at the core of concurrent e-learning design. Several principles are connected to the results that the projects are meant to produce.

In the remainder of this section, we present sixteen principles of concurrent e-learning design. First, we present separate sections for each category of principles, offering discussion in turn of each principle within the larger category. Finally, all principles are presented in a summarized review.

Adaption to the Surroundings

The process of adapting to surroundings is a method calibration process performed in the initial phase of the project. These activities must occur in

Figure 2. The wheel of principle categories for concurrent e-learning design



order to adjust the methodological approach to the project in question. In this context it is important to decide what to produce (expected results), who should be involved (relevant stakeholders), how and when things should happen (project activities), and what facilities are needed (infrastructure and tools).

The concurrent e-learning design method can be regarded as a prescriptive framework. We offer concrete examples describing how projects can be implemented. For example, we met with success through the implementation of five cooperation sessions and four defined focus areas. The five different cooperation sessions were:

1. Situation analysis,
2. Possibilities study,
3. Solution selection,
4. Solution design, and
5. Design completion and implementation planning.

The four defined focus areas were:

1. Pedagogical strategies and learning activities, i.e. how to learn,
2. Knowledge and learning outcomes, i.e. what to learn,
3. Technical delivery, i.e. how to conduct distributed communication and dissemination, and
4. Business matters, i.e. which business related needs, economic conditions, and administrative needs must be addressed.

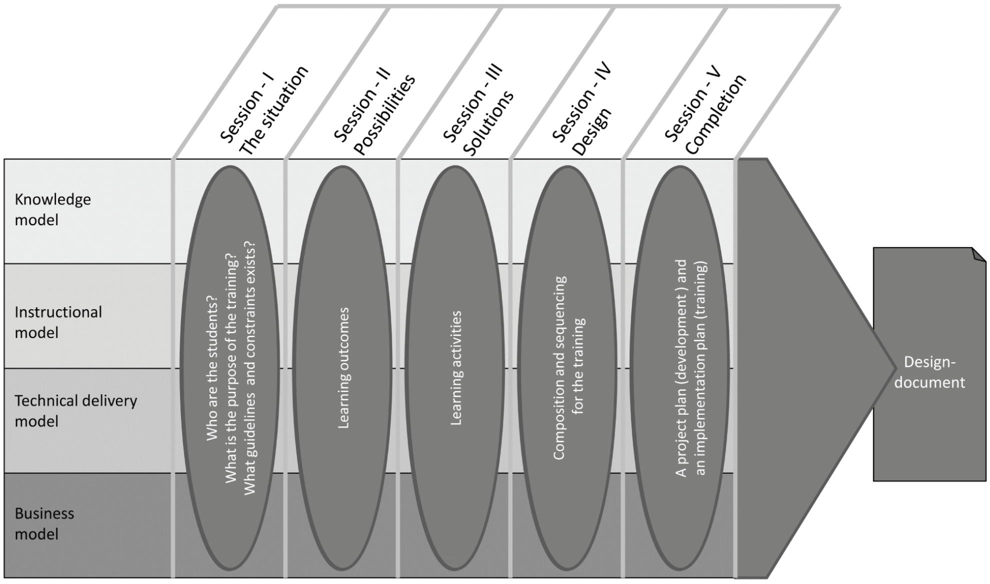
Figure 3 illustrates the default implementation of five cooperation sessions and four defined focus areas. Furthermore, it explains the final result and deliverable (i.e. the design document for the upcoming e-learning course) as an integrated solution that is composed of four different models and developed through five cooperation sessions. Thus, the final deliverable will offer both a holistic perspective and a detailed perspective in relation to the respective sub-models. We believe this approach can be a good starting point for new projects in which designs for e-learning deliveries are to be developed. At the same time we anticipate the need to make adjustments within each individual project, which allows us to deviate slightly from this approach.

A new project is always something unique that has not been conducted before, a truism that holds for projects that aim to develop new e-learning designs. Projects that are candidates to use the concurrent e-learning design method may be very different, and in size varying from a handful of participants to a dozen or more. Therefore it is important to adapt the method to the current project and surroundings. We present the four different principles connected to the process of adapting to surroundings below.

The Principle of Defining Project Deliverables

The production of project results and deliverables is always very important since these are the very reason the project exist. Results and deliverables are the end products of the design process and they should typically last for a long time after the project is finished. Two kinds of results are produced in concurrent e-learning design: intermediate results, which should typically be available following a cooperation session (different results for different sessions); and final results or actual project deliverables, which will be available at the end of the project. The important thing in this context is to determine the project deliverables and their composition, i.e. to decide what to produce in the particular project we now face. The concurrent e-learning design method provides recommendations in relation to both intermediate results (e.g. a situation analysis document or a study of possibilities document) and final results (e.g. a design document that is composed of an instructional model, a knowledge model, a technical delivery model, and a business model).

Figure 3. Five cooperation sessions and four focus areas to produce a comprehensive design document



Expected project deliverables can vary significantly between different projects and an initial order that defines the objectives can be very helpful. Our experience shows that it is important to know what the expected project deliverables are, because this creates many constraints in terms of how the project should be organized. More information about project deliverables can be found in the Results section.

The Principle of Defining Participants and Roles

In any project, different participants are needed to fill different roles. Some of these roles contribute most to the articulation work (Schmidt & Simone, 1996), while other roles contribute to the real cooperative work that leads to project deliverables and results. First, we need someone to articulate the work, i.e. a project leader to manage the entire project and a facilitator to facilitate the cooperation sessions. In addition, we need someone to work directly with the project deliverables and results, i.e. a multidisciplinary team where the necessary expertise and decision-making authority are represented, so that stakeholders such as customers, service providers and prospective users can reach comprehensive solutions. It is important to identify what roles are needed and who should fill them as early as possible after the expected project's deliverables and results are described. More information about participants and roles can be found in the Stakeholders section.

The Principle of Defining Activities

The purpose of this principle is to define the expected project process at a general level, i.e. what needs to be done, how this should be performed, and when it will happen. Our recommendation is to produce a plan or outline that would typically list training activities, technical testing requirements related to the equipment to be used, cooperation sessions and focus areas to implement, any activities required between the cooperation sessions, how evaluation will take place, etc.

When working with such a plan, one must also consider how the cooperation between the project participants should take place. Based on the project's final results and deliverables, as well as the themes for the project's cooperation sessions, one should try to put assemble multidisciplinary groups that work together optimally. These groups will typically be responsible for their respective portions of the final deliverables. More information about project activities can be found in the Activities section.

The Principle of Defining the Project Infrastructure

The project infrastructure consists of facilities, technical aids and tools to be used in the project. Concurrent e-learning design projects require, first and foremost, access to a concurrent design facility, i.e. a technically equipped room for cooperation sessions that will serve as a shared workspace and common information space for project resources (Bannon & Bødker, 1997).

As early as possible, one should decide upon the facilities and tools to be used. Once these are in place some customization should be considered in order to appropriately adapt tools to the current project. For example, we have had good experiences with the use of templates that act as guidelines for the design documents to be developed, but these must often be adjusted in relation to the objectives of the current project. This means that the templates for the preparation of the final deliverables should be produced from within the current project.

Once decisions about technical equipment are made and the necessary adjustments are performed, we should test the equipment to be sure it works as intended. In addition, we need to conduct necessary training for any personnel involved, so they are well prepared when the project work and the cooperation sessions begin. This training is conducted with the objective of describing the kinds of tools available and how they should be used. More information about project infrastructure and tools can be found in the Infrastructure section.

Stakeholders

A primary feature that distinguishes concurrent e-learning design projects from more traditional development projects is the implementation of cooperation sessions where concurrent cooperation (i.e. communication, collaboration, and coordination) takes place. It is important to staff the projects so that these sessions can be performed most effectively. These sessions consist of real time multidisciplinary cooperation that requires specific contributions from each participant. Cooperation sessions must be staffed with the necessary stakeholders, e.g. customer representatives, institution staff, service providers, prospective users, different experts and decision makers, in order to ensure comprehensive solutions that are sustainable and viable.

In the remainder of this section concerning project stakeholders, we will first discuss some of the specific roles in more depth. Next, we will discuss the interaction between the different roles that constitute the project team when taken as a whole.

The Principle of Different Roles and Sufficient Authority

A variety of roles are required when we carry out concurrent e-learning design projects; these roles are particularly relevant to the cooperation sessions. In these sessions, we need some roles that contribute to the articulation of the cooperative work, i.e. someone to ensure that the interdependent activities are coordinated, scheduled, aligned, interconnected, integrated, and the like. Furthermore, we need someone who performs the real cooperative work that leads to expected project deliverables. As Schmidt and Simone note, "Cooperative work is constituted by the interdependence of multiple actors who interact through changing the state of a common field of work, whereas articulation work is constituted by the need to restrain the distributed nature of complexly interdependent activities" (1996, p. 158). In the rest of this section, we present some of the most important roles related to concurrent e-learning design:

Project Manager

The project manager is responsible for managing the project from beginning to end; this role resembles traditional project management roles in other project models. It is the project manager's responsibility to implement the project within specified constraints and to perform project planning, management, and monitoring during the project life cycle. The project manager should for instance ensure:

- That an appropriate degree of organization exists,
- That processes are properly followed,
- That cooperation sessions are planned and implemented,
- That a good working environment is maintained, and
- That appropriate aids and tools are available and used properly.
- In order to fulfill these responsibilities, the project manager is granted the authority:
- To manage allocated resources,
- To change the project's organization if needed,
- To organize project meetings and cooperation sessions,
- To negotiate with customer representatives, service providers and other stakeholders, and
- To approve or reject project deliverables.

The project manager is central to the articulation of the cooperative work throughout the project life cycle, but not always particularly active in the cooperation sessions, since the management of these sessions are the facilitator's responsibility.

Facilitator

The facilitator is perhaps the most important role in concurrent e-learning design. This role is responsible for facilitating the cooperation sessions, which normally take place in a concurrent design facility. This means it is a dedicated role that can be compared to a conductor, who ensures that the interactions between the participants are running smoothly. The facilitator helps coordinate cooperation so that the transitions between individual and collective work are natural and appropriate. Facilitators should have expertise in relation to all aspects of the products under development, in the case at hand a design document for an upcoming e-learning course that deals with challenges regarding learning outcomes, learning activities, technical delivery, and business matters. Because of the requirement for multidisciplinary skills in this position, often senior group members occupy this role. Even these individuals may require a lengthy period of practice before they become effective facilitators.

A facilitator must exercise sufficient authority, but should not be too dominant or override the experts. Furthermore, facilitators must be good listeners who sense what is going on, while they also must be very well prepared, so that they understand the tasks and issues they are faced with during the cooperation sessions. The responsibility of the facilitator is:

- To plan, implement and evaluate the cooperation sessions,
- To contribute to relevant information exchange between all session participants so that the objectives of each session are achieved to the greatest extent possible, and
- To contribute to decisions related to multidisciplinary issues that require clarification before the process can proceed.

The facilitator has the authority to organize and lead the cooperation sessions, meaning that the project manager leaves the control of the cooperation sessions to the facilitator.

Session Secretary

The session secretary is an optional role but it can be very useful, especially for the facilitator. This is a person who acts as an assistant to the facilitator in the cooperation sessions. The session secretary may contribute to the technical implementation of the cooperation sessions (e.g. to switch between different screens and workstations so that all participants can see certain aspects of a sub-model under development, and take these into account for other related sub-models). Furthermore, they can perform administrative tasks such as maintaining a decision list of any decisions made during the session or maintaining an action list. A secretary typically accepts responsibility for technical implementation of cooperation session, while also relieving the facilitator of certain administrative tasks faced during the sessions.

Various Experts

Concurrent e-learning design projects must be staffed by various experts who can help to perform the project activities in order to produce the project's deliverables, i.e. to design new e-learning courses or carry out maintenance and updating of existing courses. The purpose of the cooperation sessions is to conduct multidisciplinary cooperation in real time in order to produce comprehensive solutions that take the various experts' needs into account. A variety of experts are required, depending on the requirements that the project deliverables dictate and the areas of expertise that are involved in the production of those deliverables. When we aim to produce comprehensive design documents for new e-learning courses, our default proposal is to use four expert areas, with each responsible for their respective sub-models. These areas have been:

- Instructional designer(s) responsible for pedagogical strategies, learning activities, etc. that will be documented in the Instructional Model,
- Subject matter expert(s) responsible for the development of the Knowledge Model that contains information about competencies to be developed, learning needs, and subject content,
- Technical delivery expert(s) responsible for documenting in the Technical Delivery Model any technical matters such as the selection of technical platforms, infrastructure, solutions, or tools, and

Business expert(s) who are responsible for taking care of business related issues and administrative needs, documenting these in the Business Model (Strand & Staupe, 2010a).

The different experts must exercise sufficient decision authority and take responsibility for decisions within their relevant subjects. Moreover, the different experts must use mutually understandable language. In this context the model elements, which are exchanged between session participants, serve as boundary objects (Carlile, 2002). I.e. these model elements contribute to information exchange between different expert areas and disciplines.

In summary, we conclude that we need a variety of experts, but the particular need varies depending on the requirements of the project deliverables.

Customer Representatives

Customers can participate with several people in the project according to their requirements and needs. A customer representative is in this context one or several persons that will help ensure that the quality of the e-learning products and services are in accordance with customers' requirements. In concurrent e-learning design projects, customers can typically help with the definition of learning outcomes, learning activities, technical deliveries, and business matters. They will typically be responsible for communicating claims on behalf of the customer. Furthermore, they will participate together with the various domain experts and other participants in the decision-making process and help make decisions. In some cases, the project manager can be a customer representative, i.e. the project manager uses multidisciplinary cooperation sessions to bring out new designs for e-learning products and services.

In the bullet list above, we discussed the most important roles for concurrent e-learning design projects. These roles will vary from project to project – the important thing is to get the interplay between them work properly. This is the theme of the next principle.

The Principle of Multidisciplinary Cooperation

Concurrent e-learning design sessions are, as previously mentioned, real time multidisciplinary cooperation between stakeholders such as the facilitator, the session secretary, various domain experts, the project manager, customer representatives, institution staff, service providers, prospective users, and others. The goal is to achieve fruitful and effective cooperation between all these stakeholders, so that they eventually cohere as a high-performing team that produces comprehensive solutions that are sustainable and viable.

Katzenbach & Smith offer the following insight about teams: "A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable" (1993, p. 45). In accordance with this insight, implementing the following considerations will achieve superior team effects:

1. A meaningful purpose that is sufficiently challenging and that everyone can identify with,
2. Specific performance goals that clearly indicate what to achieve and how to measure progress along the way,
3. Commitment to a common approach regarding the means of cooperation required to accomplish the team's purpose and goals,
4. A balanced mix of complementary skills (i.e. technical and functional expertise, problem-solving skills, decision-making skills, and a wide range of interpersonal skills), and
5. Mutual accountability in that each participant holds themselves, both as individuals and as a team, responsible for the team's performance.

Effective cooperation in concurrent e-learning design sessions is also affected by the participants' spatial placement. It is for instance appropriate to place the experts that we know will be cooperating closely at joint desks, while those who will interact more sporadically may sit at separate desks. In addition, the facilitator should be placed centrally to maintain physical contact with all participants during the session. Effective multidisciplinary cooperation does not occur on its own, but if we are aware of the matters mentioned in this principle, we believe there is a greater chance of success. Furthermore, the facilitator's performance is very crucial to the success of the undertaking. Effective communication and coordination are the result of effective facilitation; thus the facilitator may be the critical factor responsible for ensuring successful real time multidisciplinary cooperation between all involved stakeholders.

Activities

In any project it is important to decide upon questions such as what should be done, why this should be done, how it should be done, who should be involved, and when it should happened, i.e. to decide upon the activities. In our model for concurrent e-learning design projects, we have defined and used a process that includes some sub-processes and related activities to be performed. Such processes can typically be divided into:

1. A preparation phase where initial and planning activities are carried out,
2. An execution phase where cooperation session activities are performed, and
3. A conclusion phase where final activities such as summative evaluation and reporting is carried out.

Different concurrent e-learning design projects often have different starting points as they specifically adapt to the surrounding environment. As a result, we believe it can be just as appropriate to focus on activities to be performed in the project at hand, rather than describing a general process that usually consists of a sequence of activities that is repeated each time.

In the following text we present some principles that are closely related to the most central activities in concurrent e-learning design projects.

The Principle of Training and Preparation

Some knowledge and experience is beneficial and training can proceed in several ways to achieve this. On the one hand, the participants need to learn about the methodological approach and the basic principles of concurrent e-learning design, and understand what is expected of each participant when cooperation sessions are conducted. Training activities related to the methodological approach, working techniques, equipment, and tools can take place as lecture-based training or more hands-on training sessions where participants can try out methods and technologies in practice. On the other hand, it is very useful to familiarize participants with specific issues and background material directly pertinent to the project at hand. This type of preparation takes place before the project starts, and it can also take place before each cooperation session. It is important to be well prepared before each session; an important part of this preparation is to become familiar with all relevant material, which should be available before the session, e.g. guidelines and requirements in relation to subject content, pedagogy, or technical delivery.

The Principle of Session Plans (i.e. a Plan for the Most Central Activities)

Cooperation sessions are the most central activities in concurrent e-learning design projects and it is necessary to establish a session plan that contains details about all the upcoming sessions. A session plan normally starts with some overall objectives and general information before each session is described in detail. For each session, the plan typically contains information such as:

1. The name of the session (e.g. a study of possibilities),
2. General information (e.g. that we should aim at describing a wide range of possible solutions for the upcoming e-learning course),
3. The date and time when the session will take place,
4. A reference to the infrastructure and the tools to be used during the session,
5. The people who are going to participate and their respective roles,

6. What kind of preparations that are recommended before the session starts and which documents are relevant,
7. The objectives for the session and the deliverables that should be produced, and
8. An overview of how the session will be evaluated.

The facilitator and/or project manager is mainly involved in the session planning work. The final session plan can be regarded as a coordination tool for all project participants, since it offers them the chance to be well prepared for the sessions. The session plan is made early in the project, following the adaption to the surroundings. This means that much is already known about the overall focus areas for the project (e.g. pedagogical strategies and learning activities, knowledge and learning outcomes, technical delivery, and business matters) and the themes for each focus area (i.e. questions related to each focus area that are to be discussed in the respective cooperation sessions). Based on these assumptions and further detailed planning, the details are entered into the session plan.

The Principle of Sessions

The cooperation sessions are, as previously mentioned, the most important activities in concurrent e-learning design. Before the sessions start, we need to know who should participate and what roles they should play (i.e. in compliance with the principle of different roles and sufficient authority). Next, it is important to decide when the project participants should meet for cooperation sessions and what the expectations and goals of each session are. Detailed information concerning each session is summed up and collected in a session plan, which consequently is very important for project coordination.

Participants must have sufficient authority within their respective areas of expertise, and they must attend all sessions throughout the project. This can be understood as an either-or proposition: managers or others who only want to attend one or a few sessions should be given a role as observers, while participation should be mandatory for those who are responsible within a given field. Mandating attendance is recommended since absences can have strong negative consequences, both for cooperation and progress.

In the cooperation sessions, we want to achieve the benefits of concurrent work, effectively producing comprehensive solutions that satisfy all involved stakeholders and their needs. Here are some pointers for success in cooperation sessions:

- **Preparation before each session:** Good preparation is important for every session, but especially before the first one. Before the first session, participants are often nervous as they do not know the details of the project. Therefore, participants must be prepared in relation to the method (i.e. how to conduct concurrent e-learning design sessions) and the current project (i.e. what will be produced in both the current session and the entire project, what is expected from each participant, and how they should prepare themselves). Furthermore, it is important to perform technical preparations to ensure that the infrastructure, equipment, and tools are working properly, as well as other preparations such as obtaining coffee and cakes or other suitable food and drinks. Our experience suggests that some food must be available for the participants since the duration is 3 - 4 hours.
- **The session startup phase:** The first part of a session is always important and the facilitator is central in this context. In this phase, the facilitator should:
  - Ensure that all equipment works in the technical sense,
  - Ensure that all participants become acquainted with each other (i.e. that

they introduce themselves and tell about how they have prepared, or the like),
  - Make a presentation of the project status up to this session,
  - Make a presentation of the objectives and goals of this session and the expected deliverables, and
  - Ensure that the cooperation starts in a satisfactory manner.
- **The session implementation phase:** During the implementation phase, the goal is to achieve effective and efficient cooperation and to produce good results. This is usually achieved through a mix of individual work, cooperative work in small groups, and cooperation between all involved parties. It is the facilitator's responsibility to coordinate the cooperation so that the mix between individual and collective work runs smoothly. The facilitator must provide some breaks to discuss relevant issues and handle cases of common interest in plenum. In this context it is also important to write down all decisions made, as these decisions will guide the future work. Moreover, it is important to register upcoming actions that have to be performed within and between the cooperation sessions. If you have participants without adequate decision-making authority, calling for assistance regarding decisions is a possibility, but this should be worked out in advance.
- **The session termination phase:** The termination phase of a cooperation session is very important, as is the facilitator's role in bringing the session to a close. During this phase it is common to let all participants present what they have achieved in the current session, so that all participants may establish a common view of the project. Furthermore, focus should be maintained on decisions made (i.e. to update the decision list) as well as actions to be performed (i.e. to update the action list). As a result, all participants reach a common understanding about these areas and have the opportunity to discuss relevant issues along the way. The work with the decision and action lists is also an important method of determining the work on future tasks and duties that must take place before the next session. Formative evaluation of both the session work (i.e. the process) and the products (i.e. results produced so far) are also common in this phase. Typically, an oral evaluation in which everyone has an opportunity to communicate their views is conducted, follow up with surveys later on.

The sessions are the most important contribution to the upcoming deliverables in concurrent e-learning design, thus it is always important to focus on the objectives and goals for the current session. We should strive for punctuality and discipline as the room, people's time, and the available infrastructure is costly. There are usually no common breaks during a session, but the participants are free to move around the room, eat available refreshments, and engage in discussions with other participants. If required, the participants should also contact the facilitator to discuss issues and assist the facilitator in pointing out important issues and coordinating the participants.

The Principle of Working Activities between the Sessions

The work that occurs between the sessions is of paramount importance in concurrent e-learning design. It is during the sessions that we conduct multidisciplinary cooperation and produce comprehensive solutions, but it is between these sessions that we prepare for this cooperation. Preparation, in which we think through matters that must be considered within the different expert disciplines, is very important to maintain flow and progress through the cooperation sessions.

These preparations help us to strategize how the upcoming session should be carried out, providing insight in relation to how participants should best prepare themselves. Based on the results of these planning activities we could for example send out documents in advance of the next session, so that all participants are properly prepared. In addition to the preparation work for the next session, it is also common to conduct some activities that could be considered a continuation of work from the previous session. During the sessions we can typically determine solutions for issues, but it often requires a little more time to finish the tasks, thus the work must continue after the session. Such activities are normally described in the project's action list so that we know who should do what, what the status is, and what time limits apply.

In conclusion, we emphasize that the activities between the sessions are important for coordinating the project; it is not unusual to place milestones and decision points between the cooperation sessions.

Infrastructure

Infrastructure is in this context realized as the technical and physical circumstances that must be available in order to carry out concurrent e-learning design projects. The infrastructure must support multidisciplinary cooperation, both during the synchronous cooperation sessions when the participants are co-located, and between these sessions when they are distributed and working asynchronously. This means that the participants should be able to communicate, collaborate and coordinate the details of their own activities, while maintaining awareness of activities in the whole environment. In the following section, we examine four principles for infrastructure design.

The Principle of a Concurrent Design Facility

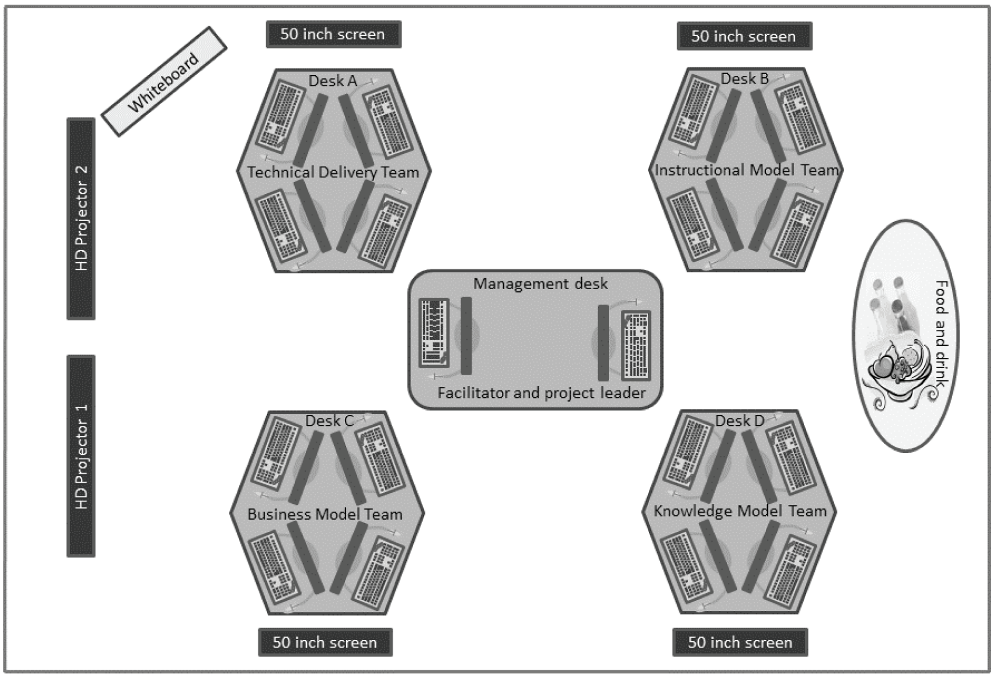
A key infrastructure element for both industrial concurrent design and the concurrent e-learning design method we refer to in this chapter is the concurrent design facility (Bandecchi et al., 2000). This is a room where the team of specialists meets to conduct cooperation sessions. The layout of the room and the location of different equipment are designed to support the design process and facilitate multidisciplinary cooperation between involved experts and other stakeholders. Experts who will cooperate closely will be placed close to one another, while the facilitator and any customer representatives are typically placed in the center of the room. The facility and the software and hardware tools the facility is equipped with constitute the infrastructure for the project. The room is equipped with computer workstations and some large public screens that are used to share design elements among all participants. For the exchange of model elements to function as efficiently as possible we use technological solutions that allow any workstation desktop to be displayed on large screens or video projectors.

Figure 4 shows a representation of the concurrent design facility used in our study. It consist of four desks (desk A-D), each with four workstations and one common large screen that primarily is used to present the desktop from one of the respective workstations. This means that four teams:

- The instructional model team,
- The knowledge model team,
- The technical delivery model team, and
- The business model team is placed on each respective desk.

The management desk is located centrally between the others so that the facilitator can get a good overview and assist the progress of co-

Figure 4. The concurrent design facility realized as a room with the necessary technical equipment



operation. Every workstation is connected to the projectors so that the facilitator or the participants themselves can present content from selected workstations, whenever needed.

Cooperation sessions are intensive and last for approximately 3.5 hours, with no common break. We must therefore consider conditions such as temperature, air quality, and noise, as well as access to food and drink. The participants need the best possible working conditions and they should be able to replenish their energy when needed. In fact, this need is so broad in scope that we could have conducted a separate study related to how the concurrent design facility best should be designed, but this is outside the scope of this chapter. The following principles more specifically discuss the various tools that in many ways become a part of the concurrent design facility.

The Principle of General Tools

General tools are used in many projects, regardless of the involved specialists' areas of expertise or the particular tools the different experts use to solve specific problems within their fields of study.

The facility with technological solutions to display workstation desktops on large screens or video projectors is also one of the general tools. Both hardware-based video splitters as well as software-based solutions are available. Initially, we chose to test out a commercially available software-based solution (i.e. NetSupport School[2]), although we have now developed our own software in order to more effectively meet our specific needs. We also consider the session plan, the action list, and the decision list to be general tools; more in depth description follows.

- The session plan is a tool that is used both for communication and coordination purposes; it helps the participants to prepare themselves. It can be implemented as a document that all project participants may access, but it could also be appropriate to develop specialized software to meet these requirements. More information about this tool can be found above under the "principle of session plans" subheading.
- The action list is a tool that is used to maintain an account of the tasks that must be performed in the project; it is especially vital that tasks that must be completed between the cooperation sessions be registered in the action list. During the cooperation sessions the action list is maintained so that we know who is responsible for what and which time limits exist. Many of these tasks have to be carried out between the cooperation sessions since these tasks often are complementary work from a previous session or preparation for the next.
- The decision list is very important to concurrent e-learning design, as it is used to register significant project decisions. These decisions are made in plenary when cooperation sessions are conducted; they provide guidelines for further work in the project. The decision list is therefore a tool that the participants will refer to throughout the project.

The session plan, the action list and the decision list should ideally be available to all participants, independent of time and place. This demand is discussed below under the subheading "the principle of common information spaces."

The Principle of Expert Tools

Different experts may need specific tools to develop their respective models and solutions, such as subject-specific tools that support design and modeling within a particular subject area. The joint work that the different experts perform as part of the cooperation sessions in concurrent e-learning design are to a great extent conversations between the parties. Participants therefore need tools that allow them to register the most important findings from these conversations and review these contributions, while also editing and expand these contributions. We have had good experiences with the use of modern tools for interactive co-writing; in this context we have tried web-based mind mapping tools to co-edit mind maps (e.g. Mindjet Catalyst[3]), simple web-based document editors (e.g. the open source based Etherpad) and slightly more advanced tools for collaborative writing (e.g. Google Docs[4]).

Furthermore, participants' use of these tools is best controlled through the use of templates. These templates typically contain questions to be answered in each session – we recommend having one template for each area of expertise. Once the template within a given area of expertise is completed, we have a basis to work from in completing the sub-models for the respective fields (i.e. the instructional model, the knowledge model, the technical delivery model, and the business model). These sub-models will together constitute a comprehensive design model for the entire e-learning delivery. As previously mentioned, these templates assist in managing the process, offering an outline of questions and issues the various experts have to deal with during the cooperative sessions. The facilitator plays a key role in leading the participants so that they touch on all relevant aspects of the templates during the sessions and conduct fruitful discussions along the way.

We have discussed some tools that may be suited to concurrent e-learning design, but the different experts should generally be able to select their own tools as needed. An important feature of these expert tools is that they work for synchronous collaborations between several simultaneous users as well as the asynchronous collaboration that typically takes place between the cooperation sessions. Furthermore, communication and integration between the different expert tools is beneficial since the overall model is built up of the sub-models developed using the respective tools. The exchange of product data based on open standards has been studied in connection with industrial concurrent design projects. The standard for exchange of product model data (STEP) is an ISO standard (ISO 10303) that explains how digital product information could be represented and exchanged between different tools. Major computer aided design and computer aided manufacturing systems now contain modules to read and write STEP compliant data, but this is not a typical tool used in instructional design. We therefore recommend using and adapting existing cooperative software, as we have already described.

The Principle of Common Information Spaces

As Schmidt and Bannon note, "Cooperative work is not facilitated simply by the provision of a shared database, but requires the active construction by the participants of a common information space where the meanings of the shared objects are debated and resolved, at least locally and temporarily (1992, p. 27)."

The common information space established in connection with our concurrent e-learning design projects consists of the concurrent design facility (i.e. the room where cooperation sessions are conducted) and the interrelationship between participants, artifacts, information, and the cooperative work taking place within these surroundings. Both the general tools and the special tools that were discussed above are regarded as artifacts in this context. In addition, we regard tools intended to facilitate information sharing to be central artifacts in the common information space. These tools should be easily available to all participants during the whole project so that everyone can take advantage of relevant information and material. Solutions are available in the form of general tools for enterprise content and document management (e.g. SharePoint[5]) or free web-based office suits that allow collaborative users to create and edit documents online, offering integrated data storage services for these documents (e.g. Google Docs).

We have tested several cloud-based online services that provide secure online workspaces (i.e. Google Docs and Mindjet Catalyst). Project participants have expressed a high degree of comfort working in these cloud-based environments, commenting that it is very beneficial to have easy access to what the other project participants have produced. It is more important to define how services should be used in the current project rather than having endless discussions about what services are best. These services and the information they contain (i.e. session plans, action lists, decision lists, different templates, and models under development) should ideally be available for all participants independent of time and place. Furthermore, these services must support synchronous and asynchronous cooperation among both co-located and distributed participants.

Results

The goal and fundamental reason for performing any project is always the pursuit of results. When we speak of results we include the results we wish to produce along the way as well as the final results that remain when the project is finished.

It is important to know what results you want to achieve early in the project since the results are a primary input for the initial principles regarding adaption to the surroundings. It is common to operate with two categories of results in concurrent e-learning design: the intermediate results, which are to be completed during the project, and the final results, which should be available when the project is finished. The following two principles are related to these particular result categories.

The Principle of Requirements for Intermediate Results

Intermediate results will be available during the project and they are usually prepared in connection with the cooperation sessions (i.e. different results for different sessions). Several benefits accrue when fairly detailed requirements for the intermediate results that should be available after a particular session are described. These detailed requirements are highly effective in the preparation phase, when the session participants make their preparations for the session. They are of great use during the session, since knowing what to do and what the expectations are is essential for the best possible coordination of the cooperative activities. Finally, these intermediate results are of great help later on in the project, when work builds on previous results and decisions.

Typical examples of intermediate results include the following:

- A situation analysis document containing relevant information about the current situation for the upcoming e-learning course,
- A study of possibilities document that describes a wide range of possible solutions in relation to the upcoming e-learning course, or
- A selection of solutions document that contains an evaluation of the possibilities and a selection of solutions that have been chosen to facilitate the project's final e-learning delivery.

A focus on intermediate results has been helpful in relation to the decisions that have to be made along the way. Decisions can be made more quickly and missteps hopefully avoided when decisions are tied to independent intermediate results.

The Principle of Requirements for the Final Results

The final result that should be available after a concurrent e-learning design project varies from project to project. In some projects we want to produce a design document that describes how e-learning products or services should be developed, without beginning the real production of these products or services. In other projects, however, the final deliverables may include a business plan, a marketing plan, a project plan, a concept study, or even a complete and fully developed e-learning course. The determination of the final project results normally occurs as part of the startup activities.

The first principle under the adaption to surroundings category deals with project deliverable definitions, and although these can vary widely, we state that the default deliverable from concurrent e-learning design projects is a design document. The design document is by default composed of the following four sub-models:

- The knowledge model, which covers information about learning outcomes and competencies to be developed,
- The instructional model, which covers learning activities and pedagogical strategies,
- The technical delivery model, which covers technical matters such as technical platforms, technical infrastructure, solutions, and tools, and
- The business model, which covers business related issues and administrative needs.

Furthermore, these sub-models are by default developed through the following five cooperation sessions:

1. A situation analysis of the current situation in relation to knowledge aspects (Knowledge Model), instructional schemes (Instructional Model), technological aspects (Technical Delivery Model), and financial and administrative issues (Business Model);
2. A study of possibilities describing a wide range of possible solutions for the e-learning delivery in relation to each of the four sub-models;
3. Selection of solutions to use in the upcoming e-learning delivery;
4. Solution design, which is a detailed preparation of the design model that will typically enumerate the order in which instructional activities are to be carried out (Instructional Model), the order in which appropriate learning material will be presented (Knowledge Model), how the different technical solutions should be designed (Technical Delivery Model), and how economic and administrative solutions should be implemented (Business Model); and
5. Completion of design and implementation planning, where the aim is to complete the design model for the entire e-learning delivery and make plans with respect to development and implementation (Strand & Staupe, 2010a).

Figure 3 that we presented earlier in this section illustrates the default final project result (i.e. the design document for the e-learning delivery) as an integrated solution that is composed of four different models and developed through five cooperation sessions. Thus, the final deliverable offers both a holistic perspective and a detailed perspective in relation to the respective sub-models. Our experience suggests that it is advantageous if a dedicated person is responsible for the final results and the maintenance of this design document. Such a dedicated person will typically be able to ensure that the balance between the holistic perspective and detailed perspective is appropriate. It is also worth mentioning that we as a higher education institution have experienced several advantages of using this methodological approach and involving external corporate clients, also when the final results are put into production, i.e. when the course implementation takes place. We have for instance experienced increased participation as compared to other courses, which may be due to the fact that external representatives are ambassadors for the new course in their own organization, which in turn has an impact on the employees and results in course participation. Another advantage is the fact that the educational institution establishes a relevant course that is also demanded by other students than those employed in the client's organization.

Summarized Review of the Principles

In this section we have presented sixteen principles related to concurrent e-learning design. These principles are regarded as this chapter's most important contribution; they are repeated in the table that follows. Table 1 acts as a summary of the principles. We have chosen to provide a brief comment regarding each principle in order to emphasize what is covered.

POSSIBLE ERP SUPPORT IN THE DESIGN PROCESS

While this chapter deals mainly with a presentation of the concurrent e-learning design method, this book as a whole concerns challenges related to the design, development, implementation, and management of educational institutions' resources through ERP systems. In this case, there is a lot of overlap in the issues we aim to understand, the solutions we work to realize, and the benefits we want to achieve, as the concurrent e-learning design approach also deals with effectiveness and efficiency related to the design and development of central academic resources, i.e. e-learning courses

Table 1. A summarized presentation of the principles of concurrent e-learning design

Category	Principle	Comment
Adaption to the surroundings	The principle of defining project deliverables.	The project's goals and aims for development must be defined. We want to know as much as possible, as early as possible.
	The principle of defining participants and roles.	Human resource needs must be identified. We want to know what kind of people we need as early as possible.
	The principle of defining activities.	The project work and the activities to be performed must be identified. We want to know what should be done as early as possible.
	The principle of defining the project infrastructure.	Needs related to the facilities, tools, etc., that are to be used in the project must be identified. We need to know what kind of facilities, equipment and tools should be used in the project.
Stakeholders	The principle of different roles and sufficient authority.	Who should participate and what they should be responsible for are both key decisions; i.e. who should cover the respective roles of the project.
	The principle of multidisciplinary cooperation.	The details of multidisciplinary cooperation should be worked out; i.e. identify the participants who will work most closely together (sharing a desk) and those who do not have to work so closely.
Activities	The principle of training and preparation.	We must decide which training activities and other preparations are to be undertaken.
	The principle of session plans.	A session plan should include all necessary information about the sessions that are to be conducted. This plan is very important for both communication and coordination of the project.
	The principle of sessions.	It is important to decide how the sessions should be conducted. This is a crucial activity since this is where the multidisciplinary interaction, which leads to holistic products, takes place.
	The principle of working activities between the sessions.	The work between the sessions is very important and must not be neglected. Between the sessions we make plans for how to conduct the sessions most appropriately, and also perform tasks that require more time.
Infrastructure	The principle of a concurrent design facility.	A concurrent design facility, i.e. a room with the necessary equipment, is needed to conduct concurrent e-learning design. This is perhaps the most important physical installation for concurrent design.
	The principle of general tools.	Typically, we employ some general tools that are reused from project to project. General tools may be of particular assistance in articulation work.
	The principle of expert tools.	The experts who work to develop the project deliverables require some specialized tools.
	The principle of common information spaces.	A common information space is required in order to cooperate on documents and other resources and develop comprehensive solutions that meet everyone's needs.
Results	The principle of requirements for intermediate results.	It is important to be aware of the required intermediate results that are to be produced along the way.
	The principle of requirements for the final results.	It is important to be aware of the requirements associated with the final project results.

and related components that constitute educational deliveries from the institutions. This overlap will be addressed in this section through a discussion of possible ERP support in the design process.

ERP is a major field of study, and there are tens of journals that regularly publish articles on ERP-related themes (Moon, 2007). ERP systems are information systems used to manage organizations' internal and external resources; their value is primarily generated through effective and efficient usage rather than directly from the systems themselves. ERP should help improve business – successful implementations must therefore be directed by business-driven requirements, with the technological choices remaining subordinate. Furthermore, the twofold nature of ERP benefits must be considered: ERP provides a comprehensive perspective of the entire organization, including all departments and functions; it also makes available all details of individual business transactions through ERP databases (Umble, Haft, & Umble, 2003).

ERP systems are used to record, maintain, processes, monitor, and report on financials (e.g. accounts receivable and payable, or standard and period-related costing), human resources (e.g. personnel planning or training, or event management), operations and logistics (e.g. purchasing or project management), and sales and marketing (e.g. sales management or pricing). This data can obviously be helpful in a decision process and it is precisely this use of ERP systems (i.e. as a system to achieve decision support benefits) that we want to highlight in this context.

Decision support is considered important in relation to both ERP (Holsapple & Sena, 2005) and industrial concurrent design (Lonchamp, 2000). Difficulty working with decisions in concurrent e-learning design arises partly as a result of the lack of actionable data to support decision making. In the early project phase, we typically need information about employees' competence and experience when new projects are staffed and decisions regarding appropriate resources are to be made. Later on in the project we will need information about the market and sales figures for previous implementations of specific e-learning products and services within a given market segment, as such data will help us to survey the market space. It may also be appropriate to look at the relevant figures (actual expenses or incomes) from previous years, when making decisions regarding financial forecasts or financial plans for a project. Many decisions made in the process of developing concurrent e-learning design projects, especially those related to the financial and administrative aspects of new e-learning deliveries, would benefit from the assistance offered by ERP modules for financials, human resources, operations and logistics, and sales and marketing. Data availability and accessibility is crucial to making correct and appropriately-timed decisions throughout a project.

In connection with the project's infrastructure, we chose to focus on two types of tools. These were general tools that are used in multiple projects regardless of the involved experts, and expert tools that are used by various experts when they work to produce their specific parts of the project's deliverables. ERP systems can act both as general tools and as expert tools. On the one hand, project management and selection of participants for the project is something the project manager does in all projects. ERP functions used for these purposes should therefore be regarded as general tools. On the other hand, ERP functions used for decision support should be regarded as expert tools. In concurrent e-learning design we aim to focus on several relevant areas when we develop new e-learning courses, i.e. economic and administrative matters should be addressed in line with learning outcomes, learning activities, and technical deliveries. Relevant data, which can serve as a basis for economic and administrative conditions, are typically available via the institution's ERP system. This could be information such as student course registrations, sales figures for courses, information about employees' competencies, and information about employees' workload. If we are to cover economic and administrative demands in a consistent manner during the design of new e-learning deliveries, it can be very beneficial to have access to this kind of information while participating in cooperation sessions.

Thus far, we have worked to define a concept and a framework for computer supported and cooperative instructional design. This approach has been based on experiences from different subject areas and our findings are summarized with the principles of concurrent e-learning design, presented in this chapter. Since the concept has now been established and actually implemented, it is natural to continue working to improve selected parts of the process.

Improvement of the decision-making process and provision of appropriate tool support are two challenges that arise in the course of the instructional design process. In this section, we have seen that ERP systems are very likely to contribute positively in this context. In the future, it is therefore highly relevant to work on research issues related to the availability of ERP systems. Some questions for further research include:

- Will ERP systems help improve the decision making process?
- If so, how could this possibly be done?
- What kind of support can educational institutions' ERP systems provide?
- What requirements apply to ERP systems intended to support instructional design processes?

Instructional design is a key process available to educational institutions to ensure sustainable and future-oriented educational programs. If the uses of ERP systems can help improve this work it will lead to more effective instructional design processes. Concurrent e-learning design processes would directly benefit from ERP systems, but those pursuing other approaches to instructional design would probably also be able to benefit. We believe the integration of the concurrent e-learning design approach with the use of ERP systems creates a win-win situation. The e-learning design process requires information during the design process that may largely be found in the ERP system, while the resources and information that are created should in turn be plowed back into the ERP system. Instructional design processes need ERP data, while the ERP systems in turn need data from instructional design processes in order to provide a clear picture of the whole business, since information about educational resources under development might have a value in itself.

CONCLUSION

Our intention in this chapter has been to present the concurrent e-learning design approach, and to contribute a brief discussion regarding the potential of ERP to help improve instructional design processes at educational institutions. Concurrent e-learning design is a novel approach to computer supported cooperative instructional design; the sixteen principles presented in this chapter are intended to explain how this approach works. These principles are the result of several years of method engineering work related to the concurrent e-learning design approach. The results are based on available literature and theories within industrial concurrent design and instructional design, in addition to our own practical experiences applying these theories in relation to the mentioned methodological approach.

The principles presented in this chapter offer a prescriptive framework for concurrent e-learning design. We explain how the principles work and make recommendations about how they should be used, i.e. they consist of high-level guidelines or rules to be followed in the instructional design process. The intention is to provide recommendations that assist instructional designers in using this approach most optimally. There are of course many approaches to instructional design and we have not yet performed enough activities to fully assess the research evidence and the findings from this study. The question remains: how credible are these findings, how well was the data collection and analysis carried out, and how clear are the links between the original data, the interpretations, and the conclusions that are presented as principles in this chapter?

We want to increase the credibility of these findings. This means that we want other practitioners to test the validity-in-practice of these principles and contribute proposals for improvements. We hope this chapter can inspire new attempts to implement real time and multidisciplinary cooperation, which in turn should contribute to comprehensive solutions that satisfy involved stakeholders and their needs. Additionally, we have discussed how the use of ERP systems can help improve instructional design processes when new academic resources are developed. We pointed out common objectives between instructional design and ERP, and discussed how ERP can be used in this context. As an extension of this work, we will specifically study the use of ERP systems for decision support within the concurrent e-learning design processes.

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KEY TERMS AND DEFINITIONS

Concurrent Design: A methodology developed to effectively solve complex and multidisciplinary issues, through the use of a network of computers, multimedia devices and software tools.

Concurrent Design Facility: This is a room where the team of specialists meets to conduct cooperation sessions. The room is equipped with a network of computers, multimedia devices and software tools. The layout of the room and the location of different equipment are designed to support the design process and facilitate multidisciplinary cooperation between involved experts and other stakeholders.

Concurrent E-Learning Design: A concurrent design approach that is used to design and develop educational deliveries.

Cooperation Sessions: Working sessions that take place in a specially designed room, i.e. a concurrent design facility with a network of computers, multimedia devices and software tools. The word cooperation is used to indicate that session activities consist of communication, collaboration, and coordination.

Facilitator: A person responsible for facilitating the cooperation sessions, which normally take place in a concurrent design facility. This dedicated role can be compared to that of a conductor, who ensures that the interactions between the participants are running smoothly. The facilitator helps coordinate the cooperation so that the transition between individual and collective work is natural and appropriate.

Instructional Design: The practice of designing effective, efficient, and appealing educational deliveries.

Multidisciplinary Cooperation: Concurrent e-learning design sessions facilitate real time multidisciplinary cooperation between stakeholders including the facilitator, the session secretary, various experts, the project manager, customer representatives, service providers, prospective users, and others. The goal of multidisciplinary cooperation is to achieve fruitful and effective cooperation between all these stakeholders so that they cohere as a high-performing team that produces comprehensive solutions that are sustainable and viable.

ENDNOTES

[1] NVivo is a trademark or registered trademark of QSR International Pty Ltd.

[2] NetSupport is a trademark or registered trademark of NetSupport Ltd.

[3] Mindjet Catalyst is a trademark or registered trademark of Mindjet LLC.

[4] Google Docs is a trademark or registered trademark of Google Inc.

[5] SharePoint is a trademark or registered trademark of Microsoft Corporation.

Appendix B: Secondary Papers

This appendix includes general information on four secondary papers I have contributed to, i.e. one peer reviewed paper and three project reports. These secondary papers are not found relevant enough to be included in their entirety.

SP1: Online Learning and the Success Behind the Establishment of New Business Activities

Reference: Staupe , A., & Strand, K. A. (2009). Nettbasert læring og suksessen bak etablering av nytt næringsliv. In Haugen, H. & Postmyr, L. (Eds.), Læringsmiljø på nett – erfaringer fra forsøk og prosjekt (pp. 77-96). Nettverksuniversitetet & Tapir Akademisk Forlag.

About this paper: This paper is written and published in Norwegian and the original title is: *Nettbasert læring og suksessen bak etablering av nytt næringsliv.* The paper explains the establishment of new business activities in the Ytre Namdal region. It also clarifies the need to follow online learning programs to acquire necessary competencies as required by these new business activities.

Ytre Namdal is located in rural Norway and the local businesses have been through restructuring processes where new competencies and new skills are essential. Online learning is a nearby alternative for those located in this area since the distance to the nearest university city of Trondheim is too long for daily commuting. Online learning between higher education institutions in Trondheim and various organizations in the Ytre Namdal region has been in place since the mid-1990s, and this article was written while the EIK project was on-going.

EIK is a Norwegian acronym that refers to an innovative competence project which was established in 2007. As a part of this project an agreement between HiST/AITeL (educational provider), NTNU/IDI (technical provider), TISIP (local partner), and selected organizations in the Ytre Namdal region (customers and the local organizer) was signed. The local organizer was Norsk e-læring, a division of Ytre Namdal upper secondary school which was responsible for local services and the five local partners were Telenor, Gothia, Aktiv Kapital, Manpower and Lindorff. With this agreement HiST/AITeL was responsible for development and delivery of eight online college courses (each course worth 7.5 credits) within a period of two years (four semesters). This project is referred to as BITØK/EIK in Section 3.2.1 of this thesis. Experience gained from implementation of the BITØK/EIK project has been important for both this article and for the research on design of customized e-learning for corporate clients, in which I did more research in later phases of the doctoral program.

Relevance to this thesis: This study illustrates the need for online distance learning and it shows that higher education institutions have the opportunity to offer such education to corporate clients. Furthermore, the study helps to identify challenges that must be taken into account when online education are to be developed and delivered to corporate clients. Flexibility with content customized to client demands, suitable pedagogical delivery, technological quality, a sustainable business model, adapted administration and marketing, and local organizing are among the key challenges in this context. We identified these challenges in the early phases of the doctoral program and gradually we worked to find solutions related to this.

My contribution: The first author of this paper is my main supervisor and he was also in charge of writing this paper. My supervisor has been involved in the delivery of online education to this community in the Ytre Namdal region since its inception and this paper is based on data collected throughout this period. My contribution is that I conducted surveys and interviews against students and teachers in the BITØK/EIK project. The results of these investigations are presented in this paper and it constitutes about 15%.

SP2: Process Description for Concurrent E-Learning Design

Reference: Strand, K. A., Hjeltnes, T. A., Staupe, A., Storvik, M., Hjeltnes, T., & Maribu, G. (2011). Prosessbeskrivelse. The current version was created on the 10th of March 2011 and stored at the CCeD project web site: http://www2.tisip.no/cced/dok/Prosessbeskrivelse-CCeD.pdf

About this document: This document is written and published in Norwegian and the original title is: *Prosessbeskrivelse.* It was one of the final deliveries from the CCeD project (see Section 3.2.1 for more information about this project). The document describes the process to be followed in cases where the CCeD Method should be used and the document consists of the following elements: (1) a brief introduction to the CCeD Method, (2) an overview of the process that is graphically designed with Business Process Modeling Notation (BPMN), (3) a description of the process which includes a description of the operational roles and functions, decision points, collaborative teams, sub-models to be developed when the process is used, and the sub-processes included in the process, (4) an overview of the infrastructure at the facility where the CCeD sessions are to be conducted, (5) input and entry criteria required to start the process, (6) output and exit criteria describing the deliveries from the process, (7) an overview of all sub-processes where each sub-process is graphically designed with BPMN, in addition to a list of activities, tasks and guidelines, roles, and expected output, (8) a section on practical applications of the process, (9) an overview of process evaluation activities, (10) appropriate tools that can be used in conjunction with the process, (11) some advices in relation to required skills and training needs, and (12) the references used.

Relevance to this thesis: This document is considered relevant since it contains a description of how concurrent e-learning design projects should be implemented. The document was particularly important when it was used as a preparation for the participants in the three different CCeD projects that were conducted as part of the R&D project named CCeD (see Section 3.2.1).

My contribution: I was in charge of the writing process, but all participants in the CCeD project contributed to this report.

SP3: Template descriptions for Concurrent E-Learning Design

Reference: Storvik, M., Hjeltnes, T., Maribu, G., Strand, K. A., Staupe, A., & Hjeltnes, T. A. (2011). Malbeskrivelse. The current version was created on the 4th of April 2011 and stored at the CCeD project web site: http://www2.tisip.no/cced/dok/Malbeskrivelse-CCeD.pdf

About this document: This document is written and published in Norwegian and the original title is: *Malbeskrivelser.* It was one of the final deliveries from the CCeD project (see Section 3.2.1 for more information about this project). The document goes through the four templates used to develop the four sub-models in concurrent e-learning design, i.e. the instructional model template, the knowledge model template, the technical delivery model template, and the business model template. These templates are used as an aid in relation to focus on relevant issues during the concurrent e-learning design process when new e-learning deliverables are designed and developed. In this document each of the four respective templates are reviewed in detail. As a prelude to this, there is an introduction to the CCeD process which can also be regarded as a summary of the process description for concurrent e-learning design (i.e. SP2).

Relevance to this thesis: This document is considered relevant since the templates presented here serves as an important tool when CCeD projects are carried out. Mind-map based versions of these templates were used in the three different CCeD projects that were conducted as part of the R&D project named CCeD.

My contribution: I was one of four authors who were in charge of writing this document, while the rest of the project participants gave valuable comments during this writing process. For my part, I wrote the introduction and the section about the technical delivery model and this constitutes about 30%.

SP4: Distributed Concurrent Design – Process Description

Reference: Strand, K. A., Hjeltnes, T. A. (2011). Distributed Concurrent Design – Process Description. The current version was created on the 8th of November 2011 and stored at the UnderstandIT project web site: http://aitel.hist.no/understandit/docs/WP2-Distributet-Concurrent-Design-%28Process%20Description%29II.pdf

About this document: This document is one of the final deliveries from the UnderstandIT project, i.e. result number 4 from work package number 2. The document contains basic requirements for distributed concurrent design which is a methodological approach that builds on computer-supported cooperative work and traditional (co-located) concurrent design. Successful distributed concurrent design has an overall need for communication, coordination, collaboration and workspace awareness to support the needed interactions between involved people, the processes and the tools. This description consists of: (1) an introduction which says something about the background of the distributed concurrent design approach, (2) a section with benefits of distributed concurrent design which is largely based on theoretical considerations (i.e. communication, coordination, collaboration, and awareness), (3) a section about the people involved, (4) a section about the process for distributed concurrent design projects, (5) a section about appropriate tools, (6) a section that deals with project deliverables, and (7) a section containing the referred sources. The theoretical considerations in this document are largely based on P5, which also uses empirical data from the UnderstandIT.

Relevance to this thesis: This document is relevant since it contains instructions for how to implement distributed concurrent design in the UnderstandIT project. The planning and the implementation of distributed concurrent design as part of the UnderstandIT project formed the basis for a central part of C4 in this thesis.

My contribution: I was the leading author of this document but I had fruitful discussions with my co-author along the way. It was me and my co-author who had primary responsibility for implementing distributed concurrent design in the UnderstandIT project and it was also us who facilitated the cooperation sessions in this project.

Appendix C: Statements of co-authorship

This appendix includes a statement of co-authorship from all co-authors in this paper based thesis. This includes the following:

Statement of co-authorship on selected primary papers from:

1. Arvid Staupe
2. Geir Magne Maribu
3. Tor Atle Hjeltnes

Statement of co-authorship on selected secondary papers from:

1. Arvid Staupe
2. Tor Atle Hjeltnes
3. Monica Storvik
4. Thorleif Hjeltnes
5. Geir Magne Maribu

To whom it may concern

Statement of co-authorship on joint publications to be used in the PhD-thesis of Knut Arne Strand

(Cf. NTNU PhD-regulations §7.4, section 4)

As co-author on the following joint publications in the PhD-thesis: *"Concurrent Design Approach to the Design of Customized Corporate E-Learning"* by Knut Arne Strand:

- **Paper 1** — Strand, K.A. & Staupe, A. (2009). To Provide Online Distance Learning as a Portfolio of Services. In G. Siemens & C. Fulford (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2009 (pp. 4433-4442). Chesapeake, VA: AACE.
- **Paper 3** — Strand, K. A. & Staupe, A. (2010). The Concurrent E-Learning Design Method. In Z. Abas et al. (Eds.), Proceedings of Global Learn Asia Pacific 2010 (pp. 4067-4076). AACE.
- **Paper 4** — Strand, K. A. & Staupe, A. (2010). Action Research Based Instructional Design Improvements. In Falmyr, T. (Eds.), Norsk konferanse for organisasjoners bruk av informasjonsteknologi, NOKOBIT 2010, (pp. 25-38). Gjøvik University College.
- **Paper 5** — Strand, K. A., Staupe, A. & Maribu, G. M. (2012). Prescriptive Approaches for Distributed Cooperation. In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2012 (pp. 1011-1020). Chesapeake, VA: AACE.
- **Paper 6** — Strand, K. A., Staupe, A., & Hjeltnes, T. A. (2013). Principles of Concurrent E-Learning Design. In K. Patel, & S. Vij (Eds.), Enterprise Resource Planning Models for the Education Sector: Applications and Methodologies (pp. 48-75). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-2193-0.ch004
- **Secondary Paper 1** — Staupe, A., & Strand, K. A. (2009). Nettbasert læring og suksessen bak etablering av nytt næringsliv. In Haugen, H. & Postmyr, L. (Eds.), Læringsmiljø på nett – erfaringer fra forsøk og prosjekt (pp. 77-96). Nettverksuniversitetet & Tapir Akademisk Forlag.
- **Secondary Paper 2** — Strand, K. A., Hjeltnes, T. A., Staupe, A., Storvik, M., Hjeltnes, T., & Maribu, G. (2011). Prosessbeskrivelse. The current version was created on the 10th of March 2011 and stored at the CCeD project web site: http://www2.tisip.no/cced/dok/Prosessbeskrivelse-CCeD.pdf
- **Secondary Paper 3** — Storvik, M., Hjeltnes, T., Maribu, G., Strand, K. A., Staupe, A., & Hjeltnes, T. A. (2011). Malbeskrivelse. The current version was created on the 4th of March 2011 and stored at the CCeD project web site: http://www2.tisip.no/cced/dok/Malbeskrivelse-CCeD.pdf

I declare that his contribution to the publications is correctly identified, and I agree that this work is to be used as part of the thesis.

Trondheim 13/7 - 2012

Place, Date

Arvid Staupe

To whom it may concern

Statement of co-authorship on joint publications to be used in the PhD-thesis of Knut Arne Strand

(Cf. NTNU PhD-regulations §7.4, section 4)

As co-author on the following joint publications in the PhD-thesis: *"Concurrent Design Approach to the Design of Customized Corporate E-Learning"* by Knut Arne Strand:

- Paper 5 — Strand, K. A., Staupe, A. & Maribu, G. M. (2012). Prescriptive Approaches for Distributed Cooperation. In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2012 (pp. 1011-1020). Chesapeake, VA: AACE.
- Secondary Paper 2 — Strand, K. A., Hjeltnes, T. A., Staupe, A., Storvik, M., Hjeltnes, T., & Maribu, G. (2011). Prosessbeskrivelse. The current version was created on the 10th of March 2011 and stored at the CCeD project web site: http://www2.tisip.no/cced/dok/Prosessbeskrivelse-CCeD.pdf
- Secondary Paper 3 — Storvik, M., Hjeltnes, T., Maribu, G., Strand, K. A., Staupe, A., & Hjeltnes, T. A. (2011). Malbeskrivelse. The current version was created on the 4th of March 2011 and stored at the CCeD project web site: http://www2.tisip.no/cced/dok/Malbeskrivelse-CCeD.pdf

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3.7.2012, Trondheim	Geir Maribu
Place, Date	*Geir Magne Maribu*

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- Paper 2 — Strand, K. A., & Hjeltnes, T. A. (2009). Design of Customized Corporate E-Learning. Seminar.net - International journal of media, technology and lifelong learning, 5(2), 14.
- Paper 6 — Strand, K. A., Staupe, A., & Hjeltnes, T. A. (2013). Principles of Concurrent E-Learning Design. In K. Patel, & S. Vij (Eds.), Enterprise Resource Planning Models for the Education Sector: Applications and Methodologies (pp. 48-75). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-2193-0.ch004
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- Secondary Paper 3 — Storvik, M., Hjeltnes, T., Maribu, G., Strand, K. A., Staupe, A., & Hjeltnes, T. A. (2011). Malbeskrivelse. The current version was created on the 4th of April 2011 and stored at the CCeD project web site: http://www2.tisip.no/cced/dok/Malbeskrivelse-CCeD.pdf
- Secondary Paper 4 — Strand, K. A., Hjeltnes, T. A. (2011). Distributed Concurrent Design – Process Description. The current version was created on the 8th of November 2011 and stored at the UnderstandIT project web site: http://aitel.hist.no/understandit/docs/wp2-Distributet-Concurrent-Design-%28Process%20Description%29II.pdf

I declare that his contribution to the publications is correctly identified, and I agree that this work is to be used as part of the thesis.

2. 7. 2012 — Tor Atle Hjeltnes

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To whom it may concern

Statement of co-authorship on joint publications to be used in the PhD-thesis of Knut Arne Strand

(Cf. NTNU PhD-regulations §7.4, section 4)

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- Secondary Paper 2 — Strand, K. A., Hjeltnes, T. A., Staupe, A., Storvik, M., Hjeltnes, T., & Maribu, G. (2011). Prosessbeskrivelse. The current version was created on the 10th of March 2011 and stored at the CCeD project web site: http://www2.tisip.no/cced/dok/Prosessbeskrivelse-CCeD.pdf
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I declare that his contribution to the publications is correctly identified, and I agree that this work is to be used as part of the thesis.

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Statement of co-authorship on joint publications to be used in the PhD-thesis of Knut Arne Strand

(Cf. NTNU PhD-regulations §7.4, section 4)

As co-author on the following joint publications in the PhD-thesis: *"Concurrent Design Approach to the Design of Customized Corporate E-Learning"* by Knut Arne Strand:

- Secondary Paper 2 — Strand, K. A., Hjeltnes, T. A., Staupe, A., Storvik, M., Hjeltnes, T., & Maribu, G. (2011). Prosessbeskrivelse. The current version was created on the 10th of March 2011 and stored at the CCeD project web site: http://www2.tisip.no/cced/dok/Prosessbeskrivelse-CCeD.pdf
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I declare that his contribution to the publications is correctly identified, and I agree that this work is to be used as part of the thesis.

Trondheim 3/7 -12 — Monica Storvik

Place, Date — *Monica Storvik*