OULU 2014
C 479

ACTA UNIVERSITATIS OULUENSIS

Päivi Haho

LEARNING ENABLERS, LEARNING OUTCOMES, LEARNING PATHS, AND THEIR RELATIONSHIPS IN ORGANIZATIONAL LEARNING AND CHANGE

UNIVERSITY OF OULU GRADUATE SCHOOL;
UNIVERSITY OF OULU,
FACULTY OF TECHNOLOGY,
DEPARTMENT OF INDUSTRIAL ENGINEERING AND MANAGEMENT

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Academic dissertation to be presented with the assent of the Doctoral Training Committee of Technology and Natural Sciences of the University of Oulu for public defence in OP-sali (Auditorium L10), Linnanmaa, on 7 February 2014, at 12 noon

UNIVERSITY OF OULU, OULU 2014

Acta Univ. Oul. C 479, 2014

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ISBN 978-952-62-0357-7 (Paperback)
ISBN 978-952-62-0358-4 (PDF)

ISSN 0355-3213 (Printed)
ISSN 1796-2226 (Online)

Cover Design
Raimo Ahonen

JUVENES PRINT
TAMPERE 2014

Haho, Päivi, Learning enablers, learning outcomes, learning paths, and their relationships in organizational learning and change.
University of Oulu Graduate School; University of Oulu, Faculty of Technology, Department of Industrial Engineering and Management
Acta Univ. Oul. C 479, 2014
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Abstract

The purpose of this thesis is to examine the role of learning and the constituents of learning in creating process innovations and realizing organizational change. Organizational learning was studied and the data was collected in process development projects, in which process simulations were used as a development method for process innovations and change.

The empirical research was carried out mainly in 1988–2001. In this thesis, the results of those studies are reflected on, together with the recent literature related to organizational learning theories in the context of process innovations and management of change. Specifically, the concepts of learning enablers, learning outcomes (intangible/tangible), learning paths, and their relationships are studied.

Qualitative longitudinal action research with case studies and abductive reasoning are used as the research methods throughout this thesis. The data consists of 34 cases and 99 process simulations in 12 different industries and varies from large core processes to support processes. The case organizations were mainly Finnish companies with Finns as the majority of participants. One case organization was from Switzerland, and in five cases, multicultural groups participated in the process simulations. In each project, process simulations were used at least once during a change project, in some cases even five to eight times. The data analysis proceeded in an abductive manner throughout the included five articles, and the findings are summarized based on the research questions.

The theoretical contribution of this thesis is fourfold. The findings give new understanding 1) about learning enablers, their relationships to each other and influence on learning and process innovations, 2) about the role of intangible and tangible learning outcomes in individual and organizational learning processes and 3) about learning paths in process innovations and related change processes. The thesis also defines 4) a model for effective learning processes in change projects concerning process innovations.

The contribution in the practical and managerial context should be applicable field of North and West European commercial organizations. This thesis highlights individual and organizational learning in the creation of process innovations, and it also defines the features of an effective development method for creating and implementing process innovations.

Keywords: action research, change management, learning enabler, learning outcome, learning path, organizational learning, process development, process innovation, process simulation

Haho, Päivi, Oppimisen mahdollistajat, oppimisen tulokset, oppimisen polku ja niiden suhde organisaation oppimisessa ja muutoksessa.
Oulun yliopiston tutkijakoulu; Oulun yliopisto, Teknillinen tiedekunta, Tuotantotalouden osasto
Acta Univ. Oul. C 479, 2014
Oulun yliopisto, PL 8000, 90014 Oulun yliopisto

Tiivistelmä

Tämän väitöskirjan tarkoituksena on tutkia organisaation oppimisen ja sen eri osatekijöiden roolia prosessi-innovaatioiden luomisessa ja muutoksen aikaansaamisessa organisaatiossa. Organisaation oppimista tutkittiin ja aineisto kerättiin prosessien kehittämisprojekteissa, joissa prosessisimulaatioita käytettiin prosessi-innovaatioiden menetelmänä.

Tutkimuksen aineisto kerättiin pääsiassa vuosien 1988–2001 aikana. Tässä väitöskirjassa näitä tuloksia analysoidaan vallitsevien organisaatio-oppimisen teorioiden valossa prosessi-innovaatioiden ja muutoksen johtamisen asiayhteydessä. Erityisesti tutkitaan oppimisen mahdollistajia, oppimisen tuloksia (aineettomia/aineellisia), oppimisen polkuja ja kaikkien näiden keskinäisiä suhteita.

Tutkimusmenetelmänä on käytetty laadullista pitkittäistä toimintatutkimusta tapaustutkimuksineen ja abduktiivisine päättelyineen. Aineisto koostuu 34 tapaustutkimuksesta ja 99 prosessisimulaatiosta, jotka toteutettiin 12 eri toimialalla, ja vaihtelevat ydinprosesseista tukiprosesseihin. Suurimmaksi osaksi tapausorganisaatiot olivat suomalaisia yrityksiä, ja yksi tapausorganisaatio oli sveitsiläinen. Projektiryhmät olivat pääasiassa suomalaisia, mutta monikulttuurinen ryhmä osallistui prosessisimulointiin viidessä tapaustutkimuksessa. Jokaisessa projektissa prosessisimulointia käytettiin ainakin kerran muutosprojektin aikana, joissakin tapauksissa jopa viidestä kahdeksaan kertaan. Väitöskirjan viiden artikkelin aineiston analysointi suoritettiin abduktiivisen päättelyn periaattein, ja tutkimuksen tulokset esitetään tutkimuskysymysten mukaisesti.

Tutkimuksen teoreettinen tulos kohdistuu neljään osa-alueeseen. Tulokset lisäävät ymmärrystä 1) oppimisen mahdollistajista, niiden suhteesta toisiinsa ja vaikutuksesta oppimiseen ja prosessi-innovaatioihin, 2) aineettomien ja aineellisten oppimistulosten roolista yksilön ja organisaation oppimisprosesseissa, ja 3) prosessi-innovaatioiden ja niihin liittyvien muutosprosessien oppimisen poluista. Tutkimus myös määrittelee 4) prosessi-innovaatioita koskevien muutosprojektien oppimista korostavan mallin.

Tutkimuksen tuloksia voitaneen soveltaa Pohjois- ja Länsi-Euroopan yritysmaailmassa. Tutkimus korostaa yksilön ja organisaation oppimisen merkitystä prosessi-innovaatioiden luomisessa ja lisäksi se määrittelee vaikuttavan prosessi-innovaatioiden kehittämisen ja käyttöönoton menetelmän piirteet.

Asiasanat: muutosjohtaminen, oppimisen mahdollistaja, oppimisen polku, oppimisen tulos, organisaation oppiminen, prosessi-innovaatio, prosessin kehittäminen, prosessisimulointi, toimintatutkimus

Learning enablers, learning outcomes, learning paths, and their relationships in organizational learning and change

Päivi Haho

Acknowledgements

This thesis has been a long process of learning and acting on that learning, and many people have crossed my path and helped me in bringing this research to a finish. I am deeply grateful to all of you.

I thank my principal supervisor Professor Pekka Kess from the University of Oulu for being supportive and trustful throughout the process. It has been more than a great pleasure to receive his professional guidance. Without him, I would not have finished this dissertation.

I thank also supervisor Dr. Mirja Väänänen from the University of Oulu, whose guidance and opinions were important for finalizing this work.

I am deeply grateful to Professor Jussi Kantola from the University of Vaasa and Dr. Ville Isoherranen from ABB for acting as pre-examiners of this dissertation. Their comments encouraged me and enabled me to make this dissertation stronger. I greatly appreciate their time and effort.

During my doctoral studies I worked at Aalto University. I wish to thank Prof. Riitta Smeds, Prof. Matti Vartiainen and Prof. Eero Eloranta for guiding and instructing me during that time.

Also, I would like to thank my colleagues and friends from Aalto University and Helsinki Metropolia University of Applied Sciences; Minna-Kaarina Forssén, Marika Vänttinen, Anja Karvonen-Kälkäjä, Elina Eriksson, Päivi Laine, Riikka Rissanen, and others. I thank Dr. Minna-Kaarina Forssén for insightful comments on my text in its different phases and for ongoing encouragement. I thank Docent Elina Eriksson for supporting me at the exactly right time. Marika, Anja, Päivi and Riikka have always listened to and supported me, when I needed someone to talk to during the research process.

I thank my exceptional friend Eija-Riitta Niinikoski with whom I have had the privilege to discuss and spend time during the years of my life. She was there for me at a turning point for my finishing this work.

I am thankful to my friend, translator-proofreader Ronja Addams-Moring, who has done an excellent job checking my English. It has been great to experience her entire coaching method – not just to get the text proofread, but to learn English more comprehensively with her.

I would like to thank The Finnish Work Environment Fund, who has supported my writing process through a grant. In addition, I want to thank TEKES and Aalto University for funding the research included in this dissertation.

I warmly thank my great family, especially my late father Antti, who showed me a special path to working life, and my mother Elina, who has always supported my endeavors. Finally, I thank my lovely husband Ridha, who has gracefully supported me in my life – and taught me more about life than a dissertation ever can.

Espoo, November 24th, 2013 Päivi Haho

List of original articles

This dissertation includes an extended summary and five appended articles.

I Haho P & Smeds R (1997) The Softmatch-method: Enterprise transformation through simulation games. In: Saunders P & Cox B (eds) The International Simulation and Gaming Yearbook Volume 5: Research into Simulations in Education. London, Kogan Page: 48–63.

II Haho P (1998) Strategy and operation in dynamic interaction. In: Bititci U & Carrie A (eds) Strategic Management of the Manufacturing Value Chain. Proceedings of the International Conference of the Manufacturing Value-Chain August '98, Troon, Scotland, UK. Boston, Kluwer Academic Publishers: 113–122.

III Forssén M & Haho P (2001) Participative development and training for business processes in industry: review of 88 simulation games. International Journal of Technology Management, Special Issue: Implementation of Business Process Innovations 22(1-3): 233–262.

IV Smeds R, Haho P & Alvesalo J (2003). Bottom-up or top-down? Evolutionary change management in NPD processes. International Journal of Technology Management 26(8): 887–902.

V Haho P (2004) Paths to Deutero-learning through Successive Process Simulations: A Case Study. Knowledge and Process Management 11(4): 239–251.

Contents

1 Introduction

1.1 Background

Change management is a basic task in the management of organizations, particularly nowadays, when change is a continuous effort. Therefore, it is especially important to understand how the changes in organizations should be led and put into practice, so that they would be effective but at the same time treat the personnel and their resources with respect. This is very important, when the subject of change and innovations are the activities and processes of the organization, which affect the greater part of the personnel. In the changes of organizational operations, the personnel are a positive asset, if they can be recruited to help with a change in the different phases of the change in the right ways. In this thesis, the change processes and projects connected to the process innovations in organizations are studied, in which process simulations have been used as the development method for an organizational change. The goal of the research and the research questions have emerged of the practical observation that the process simulation method could have some specific elements, which significantly enable organizational learning and the implementation of a change.

In this study, learning in organizations and its components, and its effect on process innovations during these change projects was the observed focus area. The theories of change management and innovation management, particularly of process innovations, are essential background for this study.

The role of change management in process innovations

The theory of change management explores the rules and principles for the understanding and effective management of organizational change (e.g. Kotter 1996, 2002). Change management entails profound and sensitive planning and implementation consultation with, and involvement of the people affected by the changes. The theory of change management draws together modern principles, which reinforce successful change. For example, Kotter's 8-step process for leading change (1996) formulates the steps as: establishing a sense of urgency, creating the guiding coalition, developing a change vision, communicating the vision for by-in, empowering broad-based action, generating short-term wins, never letting up, and incorporating changes into the culture.

Many others have studied the general principles of the management of organizational change (e.g. Van de Ven and Poole 1995, Kettinger and Grover 1995, Orlikowski and Hofman 1997, Waddell and Sohal 1998, Paton and McCalman 2008). Also organizational change's relation e.g. to Enterprise Resource Planning (ERP) implementation (Aladwani 2001), to the implementation of the balanced scorecard system (Kasurinen 2002), to teams (Pearce and Sims 2002, Sisaye 2005), to management control systems (Sisaye 2005), to ICT (Davidaviciene 2008), and to organizational development, transformational learning and process innovations (Sisaye 2010) has been studied. For example, Sisaye (2010) argues that it is imperative for managers to examine the relationships of organizational development (OD) and organizational transformation (OT) using the single-loop and double-loop organizational learning strategies, but not even he addresses the deeper success factors of organizational change nor of individual and organizational learning.

Innovation management, process innovations and the role of learning in process innovations

In this thesis the term *process innovation* – innovation, which is dependent of and influences the whole service, production and delivery chain – is understood broadly. Originally, a process innovation is an either radical or incremental change in the way a product or a service is created, produced or distributed (Smeds 1994, Boer and During 2001, Tidd et al. 2005, 10–13). According to Nonaka (1994, 14, see also Nonaka and Kenney 1991, 67) innovation is a key form of organizational knowledge creation, and it can be understood as a process, in which the organization defines problems and then actively develops new knowledge to solve them. Davenport (1993, 10–15) distinguishes process innovation from process improvement, process innovation meaning radical change, whereas process improvement is seen as incremental.

This thesis addresses both *incremental* and *radical process innovations*, as well as *innovations that include organizational, social or administrative elements* (Boer and During 2001, Van de Ven 1986, 591, West and Altink 1996, 4–5, see also Eduardo and Simon 2009, Baregheh et al. 2009, Damanpour and Schneider 2006, Plessis 2007), and later in this thesis all these innovations are called process innovations. In this thesis, innovation includes implementation: new knowledge has to be successfully created and implemented before it can be called an innovation (Van de Ven 1986, Urabe 1988, Smeds 1994). Therefore, the term

process innovation includes the creation as well as the development of ideas, the implementation, and the evaluation process (Forssén 2002, 19, 40). All these are demanding phases in the creation of process innovations.

Process innovations are systemic and usually also complex. Individuals are rarely capable of creating or further developing process innovations without seeking additional knowledge from the organization and its network. Process related knowledge is distributed throughout the various parts of the organization. In this sense, process-related knowledge differs clearly from expert knowledge, which in general consists of the human capital of few individuals (Hakkarainen et al. 2004b, 98). Consequently, the enrichment of process-related novel ideas and operation modes requires a shared development process. An efficient implementation of novel functional practices takes place when everyone is committed to these new practices. Therefore, the role of organizational learning in the creation and implementation of process innovations is significant. In development activities, it is thus essential to use development methods that enable common dialogue and the emergence of common understanding.

The literature that was studied dealt with the role of learning in process innovations in a variety of ways. Literature on innovation management deals with learning in a superficial manner, yet emphasizes similar factors as literature on individual or organizational learning. In the following, viewpoints that are most relevant to this thesis are compiled.

In their work on innovation management Tidd et al. (e.g. 2005, 57, 400–404, 485–494) show that organizational learning is a significant success factor both in the creation and the implementation of innovations. According to them "innovation is particularly about learning". It is a knowledge-based process, both in the sense of acquiring and deploying knowledge in a strategic fashion, and in acquiring and reinforcing patterns of behavior (Tidd et al. 2005, 57). Similar to this thesis, Tidd et al. emphasize the process nature of innovation, where learning plays a central role throughout the innovation process. Thus, innovation is a process, not merely the end result. Tidd et al. (2005, 400–404) especially point out, that the costs of not managing learning are high, and that organizations ought to find ways of managing learning in innovation processes, because the routines of organizations embody what an organization has learned about how to learn. According to them, companies should review innovation projects, e.g. with structured reflection, auditing and benchmarking in order to develop both technological and managerial capabilities. Tidd et al. (2005, 485–494) also note

the need for interaction between an organization and its stakeholders, referring especially to Japanese and European studies.

Davenport (1993, 176) stresses the need of organizational learning during innovation implementation, as extensive participation by the whole organization is rarely possible during process development. Hamel (2000, 250–256, 291–294) in turn mentions business innovations, underlining the need for fresh, new talent, i.e. young people, newcomers and those from the periphery of a company, and a rapid management process for the emerging ideas.

In the literature on Japanese management (e.g. Imai 1986, 23), Japanese continuous improvement (Kaizen), and Western innovation management are seen as opposing but mutually complementary management styles. The Japanese Kaizen is process oriented, concentrating on gradual changes, participation and openness (Imai 1986, 16, 32, 226–229). These are factors that in themselves promote organizational learning during the innovations process. Western innovation management is a great-leap approach in the wake of technological breakthroughs, or the introduction of the latest management concepts or production techniques, where individualism, individual ideas and efforts are favored (Imai 1986, 23–29). Even if management styles become globalized and gradually change, traditional approaches still have influence today.

To summarize, despite the fact that some parts of the process innovation theory are close to individual and organizational learning theories, the process innovation theory does not address learning issues deeply. Process innovation literature recognizes the significance of individual and organizational learning in innovation processes, yet deals with such learning and its enablers, i.e. interaction, participation and openness, in a shallow manner. The role of learning has not been explored in the light of relationships between various learning enablers, learning outcomes and learning paths in and between interventions. This is significant especially if the results of knowledge creation ought to be implemented.

Organizational learning in process innovations

This thesis focuses on the role of organizational learning in process innovations, specifically such process innovations that lead to genuine and lasting organizational change. Thus, organizational learning theories are studied to find out how they reflect on learning enablers, learning outcomes and learning paths,

and their relationships. The theory portion of this study focuses on mainstream organizational learning theories.

Based on the definition by Senge (1990a, b) organizational learning calls for a shared vision, systemic observation and learning together. Individuals learn through shared action. Nonaka (1994) as well as Scardamalia and Bereiter (2003) expand the organizational learning concept to cover dynamic knowledge creation and knowledge building, in which the modes of knowledge creation alternate, creating novel or altering existing knowledge. Argyris and Schön (1978) call for knowledge objects as a tool for organizational learning. Duncan and Weiss (1979) emphasize outcomes as pragmatic, goal-oriented concepts. In this thesis these definitions are used as a foundation, and organizational and individual learning in the context of process innovations are defined as follows: *"Organizational learning is a goal-oriented process, mediated by the collaborative inquiry of individual members"* and *"Individual learning is a process, by which changes occur in a person's thinking and/or behavior"*.

In this thesis, *the concept of learning enabler stands for enablers, which promote learning in the organization.* Organization and learning researchers have broadly discussed the enablers of organizational learning (e.g. Locke and Schweiger 1979, Kanter 1983, Urabe 1988, Lave and Wenger 1991, Nonaka and Kenney 1991, Nonaka 1994, Smeds 1997b, Siitonen 1999, Senge 1990a, Jackson 2006, Klimecki et al. 1991, Hakkarainen et al. 2004a). So have also the earlier Finnish studies about process simulations (e.g. Piispanen and Pallas 1992, Smeds 1994, 1996a, b, 1997b, Ruohomäki 1994, 1995a, 1995b, 2002, Piispanen et al. 1996, Pankakoski 1998, Forssén-Nyberg and Kutilainen 1998, Forssén-Nyberg and Hakamäki 1998, Forssén 2002, Smeds et al. 2006). However, this literature as well as process innovation literature (cf. chapter 1) do not address the relationships between learning enablers, and their effects on the learning and formation of process innovations.

Researchers of organizational learning and innovation management speak in various ways about the results of learning processes (Argyris and Schön 1978, Nonaka and Kenney 1991, Nonaka 1994, Duncan and Weiss 1979, Nonaka et al. 2000, Tidd et al. 2005). The outcomes of the organizational learning process are changes in organizational knowledge (Duncan and Weiss 1979, 97). In recent change and project management (e.g. Nogeste 2006, Nogeste and Walker 2005, 2008, Walker et al. 2008, Yeo and Ajam 2010) and process innovation literature (e.g. Zwikael and Smyrk 2012), the concepts of intangible and tangible learning outcome/s are discussed within different topics. Typically, the intangible

outcomes include, but are not limited to, relationships, knowledge, processes and systems, leadership and communication, culture and values, reputation and trust, skills and competences. In this thesis, organizational learning is seen as a continuous process, whereas an outcome is the result of this process, and *it is defined that intangible learning outcomes are qualitative learning results, which are difficult to measure, and tangible learning outcomes are quantitative learning results, which could be measured with relative ease* (see also Forssén and Haho 2001, Haho 2002: figure 2.2). Both intangible and tangible learning outcomes can emerge on the individual or the organizational level. Based on these definitions, learning outcomes and the relationships between them are analyzed, and they are connected to the learning processes presented by Argyris and Schön (1978). Also their relationships to learning enablers are discussed.

In this thesis, Argyris and Schön's (1978) concepts of single-loop, double-loop and deutero-learning are used to explain the characteristics of learning paths and their relationships to learning outcomes. Learning is a process-based practice of which end results, the outcomes are (see also Duncan and Weiss 1979). Learning outcomes are results of single-loop learning, if the outcomes are within the range set by organizational norms, whereas double-loop learning (and deutero-learning) can affect outcomes by changing norms in the organization (Argyris and Schön 1978). Knowledge transforms when tacit and explicit knowledge meet (Nonaka and Takeuchi 1995), creating completely new knowledge or reinforcing existing knowledge. In process innovations, individual and organizational learning and knowledge creation can be seen as a goal-oriented collective process (see also Duncan and Weiss 1979), in which the different tools and artifacts are used for the achievement of the process goals and for the continuity of the learning (see also Scardamalia and Bereiter 2003, 2006). The mentioned studies, such as the other key works of Nonaka and Takeuchi (1995), Engeström (e.g. 1999a, b) and Kolb (1984), describe learning as a cyclic or expansive process, but they do not pay enough attention to the outcomes of the learning process or to their impacts on the next steps in forming process innovations. The earlier studies of process simulations (Smeds 1996a, b, 1997a, b, Ruohomäki 2002) recognize that process innovations emerge stepwise along an evolutionary path, but they do not speak specifically about learning paths or how learning paths and intermediate outcomes affect the subsequent outcomes. In this thesis *the concept of learning path is defined: "Learning path is a (continuous) pathway from one outcome to another."*

In this thesis, the relationships of the studied elements, i.e. learning enablers, learning outcomes, and learning paths are not analyzed in a traditional sequential way. There is no theoretical pre-frame or expectation of the sequence of relationships, even if one is likely to observe relationships in a traditional way, i.e. learning enablers foster a learning path, the results of which learning outcomes are. The results regarding the relationships of the elements have emerged abductively during the research process.

Literature on organizational learning (e.g. Argyris and Schön 1978, Duncan and Weiss 1979, Kolb 1984, Engeström 1987, 1990, 1999a, b, Nonaka 1994, Nonaka and Takeuchi 1995, Nonaka et al. 2006, Nonaka and von Krogh 2009, Scardamalia 2002, Scardamalia and Bereiter 2003, 2006, Wang and Ahmed 2003, Bapuji and Crossan 2004, Liao et al. 2008, Argote and Miron-Spektor 2011), process innovations (e.g. Tidd et al. 2005, Davenport 1993, Hamel 2000, Imai 1986) and change management (e.g. Sisaye 2005, 2010) has been useful in describing how individual and organizational learning occur in organizations, but it has not focused on explaining how this learning arises in process innovations. The goal of this thesis is to fill this gap in the organizational learning, process innovation and change management literature.

1.2 Purpose and objectives

There is little systematic research that simultaneously conceptualizes the relationships of learning enablers, learning outcomes and learning paths, within organizational learning, process innovation, and change management literature (e.g. Argyris and Schön 1978, Duncan and Weiss 1979, Kolb 1984, Engeström 1987, 1990, 1999a, b, Nonaka 1994, Nonaka and Takeuchi 1995, Nonaka et al. 2006, Scardamalia 2002, Scardamalia and Bereiter 2003, 2006, Tidd et al. 2005, Davenport 1993, Hamel 2000, Imai 1986, Sisaye 2005, 2010). Likewise, researchers of process innovations have not studied empirically how the emergence of intangible outcomes might result in effective and continuous learning paths from primary outcomes to more advanced outcomes and further towards process innovations. To advance broader discussion and theory-building on the role of individual and organizational learning in process innovations, this research gap is addressed in this thesis.

Finally, to fill the research gap, this thesis seeks a model for learning to achieve process innovations (articles 1–5). The main practical objective of this thesis is to offer efficient principles and viewpoints for enhancing the

management and development of process innovations and lasting change in organizations.

To advance broader discussion and theory-building on the role of individual and organizational learning in process innovations, this research postulates the following research questions:

- Q1: What are the learning enablers and their relationships to learning paths?
- Q2: What kinds of learning outcomes emerge and what are their relationships to learning paths?
- Q3: How do the learning enablers and the learning outcomes mutually create the learning paths, and what are their relationships to each other?

1.3 Research approach

In this thesis, qualitative longitudinal action research and case studies with abductive reasoning (Grönfors 1982, 27–37, Paavola et al. 2006, Ketokivi and Mantere 2010) are used as a research method. The process simulations are used both as a process development method and as a research method. The articles in this thesis are largely based on Kaplan's (1998) thoughts: research is a cyclic process, in which the various sequential interventions complement preceding knowledge based on the feedback on practical experience.

Action research is not a loose act. On the contrary, it becomes closely integrated with the organization being studied and its activities, and also changes them. During the research process, both the theory and the praxis are learning and changing.

The 34 case studies consist of process development projects where process simulations have been used as a development method for accomplishing change. The cases vary from large core processes to support processes including metal, electronic, telecommunication, paper, printing, pharmaceutical, dairy, and consumer industries. The case organizations were mainly Finnish companies with Finns as the majority of participants. One case organization was from Switzerland, and in five cases, multicultural groups participated in the process simulations. In each project, process simulations were used at least one time during a change project, in some cases even five to eight times.

The empirical research was carried out mainly in 1988–2001. In this thesis, the results of those studies are reflected on, together with the recent literature related to organizational learning theories in the context of process innovations

and management of change. Specifically, the concepts of learning enablers, learning outcomes (tangible/intangible) and learning paths, and their relationships are studied.

The role of process simulations in this research

The process simulation method (Smeds and Haho 1995a, b, Haho and Smeds 1996a, b, Haho and Smeds 1997, Smeds 1997b, Haho 1998a, Forssén and Haho 2001, Haho 2002, Smeds et al. 2003, Smeds and Alvesalo 2003a, b, Haho 2004) is used in all articles of this thesis as both a process development method and a research method (participatory action research).

The process simulation method is a research and development method, which has been developed at the SimLab unit of Helsinki University of Technology[1]. Initially the method was developed in the Softmatch project and in the preceding feasibility study during the years 1993–1997. The researchers of SimLab developed the method further in 1998–2001, and the method was renamed the SimLab™ process simulation method. The method has been used in research projects and in organization development projects by the SimLab unit since 1998. The earlier versions of the SimLab™ process simulation method are called: simulation game, social process simulation, the Softmatch method, and the SimLab process simulation.

The process simulation method is an empowering, facilitated discussion about the activities, tasks and information flows in a selected business process. When simulating a business process, real case projects are analyzed and modeled into visual process charts, and thereafter systematically talked through in a process-oriented way, to demonstrate what the process is in reality. Similarly, a future process design can also be developed and tested in process simulation sessions. The discussions are led by a facilitator, and supported by visual process models on large wall screens. (Smeds et al. 2003, 890–891)

A process simulation is like a role-playing game (Saunders 1995, Hakamäki and Forssén-Nyberg 1996, Haho and Smeds 1997, Haho et al. 1997), where employees play their own roles explaining their tasks and problems. However, a process simulation differs from role-playing exercises in its emphasis on interaction and dialogue rather than on the playing of individual roles. Simulation stands for modeling reality, process simulation is not computer-aided, and the

[1] today a part of Aalto University

driving force behind process simulation will be found in the interaction and communication between participants, not in human-computer interaction (Smeds 1998).

During the process simulations and their planning and feedback sessions, the participants learn in many ways: they affiliate into a development network and team for a case, and they create new practices and innovations combining practical and theoretical knowledge during and between process simulations.

As the learning outcomes of the process simulations, the participants adopt a shared overall view of subject matters, they understand business operations and processes better, they expand problem solving skills, and they create new knowledge and the novel process innovations for the processes under development.

The process simulation method does not require the adopting of complex theoretical knowledge; instead it emphasizes the discovery and development of processes or networks from a practical basis. The interventions include interviewing, process modeling, facilitating and observing during simulations, and reflecting during feedback sessions in the simulation community.

The construct, the process development method, depicted in article 1 was originally developed to sustain practical changes and process innovations in an organization. The purpose of the method development has been to develop a method, which identifies the fields of know-how and potentiality in the organization, and which makes use of this potentiality to gain the objectives of organizational development.

In many change management methods, creativity and learning are killed through “paralysis by analysis”. Process simulations were developed to counter this problem. Process simulations create a development framework that respects and makes use of the skills and creativity of all organization members. (Haho and Smeds 1996b)

The process simulation method can be used as a research method for collecting research data, as in the articles of this thesis. Additionally, the process simulation method can be used at the very beginning of a research project to illustrate a research phenomenon, and to discover and focus problem-based research topics.

During a process simulation, data can be systematically collected, for example, by observing, videotaping, note taking and recording. Often a long preparation period precedes the process simulation, during which research data is collected and interviews are made. Also, quite often post-interviews are made

after the process simulations, even after several years. The development and research projects can be long, wherefore the phenomena can be investigated during several sequential simulations and between them.

The research design associated with process simulations is typically action research (cf. Lewin 1997, Gummesson 1991, Argyris and Schön 1991, Kuula 1999, Buhanist 2000), in which the case studies and cross-case studies are used as data (Gerring 2007a, b).

1.4 Research realization and the structure of the dissertation

This thesis is organized as follows. In chapter 2, key literature concerning learning in organizations, learning models, processes and paths, learning enablers, and learning outcomes in the context of process innovations and organizational change is reviewed. The earlier Finnish empirical findings about process simulations related to organizational learning theories are also introduced. At the end of the chapter, an existing theoretical gap is presented, and an initial theoretical model is outlined, which will be used to analyze the findings of the articles and to further develop the theoretical framework through abductive reasoning. In chapter 3, three research questions are presented and the research methods and research process are introduced. In chapter 4, the researchers' role in each article is described and each article is briefly introduced: the data, its collection and analysis, the findings and a discussion concerning the research questions of this thesis. In chapter 5, the findings of the articles are interpreted and the research results are presented in the form of propositions. Finally, in chapter 6, the theoretical model that emerges from this work is elaborated on and both the theoretical and managerial contribution of this thesis is described. In the end of chapter 6, the limitations of the thesis are analyzed, and some directions for future research are proposed.

2 Theoretical background

In this chapter, the key research on organizational learning in process innovations is reviewed. Firstly, the distinction between individual and organizational learning is addressed, after which the roles in organizational learning of learning models, learning processes and learning paths, learning enablers, and learning outcomes are discussed. The earlier Finnish research on process simulations concerning organizational learning is also presented. Finally, a theoretical gap in organizational learning literature is presented and an initial theoretical framework for organizational learning in process innovations is formed.

2.1 Learning in organizations

Researchers define the concepts of individual or organizational learning and their content in slightly different ways. In the following these definitions are considered, and the ones best suited are adapted for this thesis.

Argyris and Schön (1978, 17, 19) describe organizational learning as a process mediated by the collaborative inquiry of individual members. Private images and public maps are the media of organizational learning. The individuals act as agents of organizational learning as they bring changes into organizational theory-in-use by detecting and correcting errors and embedding the results of their inquiry in private images and shared maps of the organization. In their definition, Argyris and Schön bring forth experiential learning, the actions by the organization's members, and the meaning of artifacts in organizational learning.

Duncan and Weiss (1979, 84) define organizational learning as the process within the organization, by which knowledge about action-outcome relationships and the effects on the environment of these relationships is developed. Organizational learning concerns the development of knowledge, which would make a change possible or unnecessary. Thus, organizational learning need not imply any change in effectiveness or actions. (Duncan and Weiss 1979, 84) An organization can learn without the implementation of created ideas. According to Duncan and Weiss (1979, 84), individual learning is often defined as a process, by which relatively permanent changes occur in a person's behavior as a result of some experience the person has had. The views of Duncan and Weiss on organizational learning, and especially the role of outcomes in learning, are very near the interpretation of learning and outcomes in this thesis. The definition of Duncan and Weiss emphasizes a pragmatic and goal-directed view.

Scardamalia and Bereiter (2003, 1370) distinguish between learning and knowledge building: learning is an internal, unobservable process that results in changes of belief, attitude or skill, and it is a process, through which the rapidly growing cultural capital of society is distributed. Knowledge building, by contrast, results in the creation or modification of public knowledge or the cultural capital of society. Creating public knowledge results in personal learning. Furthermore, Nonaka (1994, 34) points out that learning can be related to internalization, which is one of the four modes of conversion required to create new organizational knowledge, and it has quite limited and static connotations whereas organizational knowledge creation is a more dynamic concept.

According to Senge, organizations learn through learning individuals (Senge 1990a, b). Learning is closely linked with building a shared vision and developing individual skills. Senge asserts that learning organizations include five important skills areas: systems thinking, personal mastery, mental models, building shared vision, and team learning (1990a, 3–16). Senge points out that it is vital to develop the five disciplines as an ensemble, and systems thinking integrates the disciplines, fusing them into a coherent body of theory and practice. Building a shared vision fosters commitment in the long term; mental models focus on the openness needed to unearth shortcomings in our present ways of seeing the world; team learning develops the skills of groups of people to look for the larger picture that lies beyond individual perspectives; and personal mastery fosters the personal motivation to continually learn how our actions affect our world. (Senge 1990a, 12) Senge emphasizes systems thinking, since it helps to understand a complex reality in a new way, especially from the point of view of learning.

Both in individual and organizational learning, the definitions distinguish between learning itself and knowledge creation. Learning (internalization and acquisition, as opposed to knowledge building) is an internal process that results in changes of belief, attitude or skill of an individual or an organization. Knowledge creation, by contrast, results in the creation or modification of individual or public knowledge. Even if new knowledge is created, it does not need to be implemented to constitute learning.

Based on the definition by Senge, organizational learning calls for a shared vision, systemic observation, and learning together. Individuals learn through shared action. Nonaka as well as Scardamalia and Bereiter expand the organizational learning concept to cover dynamic knowledge creation and knowledge building, in which the modes of knowledge creation alternate, creating novel or altering existing knowledge. Argyris and Schön call for knowledge

objects as a tool for organizational learning. Duncan and Weiss emphasize outcomes as pragmatic, goal-oriented concepts.

In this thesis the above definitions are used as a foundation, and organizational and individual learning in the context of process innovations are defined as follows: *"Organizational learning is a goal-oriented process, mediated by the collaborative inquiry of individual members"* and *"Individual learning is a process, by which changes occur in a person's thinking and/or behavior"*.

2.2 Learning models, learning processes and learning paths in organizational learning literature

Individual and organizational learning have been described under diverse models and processes by the several authors during the past decades. In the following, only such research of learning models and processes and the concept of learning path is investigated and reviewed, which is related to knowledge creation and is thus relevant for this thesis.

Argyris and Schön (1978, 18–20, 29) created the concepts of single-loop learning, double-loop learning and deutero-learning to explain learning in organizations. In organizational single-loop learning the individuals act in response to error by modifying strategies and inventing new ones based on new assumptions within organizational norms. The norms themselves remain unchanged. In order for organizational learning to occur, the learning agents' discoveries and inventions must be evaluated, generalized and embedded in organizational memory. In some cases, however, the correction of inconsistencies requires an organizational learning cycle, in which organizational norms themselves are modified. Argyris and Schön call this double-loop learning. Double-loop learning consists not only of a change in organizational norms but also of the particular sort of inquiry into norms, which is appropriately described as learning (Argyris and Schön 1978, 20–26, 29). The organizational learning that carries out single- and double-loop learning is called deutero-learning (Bateson, 1972). Argyris and Schön (1978, 27) remark that when an organization engages in deutero-learning its members reflect on and inquire into previous episodes of organizational learning, or of failure to learn. They discover what they did that facilitated or inhibited learning, they invent new strategies for learning, they produce these strategies, and they evaluate and generalize what they have produced.

Argyris and Schön adapted their model from Bateson (1985, 248–249, 279–308), who divided organizational learning into five hierarchical types:

- Zero learning (the receipt of a signal) is characterized by specificity of response, which – right or wrong – is not subject to correction.
- Learning I is a change in the specificity of response by correction of errors of choice within a set of alternatives. (Those learnings, which are changes in zero learning.)
- Learning II is a change in the process of Learning I, i.e. a corrective change in the set of alternatives, from which the choice is made, or it is a change in how the sequence of experience is punctuated.
- Learning III is a change in the process of Learning II, i.e. a corrective change in the system of sets of alternatives, from which the choice is made.
- Learning IV would be a change in Learning III.

Single-loop learning is close to Learning I, double-loop learning to Learning II, and deutero-learning can be seen in levels of Learning II or III.

The theories and work of Argyris and Schön (1978) are quite widely recognized within the academic community of action research, organizational learning, and other closely related disciplines even today (Crossan 2003a, 38–39, Crossan 2003b, 40–46, Senge 2003, 47–50, Easterby-Smith and Lyles 2003, 51–55). Especially their concept of implementable validity and usability (usefulness) as one main validity check besides internal and external validity has brought research closer to praxis. In the retrospective look and interview conducted by Crossan, Argyris still emphasizes the willingness to engage the ideas, the capacity to think critically and work through the problems. In their time Argyris and Schön's ideas of action research, interventions and even of importance of simultaneous organizational and individual learning and change challenged the mainstream (Crossan 2003a, 38–39, Crossan 2003b, 40–46). In his article on Argyris and Schön's work Senge (2003, 47–50) appraises that learning of the sort that Argyris and Schön advocated still largely occurs in the margin, and he continues that methods similar to theirs will come into use when such learning is no longer an option, instead it is a strategic must in the future. In this thesis, I use Argyris and Schön's concepts of single-loop, double-loop and deutero-learning to explain learning paths and their relationships to outcomes in the development of process innovations.

According to Duncan and Weiss (1979, 78) Argyris and Schön's theory is the first systematic attempt to analyze the processes of organizational learning, but

they do not consider directly the designs of an organization, nor do they deal with from where these images and maps come. In their theory, Duncan and Weiss (1979, 78–79) analyze learning processes and learning outcomes in organizational learning. They state that in order for an organization to learn it is not enough that the individuals learn (Duncan and Weiss 1979, 85–87, 119). In their view an organization learns only after the knowledge gap or the new knowledge has been communicated to the whole organization, a consensus is reached, and the new knowledge is integrated in its activity-output chains. A performance gap in the organization accelerates this organizational learning process. Even tough Duncan and Weiss raise organizational learning processes and outcomes into focus, their view of organizational learning is limited to knowledge transfer, and they do not consider knowledge transformation, knowledge building, or knowledge creation. From the point of view of this thesis their concepts of process and its outcomes as well as goal orientation in learning are interesting.

David A Kolb's (1984) learning theory, in turn, sets out four diverse individual learning styles, which are based on a four-stage learning cycle. Kolb includes this cycle of learning as a central principle in his experiential learning theory, in which concrete experiences lead to observations and reflections. These observations and reflections are assimilated and distilled into abstract concepts, which produce new implications for action, which, in turn, can be actively tested when creating new experiences. According to Kolb, this process ideally represents a learning cycle where the learner touches all the bases: a cycle of experiencing, reflecting, thinking, and acting. Kolb's experiential learning theory is thus based on a combination of four skills: the ability to participate and gain practical experience, to observe and deduce, to conceptualize and adapt and to experiment. Kolb's model offers both a way to understand individual people's different learning styles, and also an explanation of a cycle of experiential learning. Hence, the model works on two levels - a four-stage cycle: concrete experience, reflective observation, abstract conceptualization and active experimentation, and a four-type description of learning styles: diverging, assimilating, converging and accommodating. Later many other researchers have developed Kolb's concepts of the effects of learning styles on the learning process.

Kolb also states that his experiential learning theory of development focuses on the transaction between internal characteristics and external circumstances, between personal knowledge and social knowledge, and it is the process of learning from experience that shapes and actualizes developmental potentialities.

The course of individual development is shaped by the cultural system of social knowledge via interaction between individuals with their biologic potentialities and the society with its symbols, tools, and other cultural artifacts. (Kolb 1984, 133) Even though Kolb's model of experiential learning focuses on explaining an individuals' learning, the principles of the model can be adopted to organizational learning, since the theory perceives the social system as a part of the model. Instead, Kolb's model does not actually focus on transforming knowledge in society, even if the model itself provides tools for knowledge transformation (see also Scharmer 2000).

The work of Engeström and his colleagues' laboratory (called also a change laboratory, a boundary-crossing laboratory) follows an ethnographical and expansive approach by observing and developing an organization's everyday activities or activity systems on the team level (Engeström 1987, 1990, Virkkunen et al. 1999, Ahonen and Virkkunen 2003). In Engeström's laboratory, the researchers guide an organization to mirror their common activities with the help of research tools and methods (Virkkunen et al. 1999, 14). The origin of Engeström's work lies in activity theory (Engeström 1987). Activity theory is a general, cross-disciplinary approach, offering conceptual tools and methodological principles to human sciences that originate in the cultural-historical psychology school of thought, initiated by Vygotsky, Leont'ev and Luria (Vygotsky 1978, Engeström 1987, Engeström et al. 1999a). Activity theory perceives the communal activities of humankind and the role of individuals in communal activities. Activity theory is founded on the concepts of the cultural-historical background of the activities of humankind, the context-dependency of activities, and intellectual performance as a part of communal activity systems. Activity theory takes an object-oriented, artifact-mediated collective activity system as its unit of analysis, thus bridging between the individual subject and the societal structure (Engeström 1987, 1990, 1999a). According to Engeström (1990), there are three methodological principles in activity theory: 1) using an activity system as the unit of analysis, 2) searching for internal contradictions as the driving force behind disturbances, innovations and change, and 3) analyzing the activity historically. As a special strength activity theory offers a foundation for explaining change processes of communal activities.

The research approach used in the work of Engeström's laboratory is called developmental work research, which is an innovative approach to the study and reshaping of work and learning (Engeström 1990, 72; 2005, 26). In Engeström and his colleague's laboratory the models of the activity system, and an expansive

learning cycle are used as theoretical instruments for organizational change (Engeström 1987, Engeström 1999a, 34; 1999b, 380–385, Virkkunen et al. 1999, 18).

Expansive learning is the learning and development of work practices, in which workers themselves solve the problems of existing work activities by interpreting the meaning, object and outputs of the work in a new way, in broader connections (Engeström 1987, Engeström 1999a, 32–35; 1999b, 383–384, Virkkunen et al. 1999, 2010). The expansive learning cycle starts with 1) the questioning of the actual situation and the aims for the future, followed by 2) criticizing accepted practices and analyzing a situation historically and empirically. After this follows 3) the modeling of a new solution and 4) examining it by experimenting and further developing. In the next phase 5) the new model is implemented into practical action with reflection and evaluation. Finally, there is 6) establishing and generalizing a new form of work practice. (Engeström 1999a, 32–35; 1999b, 383–384, Virkkunen et al. 1999) The theory explains learning, in which new practices are created through the zone of proximal development in an activity system (Engeströn 1999a, 34, see also Vygotsky 1978, 84–91, 130, Veresov 2004).

Engeström sees knowledge creation as an expansive cycle, which begins with an almost exclusive emphasis on internalization, on socialization and on training, after which creative externalization occurs first in the form of discrete innovations. While the disruptions and contradictions of an activity become more demanding, internalization increasingly takes the form of critical self-reflection, after which externalization and the search for solutions intensifies. A new cycle begins when the new model stabilizes and internalization of its inherent ways and means again becomes the dominant form of learning and development. (Engeström 1999a, 33–34; 2005, 34)

Engeström's model emphasizes the development of activities and activity systems and is goal-oriented. Creating new knowledge is seen as potentially externalizing knowledge preceded by internalization and socialization. This thesis takes a slightly different view from Engström. The subjects that are developed and studied are systemic value adding processes and we use a process as the unit of analysis, instead of activities or activity systems (cf. Engeström 2007). Secondly, in the cases studied, the development of organizations is not primarily focused on contradictions as a driving force, but on empowering organizations' members to create innovative aggregate solutions for the work processes (cf. Engeström and Sannino 2011).

The focus of Nonaka and Takeuchi's book is on the dynamics of knowledge creation, not on knowledge per se (Nonaka and Takeuchi 1995, 6). Nonaka (1994) and Nonaka and Takeuchi (1995) state, that knowledge is created through continuous interaction between tacit and explicit knowledge. According to Nonaka and Takeuchi (1995, 3–20), in innovation processes tacit knowledge is much more important than Western literature has considered. They state that tacit knowledge creation has to pass through several ontological levels, i.e. individual, group, organizational, and inter-organizational levels in dynamic interaction, in order to become valuable to the organization as a whole. New knowledge is born in the midst of ambiguity and redundancy, and is expressed in figurative language and symbolism with metaphors and analogies. The role of senior and middle management is crucial in providing employees with a conceptual framework that helps them make sense of their own experience and identify with a coherent whole.

Nonaka and Takeuchi (1995, 62–90) postulate four different modes of knowledge conversion: 1) from tacit knowledge to tacit knowledge, called socialization, 2) from tacit knowledge to explicit knowledge, called externalization, 3) from explicit knowledge to explicit knowledge, called combination, and 4) from explicit knowledge to tacit knowledge, called internalization. Socialization is a process of sharing experiences based on close interaction and collaboration within a group. Externalization is a process of articulating tacit knowledge into explicit concepts, which happens especially through the use of metaphors, analogies, concepts, hypotheses and models, and it is triggered by dialogue or collective reflection combining deduction and induction. The combination phase is a process of systemizing concepts into a knowledge system, which involves combining different bodies of existing explicit knowledge. Internalization is a process of embodying explicit knowledge into tacit knowledge and actions in order to have real effects on behaviors. This kind of learning is closely related to learning by doing (Nonaka et al. 2001, 17, see also Revans 1982, 1983: Action learning). (After the first round of knowledge conversion, a new round in the knowledge spiral can begin.)

Nonaka and Takeuchi (1995, 62; 1994, 19) argue that socialization, combination and internalization have been discussed from various perspectives in organizational theories (group processes, organizational culture, information processing, organizational learning) but externalization, which is a central phase in knowledge creation, has been somewhat neglected, and also little attention to the importance of socialization has been paid. Nonaka and Takeuchi emphasize

the significance of externalization and socialization in knowledge creation. In their studies, knowledge creation is illuminated through the systems and frameworks, which are also utilized in this thesis.

Bereiter and Scardamalia (Scardamalia and Bereiter 2003, 1370–1373, Scardamalia and Bereiter 2006, 97–118) introduced a model for the creation of new knowledge called knowledge building. It is defined as the production and continual improvement of ideas of value to a community and through means that increase the likelihood that what the community accomplishes will be greater than the sum of individual contributions. Knowledge building will also be a part of a broader cultural effort. Knowledge building is not limited to education but it happens throughout a knowledge community. Although achievements may vary; the process of knowledge building is basically the same across the trajectory running from an individual's early childhood to the most advanced levels of theorizing, invention, and design. All knowledge builders engage in similar processes with a similar goal.

Scardamalia and Bereiter (2003, 1370) argue that the learning that accompanies knowledge building encompasses foundational learning, subskills learning, and socio-cognitive dynamics presented in other approaches, and also the additional benefit of movement along the trajectory to mature knowledge creation. A part of the knowledge building trajectory is that learners take increasing responsibility for high-level, long-term aspects of knowledge work. Such work includes identifying learning frontiers such as problems of understanding, establishing and refining goals based on progress, gathering information, theorizing, designing experiments, answering questions and improving theories, building models, knowledge objects or conceptual artifacts, monitoring, evaluating progress and reporting. Knowledge building calls for deep constructivism, and it is the key to innovation. (Scardamalia and Bereiter 2003, 1370–1371) In knowledge building ideas are treated as real things, as objects of inquiry and improvements in their own right. Knowledge building environments enable ideas to get out into the world and onto a path of continual improvement. This means not only preserving them but making them available to the whole community in a form that allows them to be discussed, interconnected, revised and superseded. (Scardamalia and Bereiter 2003, 1371)

Computer-Supported Intentional Learning Environments (CSILE)/ Knowledge Forum, a technology that Scardamalia and Bereiter have designed specifically to support knowledge building, has a variety of functions that contribute to collaborative knowledge building, which is integral to the day-to-

day workings of a community (Scardamalia 2002). Scardamalia and Bereiter stress that a shared workspace for knowledge building enables a self-organizing system of interactions among participants. Bereiter and Scaramalia's concepts help to eliminate the need for externally designed organizers of work. They also emphasize that in knowledge building, advances in understanding produce conceptual tools to achieve further advances in understanding, and there is dynamism in knowledge building, and that can be a powerful motivator. In this process people are building authentic knowledge that is immediately useful to them and their community, and they are developing skills and habits of mind that are conductive to lifelong learning. This also opens new possibilities within and between the communities for barrier-crossing and mutual support, and helps to establish socio-cognitive norms and values that all participants are aware of and work toward. (Scardamalia and Bereiter 2003, 1373) Bereiter and Scardamalia stress goal orientation in knowledge building, that knowledge creation has its own processes, and that these processes need to have continuity. Their learning model reinforces understanding, which in turn leads to the production of conceptual tools, the confirmation of knowledge, and the continuity of learning. They emphasize the significance of continuity in learning, and that these learning processes are basically the same for all people during the whole trajectory from childhood to the most advanced levels. When Bereiter and Scardamalia speak about the concept of "trajectory", it deviates clearly from the concept of "learning path", which means continuity in learning from one outcome to another. But when they speak about understanding, advancements in conceptual tools, and the dynamism of continuity, they approach the concept of learning path used in this thesis.

In their book Communities of Networked Expertise, Hakkarainen et al. (2004b, see also Hakkarainen et al. 2004a) divide learning into three categories, which they call knowledge acquisition (e.g. Chi et al. 1982, 7–15, Cherniak 1986), participation (e.g. Lave and Wenger 1991, Wenger 1998), and knowledge creation (e.g. Engeström 1987, Nonaka and Takeuchi 1995, Scardamalia and Bereiter 2003). Hakkarainen et al. (2004b, 14) argue that the parallel assessment of processes of the three metaphors is likely to produce the most interesting results in learning. The metaphors describe the division among learning theories for these three main categories. The knowledge acquisition metaphor represents the traditional cognitive approach that focuses on the mental processes and structures of formal knowledge, whereas the participation metaphor examines a process of growing up with a community. The knowledge acquisition view is

characterized as a top-down process, whereas the participation view appears to be bottom-up. Hakkarainen et al. (2004b, 110) argue that even if the processes of participation capture essential aspects of cognitive socialization and identity development, they appear merely to describe the processes of growing up into a relatively stable culture, and not to address deliberate knowledge advancement or social transformation, and thus a novel option is needed. The knowledge-creation metaphor is an effort to develop this kind of an alternative. Knowledge creation is a process of simultaneously advancing conceptual understanding and transforming social practices. (Hakkarainen et al. 2004b, 10–15, 109–110)

In education and lifelong learning literature, there are numerous studies concerning learning paths, and in these studies a learning path is defined "as sets of one or more learning activities leading to a particular learning goal" (e.g. Janssen et al. 2008, 2011). However, in organization, organizational learning, and process innovation literature only few studies are related to the concept of learning path (Filippini et al. 2012, Chenhall 2005, Morgan and Berthon 2008, Rousseva 2011, Wei and Xiaobin 2009, Gemmell 2013). In these few studies, the significance of learning processes and paths are discussed in the context of small and medium-sized enterprises, latecomer companies, knowledge management and innovation strategy, but there is no established definition for a learning path. In this thesis, *the concept of learning path is defined: "Learning path is a (continuous) pathway from one outcome to another."*

Summary of learning organizations

The above presented learning models and processes of knowledge creation can be categorized into three types:

- Category based models (Bateson 1985, Argyris and Schön 1978, Hakkarainen et al. 2004a, b)
- Learning cycle models (Kolb 1984, Engeström 1987, 1990, 1999a, b, Nonaka 1994, Nonaka and Takeuchi 1995)
- Learning trajectory model (Scardamalia and Bereiter 2003, 2006)

The category based models aspire to define what kind of learning is being considered, and how learning affects an individual and an environment. With the concept of norm, Argyris and Schön define the concepts of single-loop, double-loop and deutero-learning, and explain how these learning modes affect an individual and an organization. Double-loop learning embodies changes in norms,

and thus, it reinforces existing knowledge or creates even completely new knowledge. Bateson's model resembles Argyris and Schön's model, yet it only speaks about corrective changes within a set of alternatives. Hakkarainen et al. divide approaches to learning into three diverse categories, which they call knowledge acquisition, participation and knowledge creation. Knowledge acquisition represents a traditional cognitive approach, whereas the participation metaphor examines a process of growing up with a community, and knowledge creation metaphor examines a process of simultaneously advancing conceptual understanding and transforming social practices. All these aspects affect the learning of individuals, and also learning of organizations, though only the knowledge creation metaphor actively transforms practices.

The second type, learning cycle models define how the learning proceeds from one learning stage to another. Kolb's model offers an explanation for a cycle of experiential learning from concrete experience to reflective observation, abstract conceptualization and finally active experimentation, after which a new cycle can begin. The principles of Kolb's cycle can be applied both to individual and organizational learning. Engeström again sees knowledge creation as an expansive, six phase learning cycle from questioning the actual situation to establishing and generalizing a new form of work practice, which begins with an almost exclusive emphasis on internalization, socialization and training, after which creative externalization occurs first in the form of discrete innovations. A new cycle begins when the new model has stabilized. Engeström's learning model focuses on organizational learning. Nonaka and Takeuchi in turn suggest different modes of knowledge conversion during a knowledge spiral: socialization, externalization, combination and internalization, after which a new round in the knowledge spiral can begin. Nonaka and Takeuchi state the significance of externalization and socialization in knowledge creation and that knowledge creation has to pass through individual, group, organizational, and inter-organizational levels in dynamic interaction between tacit and explicit knowledge, in order to be valuable to the whole organization. Their model focuses on organizational learning.

The third type, Scardamalia and Bereiter's trajectory model underlines the importance of continuity in individual learning, and that these learning processes are basically the same from childhood to the most advanced levels. Their learning model stresses understanding, which in turn leads to the production of conceptual tools, to the confirmation of knowledge, and to the continuity of the learning

process. Their model focuses on both individual and organizational learning, and the aim of the model is to give a general analysis tool for the whole trajectory.

The above three learning model types of knowledge creation: category based models, learning cycle models, and learning trajectory models are slightly different. The category based models define the quality of the learning effects and outcomes, and the learning cycle and the learning trajectory models illustrate the continuity of learning in knowledge creation.

To summarize, in this thesis, Argyris and Schön's concept of single-loop, double-loop and deutero-learning are used to explain the nature of learning paths and their relationships to outcomes. Learning is a process-based practice, the end results of which the outcomes are (see also Duncan and Weiss 1979). Organizational learning and the quality of the emerged changes can be described with the concept of norm (Argyris and Schön 1978): learning outcomes are results of single-loop learning, if the outcomes of an action are within the range set by organizational norms, whereas double-loop learning (and deutero-learning) can affect outcomes by changing norms in the organization. Knowledge transforms when the tacit and explicit knowledge meet (Nonaka and Takeuchi 1995), creating completely new knowledge or reinforcing existing knowledge. In process innovations, individual and organizational learning and knowledge creation can be seen as a goal-oriented collective process (see also Duncan and Weiss 1979), in which different tools and artifacts are used for the achievement of the process goals and for the continuity of the learning (see also Scardamalia and Bereiter 2003, 2006). This thesis values the learning cycle and learning trajectory models, yet criticizes them for not clearly considering the role of preceding outcomes and learning paths from one outcome to another.

2.3 Learning enablers

In the following, key findings and contributions are presented from the point of view of this thesis, about learning enablers and their roles in learning in organization and learning literature.

According to Klimecki et al. (1991), three conditions must be met before the step from individual learning to organizational learning can be taken: 1) communication and mutual understanding, 2) transparency: making the process and activities visible, and 3) integration of group processes into the system, i.e. individuals must be able to integrate their action into the whole.

2.3.1 Visualization in organization and learning theories

Many researchers of organizational development, organizational learning and sociology (e.g. Porras 1987, 10, Latour 1988, 29–31, 52–60, Myers 1988, 231–265, Leonard and Sensiper 1998, 118, Whyte et al. 2008, Walker et al. 2008, Irani et al. 2009) have discovered that conceptual understanding can be substantially boosted through visualization; the human sense of sight is an effective device. Pictures, tables, maps, diagrams etc. assist effectively in piecing together subject matter under discussion. Through visualization the cognitive concepts are externalized.

According to Salomon (1993), people's cognitive achievements are founded on the interaction between people's cognitive processes, objects and cultural environment. Cognitive resources can be distributed between humans and tools (physically distributed cognition, Hutchins 1990, 191–220, Norman 1993, 139–153, Perkins 1993, 89–90), or between cognitive actors (socially distributed and shared cognition, Hutchins 1990, 191–220, Resnick et al. 1991). A process, in which cognitive resources are shared in order to extend individual cognitive resources, is called distributed cognition (Hutchins 1990, 191–220, 1991, 283–286; 1995, 287–316, Salomon 1993). The concept of collective mind (Weick and Roberts 1993, 357–360) emphasizes how cognition is distributed among minds or between minds and artifacts. In this thesis, the concept of distributed cognition is quite relevant, as process descriptions and individual groups are used as visual cognitive resources.

For this thesis, it is valuable to compare the process description related theory to activity theory (Engeström 1987). Both theories offer a visual tool for the analysis and development of work in organizations (figure 1, article 1, see also Imai 1986, 194, Hannus 1993). In activity theory, activities or activity systems are examined as single or interrelated nodes of a network of activities (Engeström et al. 1999b, 345–374, Ahonen and Virkkunen 2003) – the target of the examination is not a process, which adds value to a customer as it is in process development. The work is developed by analyzing the elements of activities: subject, object, tools, community, rules and division of labor, by seeking contradictions and by developing novel solutions (Engeström 1987). The major difference of activity theory and process development is in the unit of analyses and in the visualization of the subject matter. In activity theory, the analysis is focused on an activity or an activity system, whereas in the process development on the chain of activities (see also Engeström 1987, Ahonen and Virkkunen 2003, Engeström et al. 2010).

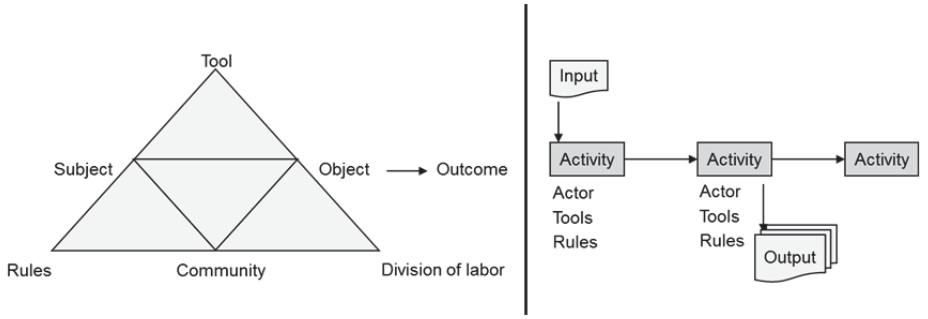

Fig. 1. The structure of an activity (Engeström 1987, 78) and the structure of a process.

Besides external memory aids, the members of a team are using each other to support their memory. Moreland (1999, 4–8, 18) argues that groups function as efficient memory units when their members learn to know each other's skills. This kind of capability is called transactive memory (Wegner 1986, 186–191, 206, Moreland et al. 1996, 63–67; 1999, 5). Transactive memory means that the members of a group relate or adapt their knowledge of who knows what about the issues they are dealing with (Wegner 1986, 189, Moreland 1999, 4–8). It means that an individual need not remember the matter if he knows that someone else of the group bears the matter in mind. The basic assumption in this thesis is that organizational development takes place in a group where the members can use each other as support when creating new knowledge.

Process knowledge, i.e. how the products and services are produced and marketed, is profoundly embedded in the actors of a process in the different parts of an organization and its network. Thus, in the development of process innovations, it is essential to use such methods, which help to collect all available knowledge of a process.

In this thesis, knowledge to be developed is depicted in visual process descriptions, and participants themselves bring their knowledge and experience with them and they act as visual objects in development sessions, and even the simulation arena acts as a visual object for learning. Therefore, theories of visualization, distributed cognition and transactive memory are important for this thesis (see also section 2.3.5 "The role of common understanding as a learning enabler").

2.3.2 Interaction, participation and empowerment in organization and learning theories

According to Lave and Wenger (1991, 100, 110–112) learning is a process of being a member of a community, during which a person learns to communicate and act based on the cultural norms in this community. Vygotsky (1978) and Engeström (1999a, b) emphasize the importance of interaction as a precondition for conceptual thinking. The theory of situated cognition emphasizes human cognition and participation in social practices and actions as basic processes of learning, instead of knowledge, which is emphasized in a cognitive perspective of learning (Brown et al. 1989, 32, Anderson et al. 1997, 20–21, Nevgi and Lindblom–Ylänne 2003, 101–103). Distributed cognition (cf. Boland and Tenkasi 1995, Cole and Engeström 1993, 1–21, Hutchins 1990, 191–220; 1995, 287–316, Norman 1993, 139–153, Oatley 1990, 102, Perkins 1993, 89–90, Salomon 1993, Salomon et al. 1991, 8, Nevgi and Lindblom–Ylänne 2003, 106) refers to a process, in which cognitive resources of symbolic knowledge, plans and goals are shared socially in order to extend individual cognitive resources or to accomplish something that an agent could not achieve alone (Oatley 1990, 102). In process simulations, interaction is possible through participating in action, in the cases of this thesis through participating in organization development.

According to the study of Siitonen (1999), freedom, liability, respect, trust, context, atmosphere, and optimism are important in the process of empowerment. The focal concept of the theory of empowerment developed by Siitonen is that empowerment, the emotion of power, emerges from the individual itself. It is a personal and social process, and no-one can grant power to another. The theory composed in Siitonen's (1999) study structures the subprocesses of empowerment according to the applied framework of Motivational Systems Theory (MST): objectives, capability beliefs, context beliefs, and emotions (see also Ford 1992, 1–16, 244–257). Once the person is committed to attain the objective, the motivation seems to move from objectives to personal agency beliefs and emotions (Ford 1992, 250). This is important to realize in the processes of empowerment. It is not enough to be committed only to the objectives – more is needed to be motivated. Empowerment is participation in action, decision making and idea generation, even with the emotions. The categories Siitonen highlights: freedom, liability, respect, trust, context, atmosphere, and optimism are fundamental factors in the initial situation for process development, and they are

also preconditions for the success of process development sessions, as we will see later on in this thesis (chapters 4 and 5).

One form of empowerment is the collective experience of flow (cf. Csikszentmihalyi 1991, 39–41, 71–77, Csikszentmihalyi 1997, 107–147, 336–342, Norman 1993, 31–41) that ties together the social, emotional and intellectual aspects of human cognition. In the experience of collective flow people become completely immersed in a collective activity and are excited, focused and deeply committed (Hakkarainen et al. 2004b, 71).

Nonaka (1994, 15–17) put emphasis on the tacit knowledge of organizations as a source of innovations. The employees who work in the process to be developed possess the significant, often tacit experiential knowledge that has to be included in the knowledge creation for appropriate process redesign, and they are also the key actors in realizing these ideas through implementation.

According to Granovetter (1973, 1367–1371, 1376–1378, see also Tidd et al. 2005, 405), weak and distant ties are effective for knowledge sharing, since through these ties it is possible to gain information, which is not otherwise available to a group. Hakkarainen et al. (2004b, 249) define that weak ties (links) are occasional relations or connections between actors, and that they are not emotionally supportive or necessarily reflective of a common experience, and that they are often far-reaching connections. Weak ties support the transmission of simple and codified knowledge. Strong ties (links) are based on joint assumptions and shared experiences (Hakkarainen et al. 2004b, 248). Hakkarainen et al. (2004b, 78–81) studied expert organizations and their knowledge creation processes. They discovered that for creating innovations both strong and weak intra- and inter-group ties are needed. The integration of the knowledge of previously separate groups and member groups is a demanding and dynamic process, where existing weak ties are converted into strong ties. (Hakkarainen et al. 2004b, 78–81) Also in the creation of novel process innovations the interaction between weak and strong ties plays an important role.

The above researchers emphasize interaction, participation and empowerment in learning and knowledge creation. In this, interaction between diverse boundaries and ties is significant.

In this thesis the process simulation session is in a central role, and it enhances empowerment through interaction and participation (see also Piispanen and Pallas 1992, Smeds 1994, 1996a, b, 1997b, Ruohomäki 1994, 1995a, 1995b, 2002, Piispanen et al. 1996, Pankakoski 1998, Forssén-Nyberg and Kutilainen 1998, Forssén-Nyberg and Hakamäki 1998, Forssén 2002). In this process, active

participants, facilitation and continuous reflection between organizational boundaries are important.

2.3.3 The holistic view and holistic knowledge in systems, organization and learning

Senge (1990a, b) emphasizes system thinking and a holistic view as a basis for an organization to learn and change. System thinking outlines the perception of entities, understanding of relationships and interaction dependency as well as observing gradual changes. System thinking assists to find such structural factors resulting in permanent changes. In system thinking feedback is seen as an empowering force or a disempowering factor, action is affected (Senge 1990a, b). Also Nonaka and Takeuchi (1995) stress that knowledge is created through systemic frameworks.

Smeds (1996a) emphasize that the holistic knowledge of the process should be represented in the process development teams. All functions and different organizations that belong to the new value-added business process, but also individuals from the different hierarchical levels have to participate in creative human interaction to generate, deepen and select valid process ideas. Smeds (1994, 1996a) highlights that these teams act as effective hologram structures for innovation (see also Van de Ven 1986, 597–601).

According to Jackson (2006, 647), many simple, quick-fix panaceas fail in their infeasibility because they are not holistic or creative enough. These simple solutions very seldom take into account interaction between parts. Holistic thinking, emphasizing comprehensiveness, perceives both structures and processes. It offers a durable base for critical thinking and re-evaluation and crossing boundaries set earlier, and it provides learning with a dialogue between theory and praxis and with the use of conscious and alternative world views. (Jackson 2006, 647, see also Ulrich 1983, Churchman 1979) Jackson (2006, 648) emphasizes that creative holism, which is related to creativity, choice, implementation and reflection, is an answer to business method requirements, by which important goals are achieved, and which aids leaders to distinguish both strategic requirements and requirements set by the technical detail of design.

Jackson (2006) argues that organization developers should consider the different world views stemming from alternative paradigms – functionalist, interpretive, emancipatory and postmodern, and encourage creativity by putting into use at different stages various metaphors and tools to facilitate a

comprehensive and rich overall picture of the process under development. On the other hand, addressing those aspects of the process under development, which are at this present moment the most significant based on the organization development. After the choice and implementation of the intervention, the organization ought to review and talk about the intervention's effects through diverse paradigms. A successful intervention should be capable of creating results according to requirements of paradigms; functionalist: goal-seeking, viability, judging in terms of efficiency and efficacy; interpretive: mutual understanding, judging in terms of effectiveness and elegance; emancipatory: fairness, judging in terms of empowerment and emancipation; postmodern: diversity, judging in terms of exception and emotion. (Jackson 2006, 650–657) Jackson (2008) highlights, that there are many manners to construct the overall picture: the overall picture can be combined of diverse factors and the final result depends on the participants of the process under development and how their world of ideas has changed during the process. The change takes place during a learning cycle.

In Engeström's model, workers themselves solve the problems of existing work activities by interpreting the meaning, object and outputs of the work in a new way in broader connections. Engeström's model emphasizes development of activities and activity systems as well as being goal-oriented.

In process development, the systemic structure manifests itself in the chain of activities, in the common objective of a process, and in the systemic analysis of the process under development (e.g. Hannus 1993).

The above researchers call attention to holism in slightly different ways. Senge (1990a, b) speaks about system thinking and a holistic view, and points out that it is vital to develop the five important skills areas: systems thinking, personal mastery, mental models, building shared vision, and team learning as an ensemble, which system thinking integrates to find such structural factors that lead to permanent changes. Smeds (1996a) emphasize that the holistic knowledge of the process has to be present with teams to generate, deepen and select valid process ideas. Jackson (2006) calls for creative holism, which is related to creativity, choice, implementation and reflection, as an answer to business method requirements.

Hannus (1993) seeks systemic methods and tools for process development on the practical level. In process development, the process description acts as a systemic object that crosses organizational boundaries and that has one – as such uncontroversial – objective, which is one comprehensive and congruent goal. Contrastingly in activity theory, an activity and its elements represent a systemic

structure that is analyzed, and contradictions are sought among the activities under development. Both theories and methods, process development and activity theory, can be kept systemic, but in a different way. In process development, the object of the examined process and its subprocesses is – already philosophically – shared, whereas activity theory basically assumes, that every activity has its own – even contradictory to the activity – object.

The above researchers put emphasis on system thinking, a holistic view, holistic knowledge, creative holism, and systemic tools as a basis for an organization to learn and change. In this thesis, it is assumed that holistic knowledge and a holistic view are needed for the organization to possess creative holism. For this, systemic tools, such as process simulations, are needed (see also article 1). In process simulations, holistic knowledge is embedded in team building, and the holistic view is expressed in shared objectives, viewpoints and knowledge, which are presented and represented during the development process.

2.3.4 Boundary crossing in organization theory

The boundary object, originally introduced by Star and Griesemer (1989, 387–388), is a concept, which refers to objects that serve as an interface between the different communities of practice. Boundary objects are entities shared by several different communities but viewed or used differently by each of them. They are not necessarily physical artifacts such as a map between two people: they can be a set of information, conversations, interests, rules, plans, contracts, or even persons. Boundary objects are used by the members of different communities in very different ways, although the representation is shared. As Star and Griesemer point out, boundary objects in an organization work, because they necessarily contain sufficient detail to be understandable by both parties, however, neither party is required to understand the full context of use by the other.

By its nature, process development supports organizational boundary crossings. This means that special objects for it are needed. Star and Griesemer (1989, 393) point out that boundary objects serve as the points of mediation and negotiation around intent. Boundary objects are flexible enough to adapt to local needs and have distinct identities in different communities, but at the same time they are robust enough to maintain a common identity across the boundaries to be a place for shared work.

The concept of a boundary object is important in process simulations (see also Smeds et al. 2006, Alin 2010), and therefore also in this thesis, because

process descriptions, the development arena, a set of information, conversations, plans, and even persons are used as organizational boundary objects to clarify a development context. The process description is also an important visual enabler (section 2.3.1) in knowledge creation.

2.3.5 The role of common understanding as a learning enabler

Klimecki et al. (1991) have emphasized mutual understanding as one necessary step before the move from individual learning to organizational learning can be taken.

Mäkelä's study (2002) indicated that common understanding is created between parties in the course of time through interaction and common experiences. According to Mäkelä (2002) common understanding is formulated through 1) common goals and objectives, 2) knowledge sharing and interdependence, 3) shared meaning, 4) common experiences and modes of operations, and 5) trust.

Many researchers emphasize that interaction, participation and empowerment create commitment to change, through which the creation and implementation of ideas into innovations is facilitated (cf. Locke and Schweiger 1979, 277–280, 325–328, Kanter 1983, 156–205, 236–240, Urabe 1988, 15–18, Lave and Wenger 1991, 110–112, 49–52, Nonaka and Kenney 1991, 78–79, Nonaka 1994, 15, 17, Smeds 1997b, Siitonen 1999).

In this thesis, the concept of common understanding is discussed using Mäkelä's (2002) five formulations of common understanding as a tool (section 5.1.4).

2.3.6 Learning in communities

The two social theories of learning, Nonaka's knowledge sharing and creation theory (Nonaka and Takeuchi 1995, Nonaka and Konno 1998) and Lave and Wenger's theory of communities of practice (Lave 1991, Lave and Wenger 1991, Wenger 1998) are important for understanding organizational learning in communities. In their studies also Brown and Duguid (1991, 41, 53–55, Communities of practice) and Boland and Tenkasi (1995, 351, Communities of knowing) seek arenas and procedures to enable open participation in the processing of issues.

Lave and Wenger (1991, 89–123) and Wenger (1996, 20–26, 1998, 45–50) conceptualize the locus of organizational learning as a community of practice. They define the community of practice as a set of relations among persons, activity, and the world, over time and in relation with other communities (Lave and Wenger 1991, 98–100, Wenger 1998, 45–50). In a community of practice people act together, and interact formally or informally to share the ways of understanding the world and to reach common goals. Communities of practice emerge as people work together, and learning in the communities of practice constitutes the competence of an organization (Wenger 1998, 251–253).

Nonaka and Konno (1998, see also Nonaka and Kenney 1991, 81) introduced a concept called "ba" for describing the knowledge creation process, and they define ba as a shared space, which generates relations, and as a foundation of knowledge creation. Ba can be physical, virtual or mental, or any combination of them. Furthermore, Nonaka et al. (2001, 19) describe ba as a platform where knowledge is created, shared and utilized.

According to Nonaka and Konno (1998, 40–54), individuals share their tacit experiences with their co-workers in a knowledge sharing and creation space, ba. Ba can also be thought of as a shared space for emerging relationships. Through these relationships tacit knowledge emerges in ba, which collects the applied knowledge of the area and integrates it. Nonaka and Konno separate four types of ba that correspond to the four stages of the socialization, externalization, combination and internalization (SECI) model of knowledge dimensions: originating, interacting, cyber, and exercising ba. They stress that managing emergent knowledge in a ba requires a different kind of leadership. The management must realize that knowledge needs to be nurtured, supported, enhanced, and cared for in a systemic way. (Nonaka and Konno 1998, 40–54, Nonaka et al. 2000, 5–34) According to Nonaka et al. (2000, 22) trust among organizational members is created as an output of the knowledge-creating process, and at the same time, trust moderates how a ba functions as a platform for the knowledge-creating process. The membership of ba is not fixed, and participants come and go, while the membership of a community of practice is fairly stable, and it takes time for a newcomer to learn about the community to become a full member. Participants of ba relate to the ba, whereas members of a community of practice belong to the community. (Nonaka et al. 2000, 15)

Hakkarainen et al. (2004b, 135–147) criticize the concept of community of practice as unsuitable for the conceptualization of communities in a mature information society. Therefore they have constructed a new concept: innovative

knowledge communities. According to them, innovative knowledge communities operate in a continuously changing environment, in which the criteria of successful performance grow stricter all the time, and the objective is to create new knowledge and innovations, not to preserve old traditions. Moreover, there are no extensive vertical knowledge or skills differences between participants in innovative knowledge communities as there are between masters and apprentices in the communities of practice. In innovative knowledge communities the expertise is diffused heterogeneously and knowledge creation is encouraged symmetrically rather than asymmetrically.

According to Hakkarainen et al. (2004b, 109–110, 119–121) there are several models of innovative knowledge communities that lead organizations to go beyond their current practices by intentionally addressing knowledge creation and innovation processes. These frameworks, such as Nonaka and Takeuchi's (Nonaka 1994, Nonaka and Takeuchi 1995, Nonaka and Konno 1998) innovative teams with shared bodily experiences, Engeström's (1999a, 34, Virkkunen et al. 1999, 18) expansive learning community, and Bereiter and Scardamalia's (Scardamalia 2002, Scardamalia and Bereiter 2003, 2006) theory of the knowledge-building community, understand innovation as a collaborative process - all of them consider knowledge creation as a primarily social process. These models (see also section 2.2) describe inquiry and learning as a process of creating or articulating knowledge and transforming social practices, where the aim is to gradually expand one's knowledge by relying on preceding experiences and knowledge.

This thesis explores one type of innovative knowledge creation community for process innovations: process simulation, and its significance in organizational learning.

2.3.7 Summary of learning enablers

To summarize, the above presented literature about organization and learning broadly addresses learning enablers and their roles in organizational learning. It also shows very well the impact of participation and empowerment and the formation of a holistic view, and it argues about the importance of visualization and of establishing learning communities. However, this literature, as well as process innovation literature (cf. chapter 1), does not address the relationships between learning enablers, nor their effects on learning and the formation of process innovations. Even if many organization and learning researchers

emphasize that interaction, participation and empowerment create commitment to change, through which the creation and implementation of ideas into innovations is facilitated, they do not formalize the relationships of interaction, participation and empowerment into common understanding, holistic view, and holistic knowledge.

2.4 Learning outcomes

In the following, the concepts of outcome and learning outcome from the point of view of this thesis are defined and positioned.

Researchers of organizational learning speak in various ways about the results of learning processes. For example, Argyris and Schön (1978, 27) remark that when an organization engages in deutero-learning its members discover what they did that facilitated or inhibited learning, they invent new strategies for learning, after which they produce these strategies. In their theory, Argyris and Schön (1978) stress goal orientation, and they define e.g. "double-loop" learning based on what kind of results emerge, i.e. are there changes in norms (see also Nonaka 1994, 19). Nonaka and Kenney (1991, 67–69) mention that as Schumpeter observes, new innovations trigger other innovations in an effect that resembles the dropping of a stone in a still pond. Duncan and Weiss (1979, 80–81) also see organizational learning as a purposeful and goal-oriented process, where lack of knowledge and efficiency steers the emerged outcomes. The outcomes of the organizational learning process are changes in organizational knowledge, which are accepted by the members of the organization for organizational action (Duncan and Weiss 1979, 97), but the development of this knowledge needs not imply any particular action or change in the organization's effectiveness or adaptation (see also Duncan and Weiss 1979, 84–85).

According to Nonaka et al. (2000, 8–9), three elements from the model of knowledge creation have to interact with each other to form the knowledge spiral that creates knowledge. These are 1) the SECI process, the process of knowledge creation through conversion between tacit and explicit knowledge (see also section 2.2); 2) ba, the shared context for knowledge creation (see also section 2.3); and 3) knowledge assets, the inputs, outputs, and moderators of the knowledge creating process (see also section 2.4). Nonaka's et al. concept of knowledge asset is pretty near the concept of outcomes (section 2.4) and on the other hand the concept of enablers (section 2.3). According to Nonaka et al. (2000, 20–22), knowledge assets are both the inputs and outputs of the

organization's knowledge creating activities, and they are dynamic and constantly evolving. They divide knowledge assets into 1) experimental, i.e. shared tacit knowledge, 2) conceptual, i.e. explicit knowledge articulated through images, symbols and language, 3) systemic, i.e. systematized and packaged knowledge, such as explicitly stated technologies, product specifications, manuals and documented and packaged information about customers and suppliers, and 4) routine knowledge assets, i.e. tacit knowledge that is routinized and embedded in the actions and practices of an organization. They also argue that the top management has to play a more active role in facilitating the dynamic process of building knowledge assets from knowledge (Nonaka et al. 2000, 24).

Tidd et al. (2005) make a distinction between intangible innovations and tangible innovations. They emphasize that innovation is associated with physical change, but much change is of a less tangible nature, for example the development of new methods or techniques. They compare this phenomenon to Japanese production and a similar change under "lean production" in Europe and America.

In recent literature about change and project management (e.g. Nogeste 2006, Nogeste and Walker 2005, 2008, Walker et al. 2008, Yeo and Ajam 2010) and process innovation literature (e.g. Zwikael and Smyrk 2012), the concepts of intangible and tangible outcome/s are discussed in relation to different topics, e.g. knowledge transfer, research work, public sector organizations, environmental modeling, and project outcomes. Intangible outcomes are also related to the social (e.g. Matthews et al. 2010) and the intellectual (e.g. Ramírez 2010) capital of an organization. For example, Ramírez (2010, 248) shows the importance of intellectual capital approaches as instruments to face the new challenges in public sector, and provides a practical help to develop means to identify, measure and manage the intangible assets of the public sector. In their article Nogeste and Walker (2005, 55–57) point out that project stakeholders are able to identify, prioritize and define intangible project outcomes when provided with a process for doing so. Typically, these intangibles include, but are not limited to, relationships, knowledge, processes and systems, leadership and communication, culture and values, reputation and trust, and skills and competences. Nogeste and Walker also argue that intangible outcomes provide the seeds for future success on other projects.

Summary of learning outcomes

In this thesis, organizational learning is seen as a continuous process, whereas an outcome is the result of this process. Process innovations are learning outcomes, results of the organizational and individual learning processes. Knowledge, either tacit or explicit, is the generator of this learning process. The tacit knowledge is very personal knowledge embedded in experiences and it is very hard to articulate with formal language, whereas explicit knowledge can be easily and formally transmitted across organization (Polanyi 1983, Nonaka and Takeuchi 1995, Nonaka and von Krogh 2009, see also Ryle 1949, 25–61).

An outcome can materialize as new tacit or explicit knowledge, as action or as artifacts (see also Niiniluoto 1997, 137). In this thesis, *it is defined that intangible outcomes are qualitative learning results, which are difficult to measure, and tangible outcomes are quantitative results, which could be measured with relative ease.* Both intangible and tangible outcomes can emerge on the individual or the organizational level. In this thesis, intangible outcomes are also called soft results, and tangible outcomes hard results. Learning outcomes are manifestations of learning during participative process development sessions, e.g. process simulations. Learning outcomes could also become manifestations of process innovations. When tacit or explicit knowledge creates new knowledge and it is implemented, it can be called an innovation (see also Van de Ven 1986, Urabe 1988).

Furthermore, operational outcomes explain the short-term dynamics of behaviors, which enhance the operational efficiency of a firm without any changes in its strategy or in its assumptions. Strategic outcomes are strategies and assumptions concerning effective performance, and norms, which define effective performance (see also Argyris and Schön 1978, 22). Cultural outcomes embrace learning on the abstract level of organizational culture: in basic assumptions and in values and norms (see also Schein 1992).

Moreover, operational and strategic outcomes are the results of single-loop learning, if the outcomes of an action are within the range set by organizational norms. Double-loop learning can affect all three outcome categories by changing norms in the organization. Deutero-learning results in cultural outcomes and promotes further operational and strategic outcomes to occur through single-loop and double-loop learning.

In this thesis, based on the above definitions, learning outcomes and the relationships between them are analyzed, and they are connected to the learning

processes presented by Argyris and Schön (1978). Also their relationships to learning enablers are discussed.

2.5 Earlier Finnish empirical findings about process simulations concerning learning enablers, learning outcomes and learning paths

In the field of process simulations, there are studies concerning enablers, outcomes and evolution paths of process innovation. Next, the empirical findings and the contributions of those studies that concern this thesis are summarized.

2.5.1 Learning enablers in organizations

Forssén (2002) studied the life cycle of incremental bottom-up ideas, which concerned process and organizational innovations, and as her data she used the case studies of the companies where the process simulation method was applied. Among other research questions, she asked what factors enable or disable the life cycle and implementation of bottom-up ideas. Her study focused on organizational and individual internal factors (Forssén 2002, 28–30), and she compared her findings with the critical factors found in the three earlier studies (Axtell et al. 2000, Hokkanen 2001, West 2001). According to her study, the most critical organizational factors (found in the above mentioned studies including her own study) were: participation, organizational climate, communication, development resources, diversity of knowledge, and clear, shared targets, and the most critical individual factors were active individuals and leadership skills. Mutually understood terms, a process/ matrix organization structure, and definition of roles were the critical enabling factors that also emerged from her study, but they had not been found in the earlier three studies. However, supportive findings for these critical enabling factors could be found from other earlier literature (e.g. Kanter 1983, Hammer and Stanton 1999). Forssén (2002, 30–31) stated that these critical factors seem to be quite consistent with the factors that support innovativeness in organizations (West 2001), the dimensions of innovations culture (Ahmed 1998), and the dimensions of the learning culture (Schein 1992).

In her study, Forssén (2002) emphasized as the most critical factors in process innovations the essence of the organizational structures and communication, as well as active organizational members, and managers with good leadership skills.

She stressed that the successful use of bottom-up ideas needs to have a supporting organizational development culture, which requires supportive experimental methods. Forssén (2002) continued that the process simulation method seems to enable the life cycle of inter-unit ideas through improving the requirements for creativity and implementation and enhancing mutual understanding and communication. In her thesis, Forssén did not study the learning enablers for process innovations, but the enabling and disabling factors in the life cycle of ideas. Yet, she emphasized that an innovation process is a social process including learning (Forssén 2002, 45). This means that the above enablers include some significant learning enablers, which enhance ideas development and process innovations, and that some enablers specifically enhance an innovation process stressing other features than learning.

Ruohomäki (2002, 101–136) reported the participants' experiences, the effects and outcomes of the Work Flow Game (WFG), which is a similar method as process simulation. She reported that the participants' motivation and commitment increased when using WFG. She emphasized WFG's usefulness in terms of broad participation, cross-functional communication and co-operation as well as promoting development activities over organizational boundaries. Of WFGs advantages, she mentioned the concrete way the work process was demonstrated, which created the opportunity for the participants to see, hear and understand the work process as a whole, the possibility to interact, communicate and co-operate with the people from different organizational departments, units and levels, and the revealing of development needs and alternatives to the work process. She also reported that the WFG created an arena for the participants for cross-functional interaction, communication and co-operation. Concerning perceived learning, the WFGs provided a rich learning experience, and the WFGs were considered by participants a unique possibility to understand the work process as a whole and the participants' own tasks as a part of the whole system. She reported that the WFGs provided an excellent or good opportunity to express one's ideas for work and organizational improvement. Even though most of the initial ideas concerned correcting errors and making existing routines more effective, however, after the WFG the new ideas presented focused on information technology, structures and strategic questions for the entire organization. Even though Ruohomäki did not speak about the learning enablers, the above mentioned effects represent such factors, which I recognize as enablers for individual and organizational learning.

In her thesis (1996a) and the associated articles, Smeds (1988, 1994, 1996b, Smeds and Haho 1995a) investigated the phenomena affecting the emergence of process innovations and drew a synthesis of research in enterprise evolution and its management. Process simulations among other data were significant case material in her study. In it she developed generic necessary conditions for successful transition. These conditions are the following: 1) the triggering innovations should create resources for the transition (law of requisite free energy), 2) the organization should possess holistic knowledge about the problem area as basis for the innovation (law of requisite variety), 3) there should exist a hologram structure, human interaction between all problem area experts for innovation (law of requisite structure) and 4) the innovations should be managed through an umbrella strategy that aligns the emergent innovations with basic identity (deep structure to prevent the system from dissolution in transition). (Smeds 1996a, 117) According to Smeds (1994, 1996a, 1; 1997b, 24) holistic knowledge (knowledge in the organization concerning all aspects of the process innovation), hologram structure (human interaction to amplify and select process innovations), empowerment (participation of the employees in the innovation process) and umbrella strategy (strategy to give a vision and guidelines for the innovations, and systematic feedback and dialogue for learning during the evolution process) are necessary organizational prerequisites for successful process innovations. Smeds (1996a) also stressed the proportion of requisite variety in an effective innovation process, as a characteristic for holistic knowledge.

Smeds concluded based on the empirical results from change projects, where the necessary conditions for evolution management were initially not fulfilled, process simulations were found to improve these conditions significantly during the project (Smeds 1996a). The basic principle of using process simulations in process development is broad participation and empowerment for commitment, innovation and learning (Smeds 1997b). She also revealed that the participants bring the knowledge to the simulations, their interaction creates the hologram and the dialogue, they are the experimenters and innovators in the process simulations, and thereafter the implementers, operators and continuous improvers of the new process (Smeds 1997b). Smeds did not use the term “learning enablers” in her studies, yet in this thesis her construct of the necessary organizational prerequisites for successful evolution management – holistic knowledge, hologram structure, empowerment, and umbrella strategy – is considered enablers for individual and organizational learning.

In their studies of process simulations, also other researches (e.g. Mäkelä 2002, Smeds and Alvesalo 2003b, Smeds et al. 2006, Alin 2010) addressed some aspects concerning learning enablers. In her study Mäkelä indicate that common understanding is created between parties in the course of time through interaction and common experiences. According to Mäkelä (2002) common understanding is formulated through 1) common goals and objectives, 2) knowledge sharing and interdependence, 3) shared meaning, 4) common experiences and mode of operations, and 5) trust. When studying global business process development in a virtual community of practice, Smeds and Alvesalo (2003b) addressed that process simulation enabled innovative negotiation between the local practices concerning the organization-wide process design, although the telepresence solution caused some limitations. Smeds et al. (2006) used the concept of boundary object in their article on the process simulation method, and they argued that a process simulation applies boundary objects in a systematic way to cross the different boundaries and to facilitate knowledge construction. In his thesis, Alin (2010) studied how knowledge is transformed at boundaries between organizations. His model suggests that at semantic organizational boundaries, knowledge is clarified and altered, but new knowledge is not created. The model also suggests that at pragmatic organizational boundaries, new knowledge is created through synthesizing existing represented knowledge.

Also some other Finnish studies of process simulations emphasize the effects of process simulations in improving communication and increasing holistic knowledge and mutual understanding (e.g. Piispanen and Pallas 1992, Ruohomäki 1994, 1995a, 1995b, Piispanen et al. 1996, Pankakoski 1998, Forssén-Nyberg and Kutilainen 1998, Forssén-Nyberg and Hakamäki 1998).

In the following table (1), the enablers of process innovations found in the studies of Smeds (1994, 1996a, b, 1997b), Forssén (2002) and Ruohomäki (2002), and others (Mäkelä 2002, Smeds and Alvesalo 2003b, Smeds et al. 2006, Alin 2010) concerning process simulations is classified, compared and summarized. The content of the articles was analyzed; the unit of analysis was the learning enablers. The content was coded labeling each learning enabler with a category, after which higher-level categories were generated based on the first coding.

Table 1. The comparison of learning enablers mentioned in the studies of process simulations.

Learning enablers	Smeds (1994, 1996a, b, 1997b)	Forssén (2002)	Ruohomäki (2002)	Others (2002, 2003b, 2006, 2010)
1) Visualization of the process under development			x	x
2) Communication, interaction, co-operation	x	x	x	x
3) Participation and empowerment	x	x	x	x
4) Holistic knowledge	x	x		x
5) Holistic view			x	
6) Common understanding of the process under development		x		x
7) Vision, strategy, goals, and guidelines for the process innovations	x	x		x
8) Boundary crossing over organizational boundaries			x	x
9) Arena for cross-functional interaction and co-operation			x	x
10) Management and leadership skills to form a supporting organizational development culture		x		

Based on the above studies, it can be summarized that the studies of process simulations recognized the above characteristics as manifestations of process innovations; some characteristics especially support individual and organizational learning during interventions, and some support other aspects of process development. The above studies did not focus on discovering what factors particularly promote individual and organizational learning in creating process innovations; neither did they explore the relationships of these enablers.

2.5.2 Learning outcomes in organizations

When describing the results of process simulations, Smeds (1997b, 25–30) divided the results for effects and outcomes. In her terminology, effects are, for example, experimentations, shared understanding and implemented grass-roots ideas, that is, immediate effects of process simulations. In contrast, outcomes resemble the concrete final results of a development project.

Ruohomäki (2002) spoke about work and organizational outcomes and reported that the outcomes of the organization development project with the WFG concern the actual changes in the work process, the division of work, and the information system and customer service. Ruohomäki thus called the concrete final results of development interventions "outcomes".

When describing the use of process simulations and the results of them, Forssén (2002, 36–38) did not speak about outcomes, instead she spoke of short-term results, e.g. an improved holistic view, mutual shared understanding, development ideas, clarified structures, enhanced communication, increased commitment, and action plans.

To conclude, both Smeds (1997b) and Ruohomäki (2002) address outcomes as the concrete final long-term results of a development project. In their terminology the immediate and intermediate effects, i.e. experimentations, a holistic view, shared understanding and implemented grass-roots ideas of process simulations are not outcomes. In this thesis, however, the term outcome is used for immediate, intermediate and final, abstract and concrete results, and categorized into intangible and tangible outcomes, and their roles is addressed in learning.

2.5.3 Learning paths in organizations

In her conclusions for the strategic management of enterprise evolution when speaking of the learning organization instead of planning organizations, Smeds (1996b, 72) mentioned that the new emerging enterprise structure is created through "acting and learning along the evolution path". Later, in one of her articles (1997a, 158, see also Smeds 1997b, 31: stepwise process innovations) she described that the management of enterprise evolution is "a succession of process innovations", and it is a managerial challenge to steer the whole organization's complex learning and knowledge-creating process towards a strategic vision.

In her study, Ruohomäki (2002, 125) also recognized the stepwise nature of organization development and stated that the WFG could initially produce its own immediate effects and these immediate effects could in turn produce some intermediate effects and those, in turn, produce long-term outcomes.

The earlier studies of process simulations (e.g. Smeds 1996a, b, 1997a, b, Ruohomäki 2002) recognize that process innovations emerge stepwise along an evolution path. They do not specifically address learning paths or how these learning paths and intermediate outcomes affect subsequent outcomes.

2.6 The research gap in the existing literature concerning the role of learning in process innovations

Earlier literature has been useful in describing how individual and organizational learning occur in organizations, but it has not focused on explaining how this learning arises in process innovations. This is true for literature on organizational learning (e.g. Argyris and Schön 1978, Duncan and Weiss 1979, Kolb 1984, Engeström 1987, 1990, 1999a, b, Nonaka 1994, Nonaka and Takeuchi 1995, Scardamalia 2002, Scardamalia and Bereiter 2003, 2006), on process innovations (e.g. Tidd et al. 2005, Davenport 1993, Hamel 2000, Imai 1986) and on change management (e.g. Sisaye 2005, 2010).

Process innovation literature recognizes the importance of individual and organizational learning in innovation processes, yet deals with it and its enablers in a shallow manner. One attempt to describe these learning processes in process innovations is process simulation literature (e.g. Smeds 1996a, b, 1997a, b, Ruohomäki 2002, Forssén 2002). Even in these studies, the focus is not on the systematic research and explanation of how learning affects process innovations. In them the role of learning has not been explored in the light of relationships between learning enablers, learning outcomes, and learning paths between interventions. This is especially significant if the results of knowledge creation are also to be implemented in practice. The goal of this thesis is to fill this gap in the organizational learning, process innovation, and change management literature.

Although organization and learning researchers (e.g. Locke and Schweiger 1979, Kanter 1983, Urabe 1988, Lave and Wenger 1991, Nonaka and Kenney 1991, Nonaka 1994, Smeds 1997b, Siitonen 1999, Senge 1990a, Jackson 2006, Klimecki et al. 1991, Hakkarainen et al. 2004a) and the earlier Finnish studies about process simulations (e.g. Piispanen and Pallas 1992, Smeds 1994, 1996a, b, 1997b, Ruohomäki 1994, 1995a, 1995b, 2002, Piispanen et al. 1996, Pankakoski 1998, Forssén-Nyberg and Kutilainen 1998, Forssén-Nyberg and Hakamäki 1998, Forssén 2002, Smeds et al. 2006) have broadly discussed the enablers of organizational learning, they have not formed a practice-based holistic picture of the influence and relationships between different learning enablers.

Even though Duncan and Weiss (1979) raise into focus organizational learning processes and very pragmatic, goal-oriented concepts concerning learning outcomes, they do not analyze or categorize different learning outcomes or explain their roles in process innovations. The earlier Finnish studies about

process simulations (Smeds 1997b, Ruohomäki 2002) speak about outcomes as concrete and final long-term results of a development project. Instead, in their terminology, the immediate and intermediate effects of the process simulations – i.e. experimentations, a holistic view, a shared understanding, or implemented grass-roots ideas – are not outcomes, but effects. In this thesis, outcomes are categorized into intangible and tangible ones, and their roles in process innovations are addressed. The outcomes are also connected to the learning processes presented by Argyris and Schön (1978).

This thesis values the models for learning cycle (Kolb 1984, Engeström 1987, 1990, 1999a, b, Nonaka 1994, Nonaka and Takeuchi 1995) and learning trajectory (Scardamalia and Bereiter 2003, 2006), yet criticizes them for not clearly considering the role of preceding outcomes and the following learning paths. The mentioned studies, such as the other key works of Nonaka and Takeuchi's (1995), Engeström's (e.g. 1999a, b) and Kolb's (1984), do describe learning as a cyclic or expansive process, but they do not pay enough attention to the outcomes of the learning process and to their impacts on the next phases that form process innovations. When Scardamalia and Bereiter (2003, 2006) speak about the concept of "trajectory", they mean that the process of knowledge building is basically the same across the trajectory running from an individual's early childhood to the most advanced levels of theorizing, invention, and design, and that all knowledge builders engage in similar processes. This concept differs significantly from the concept of the "learning path", which means continuity in individual or organizational learning from one set of learning outcomes to another. But when Scardamalia and Bereiter speak about understanding, advancements in conceptual tools, and dynamism of continuity, they approach the concept of learning path as presented in this thesis. The earlier studies of process simulations (Smeds 1996a, b, 1997a, b, Ruohomäki 2002) recognize that process innovations emerge stepwise along an evolutionary path, but they do not speak specifically about learning paths or how learning paths and intermediate outcomes affect the subsequent outcomes. In this thesis, Argyris and Schön's (1978) concepts of single-loop, double-loop and deutero-learning are used to explain the characteristics of learning paths and their relationships to learning outcomes.

Finally, although pieces of existing theories can be adapted from related theories, such as organizational learning theories, on the role of learning in process innovations, there is a lack of practice-based studies that focus on forming a model about the relationships of individual and organizational learning enablers, learning outcomes and learning paths. This lack of research is

challenging, because if we want to advance theorizing concerning the formation of process innovations, we need better understanding of the relationships between knowledge, learning enablers, learning outcomes and learning paths. This demands a longitudinal research design.

2.7 The initial theoretical model for this thesis

To tackle the above described research gap, an initial theoretical framework based on organizational learning and process innovation literature is formed to analyze the findings of the articles included in this thesis.

The existing literature shows several factors that enable individual and organizational learning in process innovations (sections 2.3 and 2.5.1). In the following, these factors except management and leadership skills are addressed. Management and leadership skills are defined out of the scope of this thesis, since they are the necessary foundation of all enablers. According to literature, it seems that the most critical factors are:

1. the visualization of the process under development (e.g. Porras 1987, Latour 1988, Myers 1988, Leonard and Senciper 1998, Ruohomäki 2002, Smeds et al. 2006)
2. interaction, participation and empowerment (e.g. Vygotsky 1978, Locke and Schweiger 1979, Kanter 1983, Nonaka and Takeuchi 1994, Smeds 1996a, Engeström 1999a, Siitonen 1999, Forssén 2002, Ruohomäki 2002)
3. a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations) (e.g. Senge 1990a, Hannus 1993, Kuutti 1994, Smeds 1994, 1996a, Nonaka and Takeuchi 1995, Forssén 2002, Ruohomäki 2002, Jackson 2006, Smeds et al. 2006, Alin 2010)
4. a common understanding of the process under development (e.g. Klimecki et al. 1991, Mäkelä 2002, Forssén 2002) and
5. an arena for cross-functional interaction and co-operation, e.g. process simulation (e.g. Nonaka and Takeuchi 1995, Nonaka and Konno 1998, Lave and Wenger 1991, Wenger 1998, Brown and Duguid 1991, Boland and Tenkasi 1995, Ruohomäki 2002, Hakkarainen et al. 2004a)

Thus, these learning enablers are used as a framework to further analyze the influences and relationships between learning enablers.

Learning literature suggests that learning is a cyclic, expansive or continuous process (Kolb 1984, Nonaka and Takeuchi 1995, Engeström 1999a, b, Scardamalia and Bereiter 2003, 2006), and process simulation literature claims that process innovations emerge stepwise along an evolutionary path (e.g. Smeds 1996a, b, 1997a, b, Ruohomäki 2002). In this initial framework a basic assumption of learning in process innovations is that learning is really a process.

Duncan and Weiss (1979, 97) conceptualize that the outcomes of organizational learning processes are changes in organizational knowledge. This definition stresses the importance and dynamism of learning outcomes in an organizational learning process, but it does not recognize the immediate and intermediate effects of organizational changes as outcomes of learning processes. In the initial framework, a learning outcome will be used as an important factor.

To summarize, the initial framework is threefold and has:

- essential learning enablers: 1) visualization of the process under development, 2) interaction, participation and empowerment, 3) a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations), 4) common understanding of the process under development, and 5) an arena for cross-functional interaction and co-operation,
- learning outcomes, and
- learning paths.

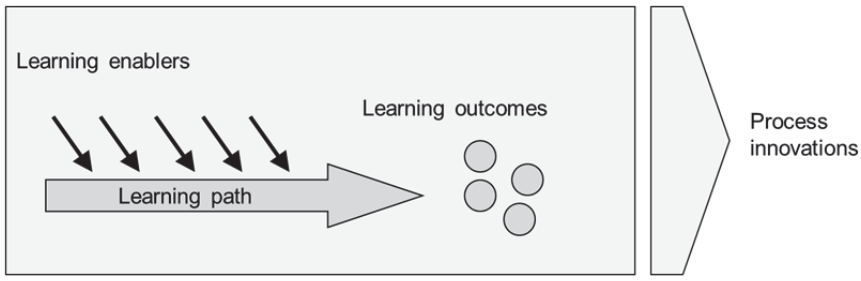

Fig. 2. The initial theoretical model of factors in individual and organizational learning in process innovations.

In this thesis, the above concepts will be regarded as key elements in individual and organizational learning in process innovations, and they will be used to analyze the findings and further develop the theoretical framework, based on abductive reasoning (Ketokivi and Mantere 2010).

3 Research questions, methods, and data

In this chapter, the research questions are presented, and the role of process simulations in this thesis, and the research methods and research process are introduced.

3.1 Research questions

There is little systematic research on conceptualizing simultaneously and as a whole the relationships of learning enablers, learning outcomes and learning paths within organizational learning and process innovations literature. Likewise, researchers have not addressed empirically how intangible learning outcomes might result in effective and continuous learning paths from primary outcomes to more advanced outcomes and further towards process innovations. To advance broader discussion and theory-building on the role of individual and organizational learning in process innovations, this research gap is addressed.

To tackle this problem the following research questions are asked:

- Q1: What are the learning enablers and their relationships to learning paths? (articles 1, 2, 3, 4 and 5)
- Q2: What kinds of learning outcomes emerge and what are their relationships to learning paths? (articles 3 and 5)
- Q3: How do the learning enablers and the learning outcomes mutually create the learning paths, and what are their relationships to each other? (article 5)

Finally, this thesis seeks a model for individual and organizational learning, which helps to achieve process innovations, to fill the research gap (articles 1–5). The main practical objective of this thesis is to offer efficient principles and viewpoints for enhancing the management and development of process innovations in organizations.

To address these research questions, qualitative longitudinal action research with case studies and abductive reasoning as a research method is used. The process simulations are used both as a process development method and as a research method.

3.2 Research methods and data

In the following, the research methods and the research process is introduced.

3.2.1 Methodological choices in action research design

This thesis is conducted through action research (cf. Lewin 1997, Gummesson 1991, Argyris and Schön 1991, Kuula 1999, Buhanist 2000) with abductive reasoning (Grönfors 1982, 27–37, Niiniluoto 1999, Paavola et al. 2006, Ketokivi and Mantere 2010) as the research method. Empirically, this research is founded on in-depth action research projects in business process development and process simulations. The case studies and cross-case studies are used as data (Gerring 2007a, b).

As Hakkarainen et al. (2004b, 119, see also Nonaka and Takeuchi 1995, 64) express, in order to create new knowledge in organizational research, it is necessary to focus also on weaker forms of rationality, such as in abduction. In abductive research, the researcher enhances the underlying theory, and also becomes a skilled implementer of a new concept. According to Nonaka (1994, 25), abduction has a particular importance in the conceptualization process, and it is very useful to pursue creative dialogues and to share images through the metaphorical process by merging perspectives. In their article Nonaka and Kenney (1991, 81) also express that in the process of creating new knowledge, the emphasis must be placed on emergence and synthesis, instead of deduction and induction, and in this process metaphors and analogies are often more useful than syllogisms and proofs.

For the reasoning strategy, inference to the best explanation (IBE) (Ketokivi and Mantere, 2010, 319, 330), i.e. theory, context and researcher variant abductive reasoning have been selected. According to Ketokivi and Mantere (2010, 319, 330, see also Lipton 2004), the abductive process of reasoning is known as inference to the best explanation, where the researcher selects the best out of a short list of plausible explanations based on considerations of epistemic virtues, such as simplicity or novelty. Abductive reasoning focuses on the descriptive rather than the normative aspects of scientific reasoning (Ketokivi and Mantere 2010, 319), and in the reasoning process contextualization instead of idealization is used as a reasoning strategy (Ketokivi and Mantere 2010, 320). Contextualization treats explanation and inference as inseparable, making inference contextualized, not abstracted or idealized, and it seeks to establish the

contextual authenticity of reasoning (Ketokivi and Mantere 2010, 323). Contextualized inference is transparent and openly partial to the explanation, as well as authentic to data and the research process (Ketokivi and Mantere 2010). Accordingly, the context, the data and the research process throughout this thesis will be carefully described.

In this thesis, abductive reasoning is necessary. Firstly, the thesis progresses abductively throughout the five articles. Each article's summarized results lead the way to the consecutive research phase. Furthermore, the three research questions of this thesis emerged in an abductive manner; new questions evolved from preceding answers. And finally, inside each question, the reasoning follows the abductive mode. The potential theoretical explanations of a phenomenon are compared during the research process. In this thesis, mainly empirical contextualization but also theoretical contextualization is used in the reasoning (see also Ketokivi and Mantere 2010, 323–325).

The articles of this thesis lean on the constructivist principle that research is a cyclic process, in which consecutive interventions complement preceding knowledge with the feedback from practical operations. Abductive research fits well with constructivism and its view on learning and knowledge creation (Rauste-von Wright et al. 2003). Also, in constructivism the interaction between environment and individual, theory and praxis, and reflective feedback are emphasized as a prerequisite for learning and knowledge creation. Abductive research is not a loose act, but it becomes integrated closely with the research object and its activities, also changing them.

In his article: "The Case Study: What it Is and What it Does" Gerring (2007a) emphasizes the difference between a case study and a cross-case study: typically the case study tends to explain and construct theory and cross-case study to confirm and test theory. Abductive research in the next phases of the cycle tends to enrich the thus far developed theoretical conclusions (Grönfors 1982, 27–37, Paavola et al. 2006, Ketokivi and Mantere 2010). Continuous progress in knowledge is fundamental for this type of a research process. Implementations pursued with the knowledge achieved from previous experiences and the enhanced theory represents a significant improvement over those that just attempt to replicate the initial experiences (Kaplan 1998). Therefore, abductive research typically represents a theory building research tradition, and the sequential interventions also act as testers of the developed model.

In this action research, the case studies have been used for two purposes: 1) to facilitate companies in their process development and training and 2) to collect

data. In the articles of this thesis, the data of the case studies have been used in two ways: on the one hand, the data gives ideas for a theoretical framework (article 2, Hirsijärvi and Hurme 2001), and on the other hand, the data is used to construct a theoretical framework through classifications (articles 3, 4 and 5, Hirsijärvi and Hurme 2001, Glaser and Strauss 1967). Article 5 is a single case study, while articles 2, 3 and 4 are cross-case studies (Gerring 2007a, b), based mainly on a qualitative analysis and in some extent on a quantitative analysis (article 3).

To summarize, this thesis has an action-oriented approach (i.e. action research), in which case studies are used to describe and set norms for the studied phenomenon. Thus, this research is both descriptive and normative. In the business economics research approaches (figure 3), the action-oriented approach and the constructive approach have a close relationship - both approaches have an empirical connection, aim for changes in praxis, and presuppose that the researcher supports the participants in an organization in their learning processes (Kasanen et al. 1993, 21). They differ in that regard that constructive research is normative, whereas action research can be both normative and descriptive (Kasanen et al. 1993, 21). As this thesis has a both descriptive and normative action-oriented approach with the cycle of the case studies, and as it aims to define a model for effective learning processes in process innovations, this thesis will be evaluated based on qualitative methods and abductive reasoning.

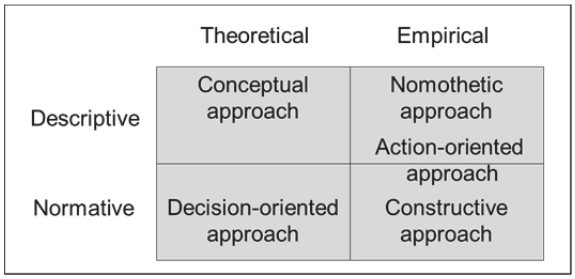

Fig. 3. The position of action-oriented approaches and the constructive approach in the business economics research approaches (based on Kasanen et al. 1993).

3.2.2 The methods in each article

All five articles have their own role in the abductive reasoning of this thesis. In table 2, the research approach, the mode of explanation and the main results

(advancement in the construct, advancement in the theoretical foundation) are explained in order to describe the role of each article in the whole thesis.

In article 1, the construct (Kasanen et al. 1991, 1993) for the process simulation and process development method is described, and explained with the theory of knowledge creation by Nonaka and Takeuchi (1995). The construct is based on several cycles of pre-cases. Article 1 also deals with learning enablers: the visualization of the process under development, interaction, participation and empowerment, and describing and explaining – how these enablers sustain learning in organizations (Q1).

Article 2 is a comparative cross-case study with a descriptive explanation of the interrelations and meaning of dialogue and boundary crossings between strategy and operations in organizational learning (Eisenhardt 1989, Yin 1989, Gerring 2007a, b). The article gives answers to the first research question (Q1) concerning learning enablers.

In article 3, the construct is tested with the cross-case study of 88 cases that used process simulations either as a development method or a learning method for different business processes and purposes (Eisenhardt 1989, Yin 1989, Gerring 2007a, b, Glaser and Strauss 1967). The article also confirms the theory of organizational learning by Klimecki et al. (1991) (Q1), and creates a hypothesis about soft and hard results (later in this thesis called intangible and tangible learning outcomes) and about tacit change in the effective implementation of process innovations (Q2).

Article 4 is a comparative cross-case study. It describes the meaning of dynamic dialogue between operational processes and strategy in process development, as opposed to pre-described change (top-down or bottom-up), and the role and meaning of a knowledge creation community, and builds theories on this (Q1). The dialogue was achieved through the method that was applied, i.e. successive process simulations.

Based on learning theories article 5 interprets the process simulation method and successive process simulations and builds new hypothesis about intangible and tangible learning outcomes and learning paths in single-loop, double-loop and deutero-learning in organizations (Q1, Q2 and Q3). The article is a single case study with a deep analysis of learning outcomes and learning paths, based on grounded theory (Eisenhardt 1989, Yin 1989, Gerring 2007a, b, Glaser and Strauss 1967).

Table 2. Approach and main results.

Article	1	2	3	4	5
Research approach	Constructive	Action research, cross-case study	Action research, cross-case study	Action research, cross-case study	Action research, case study
Mode of explanation	Constructive and explanatory	Descriptive and explanatory	Testing, descriptive and explanatory	Descriptive, explanatory and theory building	Descriptive, explanatory and theory building
Results in					
a) advancement in the process development method	Process development method with two process simulations (as-is, to-be), and other development features and phases in the method		Diverse use of method in development and training cases, and the results of the method	Successive process simulations and the meaning of them	Successive process simulations and the meaning of them
b) advancement in the theoretical foundation	*Q1: Learning enablers:* Presents together the learning enablers of an effective process development method. The two main design principles are: visualization of the process under development, and interaction, participation and empowerment.	*Q1: Learning enablers:* Reports the emerged findings on the learning enablers and their preliminary relationships in the two case studies.	*Q1: Learning enablers:* Analyzes the enablers of process simulations and their relationships more deeply than is done in articles 1 and 2 *Q2: Learning outcomes:* Intangible and tangible outcomes, tacit change	*Q1: Learning enablers including the knowledge creation community:* The meaning of dynamic dialogue between operational processes and strategy in development as opposed to a pre-described change (top-down or bottom-up), and the role and meaning of the knowledge creation community	*Q1: Learning enablers, Q2: Learning outcomes, Q3: Learning paths and processes:* The role of intangible and tangible learning outcomes, learning paths and continuous collective reflection in single-loop, double-loop and deutero learning in organizations

3.2.3 Summary of data and its collection methods

The empirical research was carried out mainly in 1988–2001. The data consists of 34 cases and 99 process simulations in 12 different industries and varies from large core processes to support processes including e.g. metal, electronic, telecommunication, paper, printing, pharmaceutical, dairy, and consumer industries. The case organizations were mainly Finnish companies with Finns as the majority of participants. One case organization was from Switzerland, and in five cases, multicultural groups participated in the process simulations. In each project, process simulations were used at least once during a change project, in some cases even five to eight times. (In this thesis, the cases are named equally in article 3, table 2.)

In this thesis, each article has its own focus. Therefore, the data collection methods also differ to some extent. In table 3 the data collection methods and the data is summarized article by article. In chapter 4 there is a detailed description of the data and its collection article by article.

Table 3. Summary of research data and its collection methods in articles 1–5.

Article	1	2	3	4	5
Data collection method					
Process modeling, process simulation	yes	yes	yes	yes	yes
Videotaping	yes (cases 17, 18)	yes, (case 17)	yes (not in all)	yes	yes
Note taking	yes	yes	yes	yes	yes
Observation	yes	yes	yes	yes	yes
Questionnaire	yes (cases 3, 4 and 18)	yes (cases 3 and 4)	yes (not in all)	yes	yes
Project documentation	yes	yes	yes	yes	yes
Interviews before the simulation	no	no	yes (not in all)	yes	yes
Follow-up interviews	no	no	yes, after the projects (not in all)	yes, 14 – 18 months after the projects, 51 interviews	yes, 1 ½ year after the projects, 27 interviews
Research data					
Cases	6 pre cases, 17 simulations	2 cases, 11 simulations	32 cases, 88 simulations *)	2 cases, 13 simulations **)	1 case, 5 simulations **)
Respondents to questionnaires	108	75 (case 34, including 3 and 4 as subcases)	1497	616	216
Respondents in interviews	-	-	32	51	27

*) The data of article 3 includes two simulations of one case reported also in articles 4 and 5.

**) Articles 4 and 5 have one same case, only the data has been analyzed again from the viewpoint of article 5.

3.2.4 Summary of the data analysis

To target the research gap defined in section 2.6, the initial theoretical framework (section 2.7) is used to analyze the findings of each article. The initial framework is threefold, it has

- essential learning enablers: 1) visualization of the process under development, 2) interaction, participation and empowerment, 3) a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations), 4) a common understanding of the process under development, and 5) an arena for cross-functional interaction and co-operation,
- learning outcomes, and
- learning paths.

The analysis proceeds in an abductive manner throughout the five articles, and summarizes the findings based on these three viewpoints from the initial framework. From one article to another, both the theoretical and the empirical understanding of the research questions increase. In chapter 4 there is a detailed description of the data analysis article by article.

3.3 The research process

In the following, the research process, the results of the abductive research cycles, and how these results and the new knowledge are used in the next cycles are described. Thus, the subsequent description depicts how this thesis advances from one cycle to another, and what this progress is founded on. For clarification, in addition to the theoretical advancement, also how the method (construct) evolved is depicted, even if it is not the goal of this thesis.

Figure 3 shows the research phases and their connections to the case studies, articles, and overall research questions of this thesis.

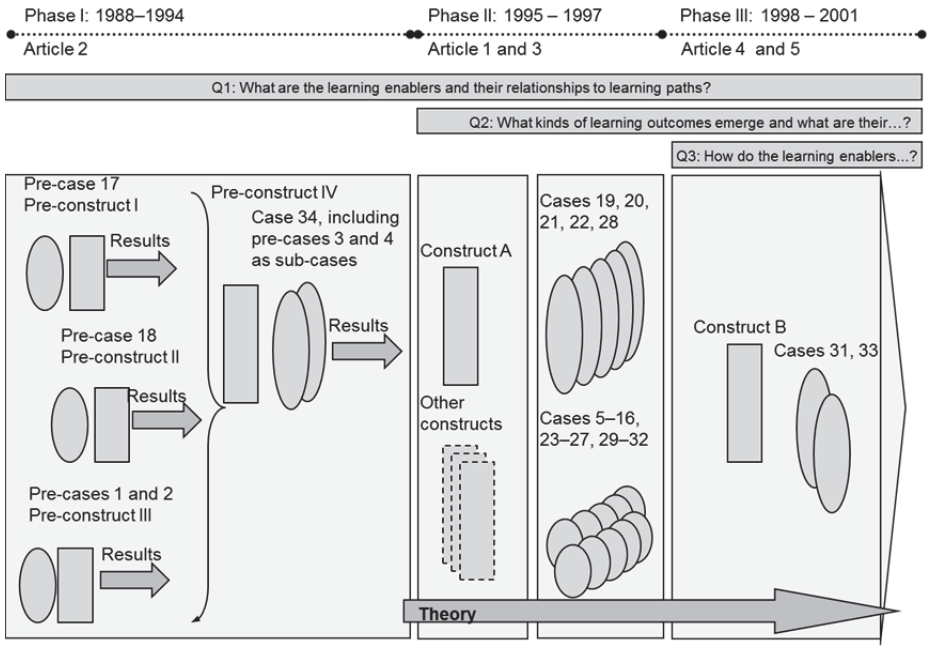

Fig. 4. The phases of this thesis.

Phase I

Advancement in the construct

The first models of the construct were developed in the feasibility study phases during the years 1988–1992 (Haho 1988, HahPhase Io 1992, Ahlbäck and Haho 1992) and 1993–1994 (Smeds and Haho 1995a, b, Smeds 1994).

Advancement in the theoretical foundation

The significance of interfaces, dialogue, and boundary crossings between strategy and operations in organizational learning are the main results of article 2, which uses the cases of phase I as data. The article reports the emerged findings on the learning enablers and their preliminary relationships in the two case studies.

Based on these findings, significant enablers of process innovations are interaction, participation and empowerment, a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations), and a common understanding of the process under development.

Phase II

Advancement in the construct

Article 1 (Haho and Smeds 1997) describes the finalized view and analysis of construct A (a construct of a process development method, which includes the process simulation method), which is already based on several cycles of action research carried out in phase I. Construct A was developed during the Softmatch-project during the years 1995–1997 (Haho and Smeds 1996a, b, Smeds 1996a, Haho 1998a).

After this, article 3 tests the construct and discusses and compares the different uses and results of the method in the development and training cases. In half of the development cases, the process simulations (as depicted in article 1) were used at least in two different development phases during the project (article 3, 239, Haho 2002). In the rest of the development projects and in the training cases only one simulation per case was used. The results and the long term effects of these interventions show that the final results of development efforts are better if the process simulations and other types of development efforts are used systematically and more than once during a development project (article 3, 251–259).

Advancement in the theoretical foundation

Article 1 presents together the learning enablers of an effective process development method, i.e. of process simulation. The two main design principles are: visualization of the process under development, and interaction, participation and empowerment. The article also contributes to knowledge creation of and the testing and interpreting of the theory of Nonaka and Takeuchi (1995) about the knowledge creating company, in each phase of the construct.

Article 3 uses 88 process simulations since phase I (1995–1998) to compare the effects of the different process simulations. In article 3, the meaning of intangible outcomes (soft results) and tangible outcomes (hard results) and tacit change are the main advancements in the theoretical foundation. The article also analyzes the learning enablers of the process simulations and the relationships of the enablers more deeply than is done in articles 1 and 2. The identified learning enablers are: 1) visualization of the process under development, 2) interaction, participation and empowerment, 3) a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations), and 4) a common understanding of the process under development. This analysis confirms the theory of organizational learning by Klimecki et al. (1991) about three conditions that lead from individual learning to organizational learning: communication and mutual understanding, transparency, and the integration of group processes so that they become a system.

Phase III

Advancement in the construct

As a result of article 3, articles 4 and 5 introduce a new construct B – successive process simulations. The new construct B is more flexible than the first one (construct A, article 1), because it considers that the process development effort is a persevering project, which still has a clear ending. The importance of successive process simulations – with a specific construct of process simulation in each development phase – is construct B's creative power.

Advancement in the theoretical foundation

Theoretically, article 4 discusses learning enablers and emphasizes the role of a knowledge creation community and that of dynamic dialogue between operational processes and strategy in development as opposed to a pre-described change (top-down or bottom-up). This confirms and expands the results of article 2. In article 4, longitudinal cases, with a follow-up period from 1998 to 2001, are used as a data.

Finally, article 5 discusses the role and interconnections of intangible and tangible learning outcomes, learning paths and continuous collective reflection in single-loop, double-loop and deutero-learning in organizations and within individuals. The article is based on one longitudinal case study – one of the two cases of article 4 – but in this article, the case is analyzed from the point of view of learning.

The results of these action research phases give perspective for the application of the research method and further development of it as well as for the creation of new theories. This is the way abductive research operates: the underlying theoretical understanding becomes deeper and the quality of implementation work increases (Grönfors 1982, 27–37, Paavola et al. 2006, Ketokivi and Mantere 2010, see also Kaplan 1998, 89).

4 The results and findings of the articles

In the following the researcher's contribution to each article is described, and each article is summarized briefly: an introduction, the data, its collection and analysis, the findings and the discussion. In this thesis only the findings relevant to this thesis are summarized, even though the articles include additional results. The articles are included in full as appendices at the end of the thesis. The articles are in the order in which the theoretical contributions were produced.

The findings are analyzed using the initial theoretical framework from section 2.7 of 1) learning enablers, 2) learning outcomes and 3) learning paths. The analysis proceeds in an abductive manner throughout the summary of the articles. When discussing each article the overall findings are summarized cumulatively.

4.1 The researcher's contribution to each article

In action research the researcher affects the interpretation of the results, and thus it is important to know the researcher's roles during the process (Miles and Huberman, 1994, 265). Accordingly, I also evaluate the effects of my role for the validity of all results, in the end of this thesis. During the action research process I have had several roles: consultant and researcher (article 1), project manager (article 2), consultant, project manager and researcher (article 3), researcher (article 4) and researcher (article 5).

Article 1

Article 1 describes how a process development method should be constructed to sustain organizational learning and to enhance commitment for the intended organizational changes. The earlier articles (Haho and Smeds 1996a, b) describe some features of the construct, but in this article the construct is described completely for the first time. During this project I acted as a consultant as well as an action researcher, and I was responsible of creating the construct for the development method, of applying it for five diverse case studies, and collecting the data of the cases and analyzing them. In addition to me, two consultants and the second author of the article participated in the execution of the research and the interpretation of the results. In article 1, I provided the description of the construct and the second author provided the theoretical background and the discussion.

Article 2

During the cases described in article 2, I acted as a project manager in the organization, and my interest was to identify the essential principles of the process and organization development in strategy and operations, through the results of two case studies. I collected the needed data and I also analyzed them myself.

Article 3

In the cases described in article 3, the authors acted mainly as researchers and outsider consultants in the change projects, from the start to the second process simulation phase. Piloting and implementation as well as long-term follow-up phases were the responsibility of the participating organization. However, in one case study, I (the second author of article 3) acted as the organization's internal consultant, with the responsibility for piloting and implementation.

My research focus was mainly business process development, participative management of change, and the dynamics of knowledge creation and accumulation in interaction between the strategic and operational processes in industrial organizations. I acted as a consultant and a project manager in these business process development cases: 17, 18, 19, 20, 21, 22, 23, 28, 29, 31, 32, and in these training cases: 1, 2, 3, 4 and 14. Thus, in the all these cases my role was also an action researcher's role.

Article 3 was written in intensive collaboration between my colleague and I, based on the experience we have from our research and consultant projects in industries. We both collected data and analyzed them independently; both researchers participated only in the data collection and analyzing of case 29. The data were interpreted together while working on the article. For the article, I conceptualized theoretically the new concepts of intangible and tangible outcomes.

In this study the first author consulted and researched these training cases: 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and these business process development cases: 24, 25, 26, 27, 29, and 30. This article has been a part of her doctoral thesis, in which she studied the implementation processes of ideas in industrial organizations (Forssén 2002). The order of the authors is alphabetical in this article.

Article 4

In the cases presented in article 4, I acted as an action researcher in both change projects and as an outside facilitator in the change project of the pharmaceutical company. My colleague, the third author, was involved as an inside facilitator and action researcher in the telecommunication company case as part of his Master's Thesis work. I collected the data from the pharmaceutical company and the third author of the article collected the data from the telecommunication company. Together with the first author and a research assistant I made the post-interviews of the cases and I analyzed their results for the article. My contribution was to compare the results and the differences between bottom-up and top-down initiated changes in business process development projects. The first author elaborated the theory of evolution management (Smeds 1996a, 1997a, b) for the article. This article was the first one that dealt with successive process simulations.

Article 5

I was engaged as an action researcher and facilitator in the case project of a pharmaceutical company from 1998 to 2000. The case company wanted to develop its New Product Development (NPD) process, aiming to shorten the time-to-market of new products, and decided to attend a research program initiated by the SimLab research unit at Helsinki University of Technology (HUT)[2] (case also reported in article 4). This multi-company research program focused on NPD process development, using process simulations as the development method. The implementation of the results was the responsibility of the participating company.

The data is the same as in one case of article 4, but I analyzed it anew from the point of view of individual and organizational learning for this article, and I conceptualized theoretically the interrelation of intangible and tangible learning outcomes as well as operational, strategic and cultural outcomes, learning paths, and the role of individual and organizational learning. This last article focused explicitly on successive process simulations and the learning outcomes and learning paths.

[2] today a part of Aalto University

4.2 Article 1: The Softmatch-method: Enterprise transformation through simulation games

4.2.1 Introduction

Article 1 introduces a participative change accomplishment method, called Softmatch. It uses customized process simulations in a systematic way to accomplish process-oriented transformation in an organization or its business network. In the article, the principles of the method are constructed and the practical experiences and results of the transformations are presented, in which the method was created and tested.

The article answers one of the research questions of this thesis:

- Q1: What are the learning enablers and their relationships to learning paths?

4.2.2 The research data, its collection and analysis

In article 1, the process simulation method and its phases are described. The construct was developed in several cycles of action research. The practical understanding developed with six pre-cases and the pre-constructs from two industries, which were created based on the case studies (Haho 1988, Haho 1992, Ahlbäck and Haho 1992, Smeds and Haho 1995a, b, Smeds 1994, Smeds 1996a). The article describes the finalized view and analysis of the process simulation method, including the construct of the process development method. Later, in article 3, the construct with case studies was systematically tested. It was further analyzed in the licentiate thesis of Haho (2002). In the elaboration of the construct, the observations during process simulations and from questionnaires after simulations, which the participants filled, were used as data. The process simulations were videotaped, notes were made and a large project documentation was collected.

Table 4. Data collection methods and the data of pre-cases in article 1.

Data collection method	Data	Collection time
Researcher's engagement in the development project, action research	Observations	1988–1994
Observation during the 17 simulations and other development efforts	Observations	1988–1994
Questionnaire after the six simulations	108 answers	1988–1994
Discussions with the development team of the company	11 persons, frequently	1988–1994
Discussions with the research team of the company	5 persons, frequently	1988–1994
Follow-up interviews after interventions	-	-

The research proceeded in the dialectics between practical experience and theoretical knowledge. With the systematic analysis of the data, and based on the results of action research, the construct advanced from one pre-construct to another. The final result of the construct represents one instance of the method.

Additionally, in the article the diverse forms of Nonaka and Takeuchi's (1995) theory of knowledge creation in the different phases of the process simulation method are described. The description is based on the analysis of the data collected during the process simulations.

4.2.3 Findings about learning enablers

Learning enablers and their relationships to each other

In the article, the process simulation method is described systematically. However, in the following only those attributes of the method, which enhance individual and organizational learning in process innovations, and the relationships between the attributes, are demonstrated.

The six phases of the method (starting a development project, first process simulation, development of new process design, second process simulation, piloting, implementation) provide visual, systematic and dynamic ways to combine tacit and explicit knowledge, analysis and synthesis, and bottom-up and

top-down approaches during a change project. In the dynamic continuum of the phases, the analysis and synthesis are combined into a rapidly altering process: the first process simulation acts as an analysis of the process under development, the new process design and the second process simulation express the synthesis. As a consequence of discussions and decisions during the first process simulation, the synthesis is created of the process and its preconditions.

The process simulation resembles the processes of a real organization, and visualizes interdependencies between different departments and activities. In this visualization the process description, participants themselves, and the arena used for simulation are important.

The process simulation is a participative method for process development and innovation. The method is composed of interactive teams, in which different organization levels and functions are involved. The participation and empowerment of employees from the design phase to process implementation accomplishes high commitment throughout the transition.

To conclude, the two main learning enablers found an article 1 are:
Visualization of the process under development

- Visualization is an integral part of process development. It is formulated in the process descriptions of the development subject. Even the participants, including the arena used in the development session, function as visual elements.

Interaction, participation and empowerment

- Process simulation is designed to enhance interaction and participation, to increase empowerment among the personnel during process development and innovation.

The article also describes that the process simulation method provides a common understanding into the whole process chain, and increases the personnel's commitment and motivation for change.

4.2.4 Discussion

Learning enablers and their relationships to each other

The empirical findings of the studies in article 2, which were realized already years before article 2 was published, paved the way for the principles of a high-

quality process development method. Such a method should improve the participants' holistic view of the processes and their interfaces, and nourish new knowledge, new ways of thinking and new understanding. These empirical findings of the cases for article 2 introduced the design principles of the method presented in article 1: to encourage a holistic view and innovativeness, the method should be visual and participative, so that everyone is able to join in the creative process. This work on article 1 added visualization to the learning enablers presented in article 2.

Of the relationships between learning enablers, article 1 only reports that the process simulation method enhances common understanding, i.e. the process simulation method is composed of such elements, which increase common understanding. The article does not analyze the relationships between learning enablers any further.

4.3 Article 2: Strategy and operation in dynamic interaction

4.3.1 Introduction

Article 2 addresses the essential principles of process and organization development in strategy and operations through the results of two case studies. In the article, knowledge creation and accumulation for interaction between the strategy and operational processes is described and the facts that affect the interactions are studied.

The article answers one of the research questions of this thesis:

- Q1: What are the learning enablers and their relationships to learning paths?

4.3.2 The research data, its collection and analysis

In article 2 the research was pursued inductively using two case studies (case 17, and case 34 including pre-cases 3 and 4 as subcases, which were executed 1994–1997) to discover the most important principles in developing and implementing process and organizational change in operations and strategy. The two cases were used to test emerging theoretical insights. Data was collected primarily through observations, note-making, project documentation, process modeling, process simulations as well as videotaping during the change project and follow-up studies made along the project.

Table 5. Data collection methods and the data in article 2.

Data collection method	Data	Collection time
Researcher's engagement in the development project, action research	Observations	1988–1997
Observation during the 11 simulations and other development efforts	Observations	1988–1997
Questionnaire after the 4 simulations	75 answers (case 34, including cases 3 and 4 as subcases)	1988–1997
Discussions with the development team of the company	7 persons, frequently	1988–1997
Discussions with the research team	3 persons, frequently	1988–1997
Follow-up interviews after interventions	-	-

The learning process model illustrated by Östel (1996) was used as a conceptual tool for the data analysis. The data analysis is also a descriptive cross-case study (Eisenhardt 1989, Gerring 2007a, b).

4.3.3 Findings about learning enablers

Learning enablers and their relationships to each other

In the first case study (case 17) the discussion alternated between strategy and operations, concepts and practice. This learning pattern created shared wider understanding in a spiral up towards best practices of customer service and future customer service strategies. The extensive interaction during the two-year project led to a learning leap, which provided a solid foundation for more advanced service, technology and productivity development in the future. If learning barriers existed in and between interfaces, as in case study 2 (case 34), they were caused by a lack of holistic knowledge and communication, especially at the beginning of the development assignments.

As a summary of the case descriptions, it can be concluded of the learning enablers that according to the participants, the most inevitable outcome of the development projects was that participation in process simulations or elsewhere increased the holistic view of the core processes significantly. Secondly, they felt

that participation gave them a good view of the subprocesses and their functions and interfaces. The participants also reported that the process simulations increased their knowledge of the process and offered new ways of thinking. They also gained a broader understanding from new points of view.

The results of the case analyses indicate that the most important learning enablers of process and organization development in operations and strategy are the following:

Interaction, participation and empowerment

- Participation and the careful informing in the whole organization are vital during a change project as a basic management principle. Participative methods, such as process simulations, aid empowering the entire personnel.

A holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations)

- Participation in process simulations significantly increases the participant's holistic view of the organization's core processes. Participative methods bring together an organization's explicit and tacit knowledge.

Process development in organizations should focus on the process interfaces in operations as well as in strategy processes. The most striking results can be achieved by solving the problems in and between organizational interfaces (boundaries).

Common understanding of the process under development

- The systematic, simultaneous and visual connection between all individuals involves the results of a shared understanding of the present situation and the changing needs.

In the first case study, the article connects the concept of common understanding with a holistic view: "the principle of holistic knowledge guided the development work during the whole project, meaning management's and employees' shared understanding of the targets and proposed operations", and reports that "the plans were developed in a participative manner" and that "the spiral of the strategy and operations, concept and practice was a learning pattern for realizing the best practices". However, the second case study reports that "the interaction during the four-year project was quite intensive, but not sufficient enough for holistic knowledge to evolve between different units and staff members", and "the results

of the project slowed down". Thus, it can be claimed that the article recognizes the connection between participation, the holistic view, common understanding, and emerged and achieved results.

4.3.4 Discussion

Learning enablers and their relationships to each other

Article 2 reports the emerged findings on the learning enablers and their preliminary relationships in the two case studies. Based on these findings, interaction, participation and empowerment, a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations), and common understanding of the process under development are significant enablers of process innovations.

Article 2 also identifies that there are ties between learning enablers, i.e. between participation, the holistic view, common understanding, and learning results, but does not analyze these relationships more specifically.

4.4 Article 3: Participative development and training for business processes in industry: review of 88 simulation games

4.4.1 Introduction

Article 3 reports the results of 32 case studies, which included 88 process simulations. The goal of the article is to describe 1) how the process simulations were used in participative process development and training projects for different processes and purposes, and to elucidate 2) what kind of effects do process simulations have on individual and organizational learning, on creation of new ideas, on developmental actions, and on implementation?

The article answers two of the research questions of this thesis:

- Q1: What are the learning enablers and their relationships to learning paths?
- Q2: What kinds of learning outcomes emerge and what are their relationships to learning paths?

4.4.2 The research data, its collection and analysis

The article presents the results of using the construct as a development and learning method, and indicates the relation of the method and knowledge creation, the management of organizational change, and the creation of process innovations. The research was pursued inductively with 32 case studies, in which altogether 88 simulations were realized. The cases were carried out between 1988 and 1998 in Finland, apart from one case from Switzerland. The participatory action research approach (Whyte et al. 1991, Whyte 1991, 269–287, Argyris and Schön 1991) was followed throughout the whole process. In each case, the process simulation method was used mainly to develop different business processes or to train employees. Each case was used to build and test emerging theoretical insights, by following a cross-case study and replication logic (Eisenhardt 1989) as well as the principles of grounded theory (Glaser and Strauss 1967).

After the simulation sessions, the data were collected primarily through semi-structured evaluation questionnaires (appendices 1 and 2 of this thesis) and note-taking, as well as by interviewing the company staff throughout and after the projects. The videotaped process simulation material was also used to analyze the results (table 6).

In the 16 training cases and in 5 process development cases, the participants filled in at the end of the process simulation sessions the questionnaire with quantitative and qualitative questions presented in appendix 2. About 15 quantitative questions or statements were asked under the three following themes (using a scale of 1-5, where 1=not at all and 5=to a very high extent): how did the game achieve its aims, were participants satisfied with the practical arrangements, was the game useful for participants? The rest of the cases, where the evaluation questionnaire was used, were studied by using the questionnaire presented in appendix 1. In this questionnaire three to four open questions were asked after each simulation.

Note 1: Article 3 only includes two process simulations of case 31. Case 31 is reported completely and in more detail in article 5.

Note 2: In addition to article 3, cases 19–22 and 28 were used in the licentiate thesis of Haho (2002), in which the practical benefits of the construct based on the comparison of the case results were discovered. According to the comparison of the empirical results and existing theory, the hypothesis of success factors

about good process development and implementation method was presented in that thesis.

Table 6. Data collection methods and the data in article 3.

Data collection method	Data	Collection time
Researcher's engagement in the development project, action research	Observations	1988–1998
Observation during the 88 simulations and other development efforts	Observations	1988–1998
Questionnaire after 79 simulations	1497 answers	1993–1998
Discussions with the development teams of the companies	1–2 persons per company, frequently, altogether 32–64 persons	1988–1998
Discussions with the research teams	3 persons, frequently	1993–1998
Follow-up interviews after the interventions	32	1998

In article 3 the data was analyzed using qualitative and/or quantitative methods, and the final results of the analysis were published in the article. For each question in the questionnaires, different methods for analysis were used. Five of the business process development cases (cases 19, 20, 21, 22 and 28) were analyzed and reported in more detail in the article. In these analyses the software tool *ATLAS.ti* was used to categorize the achievements (table 7, article 3: table 5), ideas (article 3: tables 6 and 7), development issues and results of the simulation (table 8, article 3: table 8) to conceptualize them into short-term and long-term soft, hard and future results (later in this thesis called intangible, tangible, new intangible or new tangible outcomes) (table 9, article 3: table 9). (In these five cases the used process simulation construct is the construct depicted in article 1. In article 3, also 27 other cases are reported, in which diverse process simulation constructs (different than reported in article 1) are used). Next, the analysis of the data is explained in more detail.

For the analysis, grounded theory, with the principles of the constant comparative method, was adopted to generate categories and hypotheses (Glaser and Strauss 1967). First, the units of observations were coded, and after doing so, higher-level categories based on these codes were generated.

In table 7, the unit of analysis is the answer to the question “What did you achieve with the simulation days or what was the most remarkable issue the simulation game addressed for you?” The data consisted of the answers about the above mentioned five cases. The average was 1.74 answers per person (n = 218 persons, 379 answers totally). The transcribed data was coded with the software tool ATLAS.ti by labeling each answer with the category, after which higher-level categories based on the first coding were generated. The categories presented in table 7 are these generated higher-level ones. After decoding the data, the percentage of responses (number of respondents, n=218) in each category was counted. In the end also examples for each category were chosen.

The unit of analysis in table 8 is the answer to the question “What are the main development issues in the process?” Again the data for the answers were collected of the same five cases, total 218 answers. In three out of five cases, the analysis was done after both the first and the second process simulation sessions, and in two cases only after the first process simulation session. All reported cases were sales-to-delivery process development projects, while three of them had additionally one or two support processes included in their development focus. Once more, the data was coded in two steps: first labeling each answer with the category, after which higher-level categories based on the first coding were generated. After decoding the data the percentage of responses (number of respondents, n=218) in each category was counted. In table 8 the answers to this question are shown as high-level categories in the order of frequency, according to the percentage of persons who mentioned the issue.

Table 9 shows the results of the development actions and implementations in all 32 cases. The results are categorized as intangible outcomes (soft results), tangible outcomes (hard results) and new intangible/ tangible outcomes (future results). In article 3, the intangible outcomes are called ‘soft results’, the tangible outcomes ‘hard results’ and both new intangible and new tangible outcomes ‘future results’. In this short description, these new terms are already used. The intangible outcomes measure qualitative learning results, whereas the tangible outcomes measure quantitative results and changes (see also section 2.4). The new intangible or tangible outcomes have pronounced transfer effects over a long time span after the business process development or training projects, and can even transform the corporate culture.

Both the intangible and tangible outcomes can emerge on the individual or the organizational level. In table 9, the outcomes are also classified as either short

term or long term. Short term results appear within three months after the process simulation session, while long term outcomes appear in three to six months.

The subheadings of table 9 follow the categories in tables 7 and 8, also including the data of tables 6 and 7 in article 3. The three high-level categories (soft results/intangible outcomes, hard results/tangible outcomes and future results/ new intangible or tangible outcomes) have emerged from lower level categories based on the methods of grounded theory (Glaser and Strauss 1967).

4.4.3 Findings about learning enablers and learning outcomes

In the following, the results of the data analysis in article 3 are reported and interpreted.

Learning enablers and their relationships to each other

As shown in table 7, the most significant effect of the simulations was that the process simulations significantly strengthened the holistic view of the core process(es) (43% of the participants mentioned this in their answers), even so well that the holistic view of the process was no longer among the pressing needs after the simulations (table 8). The following examples describe the holistic view as a learning enabler:

> *"The process simulations created the holistic understanding of the lead times and problems in the order-to-delivery process; for the first time a complex process was understood as a whole."*
>
> *"I saw what other people expect from me and others."*
>
> *"I understood my single [individual] role as a part of the whole process"*

Secondly, the participants reported that the process simulations gave them a good view of different subprocesses, their functions and interfaces. In some cases, the interfaces clarified in the first simulation, in the others, in the later phases of the development project, depending on the macro and micro level complexity of the process and its interfaces. Therefore, the overall need for communication and co-operation increased in some cases after the first process simulation (table 8), to build up the shared holistic view as well as new solutions for the existing interfaces. The next example portrays well the importance of visualization and clarification in and between the interfaces:

"It illustrated the whole process and especially the interfaces: the theoretical and planned process is not always the practice"

"The simulation team can visualize the whole process whereas one person alone would be blind to many alternative solutions."

Thirdly, the games gave the participants a good opportunity to communicate and get to know others from different processes and departments. In some case studies, in the second process simulations of the development project, the knowledge of the process increased and was absorbed further on, as the participants became more aware of the rules of the process as well as of co-operation, teamwork, responsibilities, and developed empathy for the opinions of others. The participants reported of the process simulation that:

"It opened up communication"

"It increased my knowledge of terms and concepts"

"I now understand the whole chain; I am not alone even though I sometimes feel so."

"It created mutual understanding"

Table 7. The main benefits of the process simulations, according to article 3.

The main benefits, prioritized	% of per-sons	Examples of open answers
The holistic view of the process	43%	"The simulation games created a holistic understanding of the lead times and problems in the order-to-delivery process; for the first time a complex process was understood as a whole." "I understood how many people there are in the process" "I saw what other people expect from me and others" "All the people involved were, at last, present at the same time and were heard. The managers with decision-making power were also present."
The function of subprocesses, interfaces	26%	"It illustrated the whole process and especially the interfaces: the theoretical and planned process is not always the practice." "The functions are unclear in project management..."
New ways of thinking, experiences and learning to understand	23%	"I realized that nobody knows or understands…"

The main benefits, prioritized	% of per-sons	Examples of open answers
New information and knowledge	19%	“It increased my knowledge of terms and concepts”
Problems identified	16%	“to understand that others have problems too” and “ to learn from others” problems” “to realize that the communication between marketing and production is insufficient” “to see how things go wrong, and I hope we learn from this”
Getting to know others’ tasks	10%	“I noticed the role and tasks of different people” “I understood my single role as a part of the whole process”
Clarifying the process and its tasks	9%	“It was important for everyone to see and understand the interconnections between activities and tasks. The simulation team can visualize the whole process whereas one person alone would be blind to many alternative solutions.”
Ideas identified	6%	“Many new ideas were conceived.”
Method for open communication, informal discussion and interplay	5%	“People are sitting around the same table, and most importantly, talking to each other” “open atmosphere; multi-faceted comments from people in different phases of the process” “now names have faces” “to start better collaboration” and “to realize how many groups there are”
Method for process and organizational development	5%	“The simulation was a good training tool for smaller groups and newcomers.” “No one should miss the simulation game.” Discussion of real cases: “We treat the real cases and their slips and mistakes as well as how to correct them.”
Others	13%	To bring up the customers’ points of view : “to discuss with customers face to face”

Table 8. The main development issues in the process under development, according to article 3. T (F) =Total % in the first process simulations and T(S) = Total % in second process simulations. X = number of participants who answered the questionnaire. F= First simulation, S= Second simulation. Note: In T (F) and T(S) the number of cases is 3.

Case number	19		20		21		22	28	T(F)	T(S)	Total
First/Second game	*F (n=25)*	*S (n=18)*	*F (n=31)*	*S (n=7)*	*F (n=21)*	*S (n=11*	*F (n=14)*	*F (n=91)*	*F (n=77)*	*S n=(36)*	*All (n=218)*
Persons % of persons	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
Sales-to-delivery process	23	24	21	25	34	32	21	22	26	27	24
Production planning	15	13	1	0	16	18	6	8	10	13	9
Control systems in sales	0	11	15	8	15	14	13	6	10	11	9
Other	9	0	5	17	3	0	1	8	6	3	6
Support processes	13	18	14	8	11	0	3	27	13	11	17
Material management	2	2	1	0	8	0	0	15	3	1	7
Products and product development	6	9	13	8	1	0	0	8	7	6	6
Forecasting	1	2	0	0	1	0	1	3	1	1	2
Logistics	1	0	0	0	1	0	0	1	1	0	1
Other	3	4	1	0	0	0	1	0	1	3	1
Communication	14	2	8	0	7	18	7	9	10	6	9
Information systems	15	4	1	0	5	9	0	6	7	5	6
Rules and terminology	3	20	5	0	8	9	1	2	5	14	5
Change management	4	4	0	0	0	0	0	8	1	3	4
Co-operation	0	4	3	0	2	9	6	5	2	5	4
Interfaces	6	0	6	8	10	0	0	1	7	1	3
....											
Holistic view	2	0	0	0	0	0	3	0	1	0	1

To conclude, the data analysis of the learning enablers (tables 7 and 8) shows that: Visualization of the process under development

- The process description unites the organizational units and processes into a coherent whole and aids visualizing the process under development with its interfaces. The simulation team is an important visualizer of the process as well.

Interaction, participation, empowerment

- The process simulation meets the challenges of being an efficient communication channel for knowledge sharing and above all for creating new knowledge in a shared mode within an organization.

A holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations)

- The process simulations significantly strengthen the participants' holistic view of the core process(es).
- The process description unites the organizational units and processes into a coherent whole and aids visualizing the process under development with its interfaces.

Common understanding of the process under development

- The more people internalize the process, the higher level of knowledge creation they can achieve, (e.g. from identifying the process to forming the process rules, from communication to cooperation, from understanding the process to understanding others' opinions).

Article 3 describes that in some cases, not until after the first or second process simulation, the process interfaces and some other issues, e.g. support processes or production planning, clarified. Therefore, the overall need for communication and co-operation increased after the first simulation (table 8), for the participants to build up the shared holistic view as well as new solutions. After increased discussions in the next process simulation rounds, the holistic view among the participants was achieved. This indicates that the holistic view is gained through participative and visualized process development methods.

The article also reports that in some cases "process interfaces were no longer an issue in the second process simulation, whereas the process rules and terminology as well as cooperation needs grew in importance". Therefore, it was recognized that there was a need for advanced level knowledge creation after the internalization of easier issues. This calls for new reflective knowledge creation

cycles, where more advanced knowledge clarifications and refined new knowledge are built on the top of the achieved holistic view.

Learning outcomes

The findings concerning the learning outcomes presented in article 3 are shown in table 9, categorized as soft (intangible), hard (tangible) and future (new intangible or new tangible) outcomes (results). In the table, the outcomes are also classified as either short term or long term. Short term results appear within three months after the process simulation session, while long term outcomes appear in three to six months. The results were assessed during action research project by researchers.

In three months almost all the cases achieved the intangible outcome level to some extent. This was a direct result of the process simulations. In only three cases out of the total 32, the intangible outcomes required a longer period to be realized. The training cases as well as the development cases attained intangible outcomes within a similar time span and also the issues were similar.

Some tangible outcomes were met during the process simulations or at least before the three month term. However, the business process targets, some improvement actions, and in one case the improved process were not among these. The main difference between training and development cases was the scope of the targets. Therefore the outcomes differ noticeably from one another: only in development cases and in two training cases, the process description of the ideal target process was created and assessed right after the process simulation.

In many cases, the learning effect during the process simulations produced a special long-term rise (new intangible or tangible outcomes) in process development. The socialized tacit knowledge of the process as well as the externalized process model with an interface description of the subprocesses clarified a shared mental pattern and goals for future development steps. Based on article 3, it seems that the simulation experience promotes (e.g. cases 17, 18 and 19), and even encourages a company's staff in self-governing development, even long after the shared mental experience of process simulations. The case organizations acquired new intangible and tangible outcomes over a long time span. Though some results were already achieved in the short term, others emerged after months or years. These outcomes were gained mainly in the business process development cases.

Tacit change, change without any commonly known development efforts, could in principle occur in all areas that were discussed in the process simulations. The shared mental model is enough to trigger the change on the individual level: people feel encouraged to development actions and decisions after the shared experience. Individuals act on intuition, and thus the organizations adapt their processes even before the matter in question is explicated (see also Reber 1989). The following expressions from participants after their process simulation session support the hypothesis on tacit change:

"We will not come away empty-handed"

"I believe that no one is making the same mistakes anymore; we have learned a lot."

Table 9. Short-term and long-term results in the training and development cases of article 3 categorized as intangible outcomes, tangible outcomes or new intangible or new tangible outcomes.

Results	Short-term		Long-term	
	Training cases	Development cases	Training cases	Development cases
A: Intangible outcomes (Soft results)				
Knowledge				
Shared holistic understanding of the actual process	1,2,3,4,5,6-13	19,20,21, 22, 28, 31, 32		
Shared holistic understanding of the new process and/or design	3,4	17, 18, 19, 20, 21, 22, 23, 28		
Concretized problem areas for participants	1,2,3,4	17,18,19,20,21, 22, 28, 31, 32		
The needs for new knowledge and training were recognized		18		
Experimentation of the new design and concepts	3,4	17, 18, 19, 20, 21, 22, 23, 28		
Atmosphere				
The innovative atmosphere spilled over into the organization at large		17		
Communication and co-operation				
Easier to communicate, broad discussion about the process, tasks...	1,2,3,4,5	17,18,19,20,21, 22, 28, 31, 32	11	
Increased inter-functional co-operation and flexibility		19		24, 30
Increased co-operation with clients,		28	11	24

Results	Short-term		Long-term	
suppliers or other external partners				
Mutual targets				
The change project was for the first time conceived as a common challenge		18		
Experiment with all personnel in situations where the strategy is going to change		22		
B: Tangible outcomes (Hard results)				
Business process description				
Actual process: identified, analyzed, described and improved	1,3,4,5,6-13	19,20,21, 22, 28,31,32	11	
Process description of the ideal target process	3,4	17,18,19,20, 21,22,23,28		
Problems and idea implementation				
Identified problems, ideas and needed improvement actions of the process (Table 6&7)	1,2, 3,4, 5	17,18,19,20, 21,22,23,28, 31,32		
Different solutions were tested, analyzed and assessed: plans were improved	3,4	17,18,19,20, 21,22,23,28		
Decisions for improvement actions (Table 6&7)	5	17,18,19,21, 22,31,32		
Implemented improvement actions	5	17,18,19,21, 22,31,32		17,18,19,21, 22,24,30
The 'hard' business process targets were met				*17,19,21,22*
C: New intangible or new tangible outcomes (Future results)				
Simulation game will be an internal development and training method		18	2,3,4,14-16	17,31,32
Established BPR -projects in near future			2,3,4	
The simulation games had a powerful impact on the development of new IT systems		18		17,19,21,31, 32
Personnel were empowered to take new challenges				17
Helped to clarify the change objectives and had important triggering effects on evolution management principles		18,21,22		18,21,22
An effect on the organization's corporate culture		31		17,18,31
The dialogue between strategy and operation was begun		18,21,22		
The simulations are a shared experience still referred to				17,18,19,21, 31,32

To summarize, according to the findings of article (tables 9 and 8) the intangible outcomes are preconditions for achieving the tangible business results, the intangible outcomes form a base for the achievement of future results, i.e. new intangible or new tangible outcomes, and the intangible outcomes also form a base for tacit change in organization.

4.4.4 Discussion

Learning enablers and their relationships to each other

The article reports experiences of the 88 process simulations. The findings on learning enablers reflect 1497 participants' opinions of them. The data analysis of enablers (tables 7 and 8) shows that process simulations significantly enhance the participants' holistic view, visualize the process under development with its interfaces, and meet challenges of being an efficient, participative and empowering communication arena. In this reflective environment common understanding increases.

Article 3 confirms the findings of articles 1 and 2: 1) visualization of the process under development, 2) interaction, participation and empowerment, 3) a holistic view with boundary crossings, and holistic knowledge of the organization, including all aspects e.g. vision, strategy, goals and guidelines for the process innovations, and 4) common understanding of the process under development are important learning enablers in process innovations.

These findings also support the results of earlier Finnish studies of process simulations (e.g. Smeds 1994, 1996a, b, 1997b, Ruohomäki 1995a, 2002, Forssén-Nyberg and Kutilainen 1998, Forssén 2002, Mäkelä 2002): process simulation is an effective participative method, which enhances holistic view, common understanding, learning, and knowledge creation in an organization.

Of the relationships between learning enablers, the article reports that after increased discussions during the next process simulation rounds, a holistic view was achieved among the participants. This connects the concept of holistic view with process simulation and its' features: participative and visual. This leads to the negotiation of existing knowledge in reflective cycles.

Article 3 also recognizes that there was a need for advanced level knowledge creation after the internalization of easier issues. This calls for the second

reflective cycle, knowledge creation. In this cycle, refined and novel knowledge is built on the top of the achieved holistic view.

Article 2 only identifies that there are links between diverse learning enablers, i.e. between participation, a holistic view, common understanding and learning results. Article 1 adds that the process simulation method enhances common understanding, i.e. the process simulation method is composed of such elements that they increase common understanding. Thus far, we can conclude of the relationships that participation and visualization enhance the holistic view. This forms the first reflective cycle, knowledge negotiation. The achieved holistic view acts as a source for common understanding and knowledge creation. This forms the second reflective cycle, knowledge creation.

Learning outcomes

The emerged results of the process simulations in article 3 were interesting. The first look at them suggested that people gained something more than the expected results, and thus, the results were analyzed in more detail, based on grounded theory.

The data analysis of learning outcomes (table 9) suggests that learning outcomes can be divided into intangible, tangible, and future intangible or tangible outcomes (details above).

These constructs have not been widely identified in the existing literature on organizational learning (e.g. Argyris and Schön 1978, Duncan and Weiss 1979, Kolb 1984, Engeström 1987, 1990, 1999a, b, Nonaka 1994, Nonaka and Takeuchi 1995, Scardamalia and Bereiter 2003) or process innovations (e.g. Tidd et al. 2005, Davenport 1993, Hamel 2000, Imai 1986, Zwikael and Smyrk 2012). The findings of article 3 (tables 8 and 9) make it possible to hypothesize on the role of learning outcomes in learning processes. The intangible outcomes emerged before the tangible outcomes. It seems that intangible outcomes are preconditions for achieving tangible business results, intangible outcomes form a base for the achievement of future results i.e. new intangible or tangible outcomes, and intangible outcomes also form a base for tacit change in an organization. Although these results are very clear, the research on outcomes was complemented in article 5 to confirm and further explain the roles of outcomes in creating process innovations.

4.5 Article 4: Bottom-up or top-down? Evolutionary change management in NPD processes

4.5.1 Introduction

Article 4 presents two case (cases 31 and 33) studies of a simulation based business process development. One of the case companies was a pharmaceutical company, the other a telecommunication company. Both were developing their new product development processes, aiming to shorten the time-to-market of new products. Both cases applied process simulations, but they differed in their initial approach to change: top-down implementation of a pre-designed process plan (telecom), versus bottom-up development of a new process (pharma). Thus, a comparative case study was conducted in order to test and further develop the process simulation method as well as the theory behind it.

The article answers one of the research questions of this thesis:

- Q1: What are the learning enablers and their relationships to learning paths?

4.5.2 The research data, its collection and analysis

In article 4, a comparative case research was conducted. The results from the process simulations and from change management efforts were qualitatively evaluated immediately after the simulations, based on the questionnaires (appendix 3), observations of the simulation sessions, and discussions with the development teams from the companies. The insights of the cases were also gained through the engagement in the development projects. The thematic follow-up interviews (appendix 4) of key persons about the effects of the process development projects were conducted in both companies 14–18 months after the last simulation, for the purpose of evaluating the results of the change projects in the NPD process and in the company at large as well as to evaluate the process simulation method and the theory behind it. Twenty-seven thematic interviewees in the pharmaceutical company (case 31) and twenty-four in the telecommunication company (case 33) provided opinions concerning the results of the change projects and the process simulations.

Table 10. Data collection methods and the data in article 4.

Data collection method	Data	Collection time
Researcher's engagement in the development project, action research	Observations	1998–1999
Observation during the 13 simulations and other development efforts	Observations	1998–1999
Questionnaire after the 13 simulations	616 answers	1998–1999
Discussions with the development team of the companies	3 persons, frequently	1997–2000
Discussions with the research team	3 persons, frequently	1997–2000
Follow-up interviews after interventions	51 interviews	2000

The data of article 4 was analyzed using qualitative methods. In general, for the analysis, grounded theory, with principles of the constant comparative method, was adopted to generate categories and hypothesis (Glaser and Strauss 1967).

For the analysis of the learning outcomes, the data of the questionnaires of 616 respondents (appendix 3), observation of the simulation sessions, and discussions with the development team of the company were used. The unit of analysis was the perceived results and benefits of the case project, as well as the future development targets. The transcribed data was coded with the software tool ATLAS.ti by labeling each answer with the category, after which higher-level categories based on the first coding were generated. The results of the analysis are reported in a descriptive manner in the article.

The follow-up interview data (appendix 4) were taped and transcripted, analyzed and categorized conceptually using the software tool ATLAS.ti (in case 33) or Word and PowerPoint (in case 31). The results of the analysis are also reported in a descriptive manner in the article.

4.5.3 Findings about learning enablers

Learning enablers and their relationships to each other

Article 4 explains, through two case studies, how successive process simulations were used in process development, and reports the achieved outcomes and results. The projects differed markedly in their initial change approach. However, both the bottom-up initiated change project of the pharmaceutical company and the top-down initiated project of the telecommunication company achieved good results in process development. Irrespective of the differences in their product life cycles and their initial change management approach, both companies could, through the successive process simulations, start a dialogue between process development and strategy.

The pharmaceutical company migrated in its change management in an evolutionary manner, bottom-up, from one simulation to the next. In these five simulations, in interaction between operation and strategy, the most strategically relevant process improvement issues were found, a process vision began to form, and simultaneously a platform for change was built that enabled the development of the new NPD process. The company could, however, have benefited from a stronger top-down change management component, to exploit and implement fully the results from the simulations for its process development. In this company, a strategic project portfolio management would have been needed, to prioritize and synchronize the many concurrent bottom-up process development initiatives, some of which were overlapping and creating unnecessary complexity in the company. Thereafter, systematic project management practices could have been applied in process development to implement the selected projects.

In the telecommunication company, the original aim was to use the method for the training and quick implementation of a top-down initiated, pre-planned ‘closed’ process change. However, the basically ‘open’, simulations produced many crucial process development ideas during the first simulation set in this case. These were then incorporated into the new, more elaborate design for the second simulation set, which enabled the successful implementation of the new process. Thus, the change management of the company simultaneously formed into a top-down training and bottom-up development effort.

In these bottom-up change management approach of the pharmaceutical company, the successive simulations focused and guided the change project step by step towards the vision, which itself emerged during the project. In the top-

down change approach of the telecommunication company, the predefined process was tested and specified in more detail during the training period, based on the improvement ideas that grew out of the set of the first process simulations. Thus, both cases ended in learning development mode instead of a pre-described change.

In the change projects a dynamic dialogue between operational processes and strategy was achieved: starting either top-down or bottom-up, both NPD process development projects combined operational and strategic development for process innovation. This dynamic dialogue was triggered and sustained through successive process simulations. The simulations were built based on the principles of empowerment, holistic knowledge, and human interaction (see also Smeds 1996b, 1997a, b), which led to improvement ideas in processes and strategy initially and thereafter also helped in their implementation. These 'soft' organizational principles thus built the necessary platform for the 'hard' results. In both companies as a result of process simulations a shared process understanding, common language and improved communication were among the deeper-reaching results.

The above results of the case analyses show that the successive interventions, i.e. process simulations trigger continuous and dynamic dialogue between operational processes and strategy. The process simulations proceed as a learning community in this dialogue. Based on article 4, it seems that the quality of the outcomes and results is better, if there is more than one intervention (i.e. process simulation) in the project.

As a summary of the qualitative case descriptions (article 4), I can conclude about the learning enablers:

Interaction, participation and empowerment

- Process simulations are built based on the principles of empowerment, holistic knowledge, and human interaction
- The successive interventions, i.e. process simulations, trigger continuous and dynamic dialogue between operational processes and strategy

A holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations)

- Process simulations boost the emergence of common language in the organization

- Process simulations are built based on the principles of empowerment, holistic knowledge, and human interaction
- The intangible organizational principles (intangible learning outcomes) build the necessary platform for the tangible results (tangible learning outcomes)

Common understanding of the process under development

- As a result of process simulations a shared process understanding is created

An arena for cross-functional interaction and co-operation

- The process simulations serve as a learning community

4.5.4 Discussion

Learning enablers and their relationships to each other

Article 4 confirms the findings on learning enablers from the previous articles. The case descriptions show that participation and empowerment, a holistic view and common understanding are significant learning enablers and process innovations. Of the earlier mentioned learning enablers only visualization was not found in the case data. This was probably due to the fact that visualization is an obvious principle in process simulations (as described in section 1.3). Especially learning in communities was recognized by participants as an enabler for process innovations.

Of the relationships between learning enablers, the article confirms the earlier findings that process simulations boost the emergence of a holistic view and common understanding. This connects the concept of the holistic view and common understanding with process simulation and its features: participative and visual. This leads to reflective cycles of negotiation about existing knowledge and to knowledge creation.

4.6 Article 5: Paths to deutero-learning through successive process simulations: a case study

4.6.1 Introduction

Article 5 concerns a case company's (case 31) process development project, which was implemented with process simulations over the project's whole life-span, from the point of view of operative, strategic and cultural outcomes. This analysis of learning outcomes included their intangible and tangible manifestations, and the results were interpreted through underlying organizational learning theories, especially through the concepts of single-loop, double-loop and deutero-learning of Argyris and Schön (1978). The longitudinal research approach and the methods enabled studying the organizational learning process, its outcomes, as well as their interrelations, to identify paths of single-loop, double-loop and deutero-learning. Through the answers to the following research questions, the article demonstrates paths to deutero-learning, which seldom can be empirically identified in an organization: 1) What kind of outcomes did emerge during the development endeavor in the case company and 2) What are the relationships between these outcomes? 3) How did these outcomes emerge? 4) What was the role of the simulation method in the learning process? The article answers all three research questions of this thesis:

- Q1: What are the learning enablers and their relationships to learning paths?
- Q2: What kinds of learning outcomes emerge and what are their relationships to learning paths?
- Q3: How do the learning enablers and the learning outcomes mutually create the learning paths, and what are their relationships to each other?

4.6.2 The research data, its collection and analysis

This study is a single-case study (case 31) in an action research project. The research and the consultation of the process development project progressed in parallel for one and a half years. Thus, a longitudinal intervention method could be used for the study. Sequential interventions with process simulations built the longitudinal research frame. The research approach and the methods enabled to study the organizational learning process, its outcomes, as well as their interrelations, to find out paths of single-loop, double-loop and deutero-learning.

In the article, the outcomes from the process simulations were qualitatively evaluated right after the simulations, based on the questionnaires (appendix 3), on observation of the simulation sessions, and on discussions with the development team of the company. The questions and observations considered the results and benefits of the case project, as well as future development targets.

The follow-up interviews (appendix 4) of the key persons in the case project were conducted in the case company 14 to 18 months after the last simulation, to evaluate the outcomes of the project in the new product development process and in the company at large. Altogether 27 interviewees gave their opinions in thematic interviews about the outcomes of the development project, and about the individual and organizational learning. The interview themes (appendix 4) were e.g. realization of the case project, its achievements, major problems, the affected impacts of organizational changes, the impacts of development on process structures and milestones, how the objectives of the case project have changed during the project, what the main outcomes were and how the process development should have been realized?

Table 11. Data collection methods and the data in article 5.

Data collection method	Data	Collection time
Researcher's engagement in the development project, action research	Observations	1998–1999
Observation during the five simulations and other development efforts	Observations	1998–1999
Questionnaire after the five simulations	216 answers	1998–1999
Discussions with the development team of the company	2 persons, frequently	1997–2000
Discussions with the research team	2 persons, frequently	1997–2000
Follow-up interviews after interventions	27 interviews	2000

The data of article 5 was analyzed using qualitative methods. Each topic, i.e. outcomes and learning paths, was analyzed in slightly different ways. Overall, for the analysis, grounded theory, with principles of the constant comparative method, was adopted to generate categories and hypothesis (Glaser and Strauss

1967). Subsequently, the analysis of the data is explained, in more detail applied in this article.

For the analysis of the outcomes (table 12, article 5: table 2) the data of the questionnaires (n=216) (appendix 3), of the observations of the simulation sessions, and of the discussions with the development team of the company were used. The unit of analysis was the results and benefits of the case project, as well as the future development targets. The transcribed data was coded with the software tool ATLAS.ti by labeling each answer with the category, after which higher-level categories based on the first coding were generated. The categories presented in table 4.9 are these generated higher-level ones. Furthermore, the categories were combined into two separate groups: intangible and tangible outcomes, based on previously made definitions (see also section 2.4). The most significant outcomes were also compiled into a table, putting each outcome under broader heading. Finally, the relevant process simulations (1-5) were added into each category.

To illustrate interaction between intangible and tangible outcomes, several examples of the learning paths were collected and four of them (Learning paths I–IV) were reported in the article. The observed examples were collected during the project and the categories of table 4.9 were used to report the details of the learning paths.

To analyze how and why the outcomes emerged during the project at the case company, and what roles interaction and learning played in this process, the concepts of single-loop, double-loop and deutero-learning (Argyris and Schön 1978, see also sections 2.2 and 2.4) were applied for this analysis. In the analysis, follow-up data (27 interviews collected 1 ½ year after the last intervention) was used. The follow-up interviews were taped and transcripted, analyzed and categorized conceptually using MS Word and MS PowerPoint as tools. The whole data were categorized for 1) individual single-loop learning, 2) organizational single-loop learning, 3) individual double-loop learning, 4) organizational double-loop learning, 5) individual deutero-learning, and 6) organizational deutero-learning. The unit of analysis was each of the above six categories. In the article, the results were reported and illustrated with anecdotes about in what way the individual participants had learned, and how the organization had learned.

4.6.3 Findings about learning enablers, learning outcomes and learning paths

The findings on the article were threefold. They concerned learning outcomes, learning paths, i.e. the relationships of outcomes, and learning processes. In the following, the findings are briefly summarized. A more detailed description of them is presented in the article itself in appendix 5.

Learning outcomes

Table 12 summarizes the learning outcomes of the project from the point of view of two learning outcome categories: intangible and tangible.

Table 12. Learning outcomes of the project by summarized categories, according to article 5.

Learning outcome category	Process simulation	Learning outcomes of the project
Intangible		
A. Communication	1, 2, 3, 4, 5	A1. Many general themes about the processes, organization and strategy were revealed from simulation to simulation A2. Increased contacts A3. Common language and improved communication A4. Knowledge transfer A5. Better communication and interaction with the interfaces of operation and strategy A6. Reasons to re-evaluate opinions A7. Need for change awakened A8. Value discussions
B. Understanding	1, 2, 3, 4, 5	B1. A shared and increased process understanding through simulations and analysis of the existing NPD practices B2. Understanding of concepts, overall view, better management of the whole B3. Increased common understanding of the importance of milestone thinking and time dependencies in interfaces B4. The major interfaces between NPD, marketing and subsidiaries were discussed, and common understanding and language was greatly enhanced B5. Strategy-based process understanding: how to act in the future business situations

Learning outcome category	Process simulation	Learning outcomes of the project
		B6. A shift from the traditional silo-organization towards process and project thinking B7. The availability of tacit knowledge in the organization was revealed B8. Issues of team structures, roles and responsibilities were highlighted B9. Management must pay attention to the project much earlier that what has been the practice so far
C. New knowledge and its transfer	1, 2, 3, 4, 5	C1. Inter-project knowledge transfer during the process simulations C2. Learning of the interrelation of the strategy and operations C3. Improved level of understanding and the problem-solving skills of the personnel C4. Many development ideas (387 ideas) were generated, e.g. better ways to manage NPD projects and utilize human resources, the need of project management, team building, concurrent subprocesses and milestones, some of which could be immediately implemented; some required separate development projects and further simulations
Tangible		
D. Defined processes	3, 4, 5	D1. Requirements for new NPD project management practices: structure, pro-active planning tools, time perspective, team work, roles and responsibilities D2. For the first time defined NPD process: structure and milestones D3. Defined decision-making process
E. Changed practices	3, 4, 5	E1. Developed strategic interfaces between NPD and marketing: The whole commercialization process of new drugs was looked at first time in the company history with clarified roles of strategic and operative marketing. E2. Integrated Health Economics function into the NPD process E3. Implemented practices such as systematic project management, NPD project portfolio management and key performance indicators E4. Major organizational changes e.g. new project management function, new combined pre-clinical and clinical department, new international marketing function, enlarged role of the registration function E5. Advanced, team-based NPD project management with strengthened milestones E6. Focused strategic decision making in NPD with changes in decision making points E7. Furthered global pricing strategy E8. New management tools and principles for project management E9. Improved resource management and competence development E10. Increased outsourcing and co-operation with partners E11. Cultural changes

Learning outcome category	Process simulation	Learning outcomes of the project
		E12. Tacit changes, i.e. changes without any commonly known development efforts
F. Business results	5	F1. Improved performance of ongoing NPD projects
		F2. Reduced lead-times in drug development
		F3. Improved quality in NPD
		F4. Estimated time reduction of several years in the overall time-to-market of new drugs

Intangible learning outcomes, i.e. communication, understanding, and new knowledge and its transfer, emerged in all simulations, especially in the first rounds. After the second simulation round the tangible results, i.e. the defined processes, the changed practices and business results began to increase gradually. Visible business results began to shape during the fifth simulation, a year after the first simulation. In addition to intangible short-term results, many intangible long-term results were mentioned in the follow-up interviews. In the case company, also a cultural change towards an empowered, action-oriented process culture emerged. Many beneficial process improvements occurred after the simulations, even without explicit agreements, and people felt a positive development attitude.

Learning paths

Article 5 also demonstrates how the learning outcomes evolved and grew stronger simulation by simulation, and formed paths in individual and organizational learning.

It is interesting to realize that all learning paths (Learning paths I–IV) started from the increased mutual process understanding, after which the tangible outcomes realized. Some learning paths were long, and some collapsed right after the idea had been introduced. For example in learning path III, the conscious decision was to develop the top management's decision-making process, but the idea collapsed due to the unwillingness of the top management to develop the process in the empowered manner. Many times, e.g. in learning paths I and II, the steps in learning were subconscious, and after the good results in one focused area, the project managers intensified the outcomes through decisions concerning the focus in the next steps of the development project. The entire learning paths are reported in detail pages 246–247 of article 5.

Furthermore, article 5 (247–249) reports the results, and illustrates with anecdotes in what way the individual participants learned, and how the organization learned. In this illustration, Argyris and Schön's (1978) theory of single-loop, double-loop and deutero-learning is used to categorize the results. The analysis shows that there were large amount of individual and organizational double-loop learning, i.e. changes, in norms as well as organizational deutero-learning in addition to the individual and organizational single-loop learning during the project.

> *"Many matters have been up in the air, but the Stella project has created the need and improved the atmosphere and accelerated the development." Organizational single-loop learning*

> *"Milestone thinking has been awakened only during past two years. We did not understand the importance of dividing work, and that we should point out the milestones. It wasn't until the past two years that I understood this, either." Individual and organizational double-loop learning*

> *"The positive reaction of the subsidiary representatives: positive that we sat down and had a discussion. People felt empowered, especially so, because they could participate in the development [at the case company] during this phase. The significance of the Stella project as a symbol for change is more important than its outcomes, because it enabled us to start the international cooperation between different functions." Organizational double-loop learning*

> *"The Stella project has been used in the management group, both the concept and separate parts, for strategy building etc. The Stella project has been one good brick that has been used. The background information has been collected from the Stella project, separate maters from simulation rounds, and also the principle of bottom-up development. This policy has become a concept." Organizational deutero-learning*

The achieved results of single-loop learning represent huge changes in practice, which nevertheless are still based on the existing organizational norms. The learning outcomes, which represent double-loop learning, set new priorities and re-evaluate norms, and restructure the norms themselves. The analysis indicates that essential changes in the case process and organization required changes in norms. In the case there were also changes in the problem solving culture. An

organization learned how to carry out single- and double-loop learning, and it invented and generalized new strategies for learning.

4.6.4 Discussion

Learning enablers and their relationships to each other

Article 5 did not focus on learning enablers or their relationships, yet the findings of the article confirm the earlier findings and indicate that the outcomes and the learning paths are also important learning enablers. The following sections highlight these issues further.

Learning outcomes

Even though the findings on outcomes were obvious already in article 3, further research on this topic was conducted to confirm and further explain the role of outcomes in creating process innovations.

The findings on outcomes (table 12) suggest that outcomes can be divided into intangible and tangible outcomes. It can be observed from table 4.9 that intangible outcomes emerge during each intervention whereas tangible outcomes emerge later, after interventions have taken place. Intangible outcomes are therefore prerequisites for tangible outcomes. This supports the findings in article 3.

Learning paths

Article 5 demonstrates how the outcomes evolved, transformed, and grew stronger intervention by intervention, and formed paths into individual and organizational learning. The learning paths started from increased mutual process understanding, after which tangible outcomes realized. In addition to the findings in article 3, these findings and the above findings in table 12 confirm that intangible outcomes are preconditions for achieving tangible business results.

Article 5 shows how outcomes and learning paths interact over time and how empowered process development can create double-loop and deutero-learning in an organization.

Firstly, article 5 demonstrated that intangible outcomes emerged during communication, and that shared understanding and process learning were prerequisites for the process of forming learning paths as illustrated by these participant quotes.

> *"The significance of the case project as a symbol for change is more important than its outcomes, because it enabled us to start the international co-operation between different functions."*

> *"The more people understand, the better they can make goal-oriented decisions."*

The above quotes represent double-loop learning: setting new priorities and re-evaluating norms (section 2.2). These quotes indicate that essential changes in the case process and organization required changes in norms. It is through these learning paths that fundamental change in an organization occurs, resulting in changes concerning norms and rules (double-loop learning). The tangible outcomes follow changes in norms. Thus, intangible outcomes are crucial for a project, especially in its early stages.

Secondly, the case project was not important only due to the changes that occurred through single-loop and double-loop learning. An even more substantial achievement of the case project was its role as a vehicle for learning about how to learn in an organization. The project achieved deutero-learning during the one-and-a-half-year period, but in reality it had a much more far-reaching impact: it created a principle of bottom-up development and an organizational learning culture for the company. Additionally, there were changes in the problem-solving culture. The organization learned how to carry out single- and double-loop learning, and it invented and generalized new strategies for learning.

In the first simulations, lively interaction and communication between the hierarchical levels and the subprocesses of the organization began to form an aggregate systemic picture of the whole process under development. The understanding and knowledge of the operation and strategy and of the business issues increased among individuals at all levels of the organization. The results of the first simulations illuminated the next steps in the project, revealed the necessary development actions for the strategically most critical areas and highlighted the need for and focus of the next process simulation rounds (article 5: learning paths I-IV). The learning from the previous simulation rounds brought out various issues, e.g. at the end of the second simulation one participant began

to plan her next project with the help of the tools she had used in the first and second simulation. Later, the company's personnel understood the need for formal structures, and began to use the process simulations as a tool to achieve these goals (article 5: learning path II). Thus, the organizational learning processes strengthened and influenced business operations. The organization learned how to learn.

5 Summary

In this chapter, the findings of the articles are collected into a coherent presentation and the results are presented in the form of propositions about learning enablers, learning outcomes and learning processes.

5.1 Learning enablers

In the following sections, the impact of visualization, of participation and empowerment, and of the formation of a holistic view are explained in relation to the emergence of common understanding, to the role of learning communities, to the relationships of these factors to individual and organizational learning, and to the emergence of the process innovations. This whole section answers to the first research question:

- Q1: What are the learning enablers and their relationships to learning paths?

Based on the findings of article 2, significant learning enablers in process innovations are: interaction, participation and empowerment, a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations), and common understanding of the process under development. These findings pave the way for the principles of a high-quality process development method: the method should improve the participants' holistic view of the organizational processes and their interfaces, including new knowledge, new ways of thinking, and new understanding. This insight guided the design principles of the method presented in article 1: the method should be visual and participative to enhance innovativeness and the holistic view, so that all personnel are able to join in the creative process. This added the visualization of the process under development to the enablers of process innovation described in article 2.

The data analysis of learning enablers in article 3 shows that the process simulations significantly strengthen the participants' holistic view, clearly visualize the process under development and its interfaces, and meet the challenges of being an efficient, participative and empowering communication channel. In such a reflective environment common understanding increases. This confirms the findings of article 1 and 2: important learning enablers are visualization of the process under development, interaction, participation and empowerment, a holistic view with organizational boundary crossings, holistic

knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations), and common understanding of the process under development. Moreover, article 4 adds an arena for cross-functional interaction and co-operation as an enabler for process innovations.

To summarize, the theoretical and empirical findings of this thesis identify as significant learning enablers for process innovations: 1) visualization of the process under development, 2) interaction, participation and empowerment, 3) a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals and guidelines for process innovations), 4) common understanding of the process under development, and 5) an arena for cross-functional interaction and co-operation.

Table 13. The comparison of learning enablers identified in the articles of this thesis.

Learning enablers	Article 1	Article 2	Article 3	Article 4	Article 5
1) visualization of the process under development	x		x		(x)
2) interaction, participation and empowerment	x	x	x	x	(x)
3) a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals and guidelines for process innovations)		x	x	x	(x)
4) common understanding of the process under development		x	x	x	(x)
5) an arena for cross-functional interaction and co-operation				x	(x)

In the following sections, it is highlighted further how the above enablers influence learning in process innovations.

5.1.1 Visualization for common concepts and common understanding

The more complicated the matters in the organization development are, the more essential it is to visualize them. Process development and innovation are complicated endeavors, in which visualization is indeed necessary.

Based on the construct presented in article 1, construct A (a construct of a process development method, which includes the process simulation method), a process simulation session includes several visual aspects, i.e. the participants, a simulation arena, and a process description. In the following sections, visualizations in process simulations are interpreted from the point of view of these aspects.

The process simulation session serves as a visual constructive arena for knowledge building, and supports effective memory retrievals in three ways (see also Perkins 1993, 96: constructive arenas). Firstly, the simulation arena shapes a visual arena for learning; secondly, the participants themselves are visual artifacts as such, which aids them to learn and achieve their goals of process development; thirdly, the process description develops into an essential and rich visual artifact for enhancing conceptual understanding (described below).

In process simulations, cognitive resources are distributed both between humans and tools (between actors and the process description or between the facilitator and the process description), and between cognitive actors (between actors or between actors and the facilitator).

Simulation arena – a visual space for knowledge building

The process simulation session is a temporary knowledge creation community (section 5.1.5. "A temporary knowledge creation community for knowledge building"), the members of which are selected from the process under development and its interface processes to represent each in development efforts. The visuality of the process simulation helps to create connections between persons and the process under development, as well as to expand an overall picture and common understanding of process under development. The simulation arena acts as an essential visual artifact, which enhances conceptual understanding and knowledge building during development sessions.

Participants – visual artifacts for each other

In process simulations, the participants represent themselves as actors on or in the process under development, and when the facilitator directs the discussion they describe the different phases of the process flow and case examples through their own experiences (articles 1, 3 and 4). For the participants, the common view of

the depicted process is shaped during each turn in the simulation discussion. One participant even reported that "it was important for everyone to see and understand the interconnection between activities and tasks. The simulation team can visualize the whole process where one person alone would be blind to many alternative solutions" (table 7, article 3: table 5). Outlining the process is assisted by identifying the process phases with a describer, situation, space and time (see also Moreland et al. 1996, 63–67, Moreland 1999, 4–8: transactive memory). This is the way in which the participants themselves act as visual and social artifacts.

Moreover, the process simulations – the process development sessions – aid in collecting the existing knowledge and especially in identifying who knows what. Through simulations new knowledge can be created by combining the existing explicit knowledge with the tacit knowledge (as defined by Nonaka and Takeuchi 1995) the participants of the simulation give voice to. At the same time as the participants express novel ideas, the process simulation session and its' visuality enhance the ideas in the participants' memory for later use in practice.

Process description – a rich, visual boundary object

In a process simulation, a process description – the visualization of the business process – is an artifact (article 1), which connects the participants' memories to the collective memory of the process simulation group (Hutchins 1990, 191–220; 1991, 283–286; 1995, 287–316: distributed cognition; Weick and Roberts 1993, 357–360: collective mind) and guides and focuses the discussion during the simulation sessions. In the process description, the various activities are connected across the organizational boundaries into one whole and rich picture. The systemic rich representation, the process description, connects the boundaries of the functions and organizations (horizontal), and boundaries of the organizational layers (vertical), and helps the participants to create a comprehensive picture of the whole[3]. According to the participants "the process simulations illustrated and visualized the whole process and especially its boundaries" (table 7, article 3: table 5). The visual representation also extends memory, and helps participants to recollect their thoughts in discussions about the activities of the actual process. Thus, the visual process map aids in creating new ideas for process innovations.

[3] The philosophy of system theory and creative holism is discussed in detail in section 5.1.3 "Creative holism over organizational boundaries".

Development issues in organizations typically concern interfaces (article 2, 115–121). Because of this, the used methods should describe and analyze the boundary transactions effectively, from the point of view of the whole and of common objectives of the process under development. To summarize, the learning taking place in an organization is affected depending on the perspective taken in the vision of what is being developed. If the aim is already set for each activity separately, a common orientation is not going to emerge, if the development is based on contradictory aims, the generation of novel solutions is not going to happen fast enough, if at all. The process descriptions are one method to describe boundary transactions in a visually diverse way, from the point of view of the whole and of the common objectives. The process descriptions serve as a collective distributed memory of an organization (see also Hutchins 1990, 191–220; 1991, 283–286; 1995, 287–316, Weick and Roberts 1993, 357–360).

Proposition 1a:

In achieving process innovations, the development arena, the participants themselves, and the process descriptions, which constitute the process visualization, is an essential learning enabler, which enhances conceptual understanding and knowledge building during development sessions.

5.1.2 Empowerment through interaction and participation

Articles 1–5 showed that a process simulation session enhances empowerment through interaction and participation. In this process, the roles of active participants, facilitation and continuous reflection between organizational boundaries are central, which the following sections discuss.

The members of a network as active actors

In order to achieve effective and innovative results in business process development, a diversity of actors from the processes under development should be represented (article 1, 54). According to Dunbar's research (1995, 384–388), groups that have diverse but complementary knowledge are more effective and innovative than groups that have homogenous knowledge. The results of diverse groups are more unpredictable and more innovative. In process simulations this kind of cognitive diversity is facilitated by constructing cross-functional

simulation teams (article 1, 54, Smeds 1994, 1996a). It is essential that the process owner and the facilitator of the process development sessions are aware of the experience, expertise, and the strengths of the actors, which are distributed within the whole process and its interfaces. It is the process owner and facilitator's task to assure cognitive diversity in development groups to enhance innovativeness.

In well-prepared process simulations, the actors of the different phases of the process, the actors of the other processes related to the process under development and the representatives of the other stakeholder groups bring their own experience, knowledge and expertise to the development sessions (articles 1 and 3). Additionally, the communication is multi-directional between participants and a facilitator, and both explicit and tacit knowledge emerges and spreads among the participants.

Between the actors of the process simulations there are both strong and weak ties; and in some cases there are no ties at all before the process simulation session (see also Granovetter 1973, 1361, Hakkarainen et al. 2004b, 75–78). During the process simulation the participants of the development session are in such a situation often for the first time; some meet each other daily, some seldom or not at all, even if they belong to the same value adding process. The process simulation is a dynamic process itself, in which the existing or emerging weak ties between participants are transformed into strong ones through intensive multi-directional communication, in order to expand the participants' epistemic and socio-emotional knowledge. The participants' relation to a knowledge environment is profoundly context-bound; the discussion of the process with related case examples bring to light tacit non-codified knowledge, whereas the visual process maps show the knowledge in codified form.

Multi-directional communication produces a great deal of novel, unexpected ideas for process innovations (article 3, 246–249). The non-redundant and often asymmetric organizational boundary crossings in process simulations support the emergence of new innovations by engaging the simulation team in both horizontal and vertical learning. Knowledge in process simulations emerges through the co-evolution of individual and distributed cognition(s) (see also Hakkarainen et al. 2004b, 80).

The role of the facilitator

In process simulations, the facilitator's task is to act as a leader, provider, broker, mediator, interpreter and instructor of discussion during development sessions (article 1, see also Nevgi and Lindblom-Ylänne 2003, 113: learning view of humanism, constructivism and socio-constructivism and the teacher's/developer's/consultant's role in a learning process). The facilitator leads the discussion according to the process description, so that the explicit knowledge in the process description and the tacit knowledge represented by the actors interact during the discussions (articles 3 and 4) and the objectives of the development sessions are attained (article 1). Thus, the facilitator can influence how the participants' opinions are heard, and how the strong and weak ties between the participants and different groups are put to use during the discussions. It is the facilitator's tasks to build a simulation team with the awareness of that the weak and strong ties support organizational learning and the emergence of process innovations. The facilitator leads the discussion so that the visual process description benefits the discussion, and advances the participants' knowledge creation and the emergence of new ideas.

The facilitator has many weak ties, i.e. random, asymmetric, and diverse connections to various parts of the organizational network (see also Hakkarainen 2004b, 93, 75–78: information gatekeepers, brokers), and she mediates the discussion, and has thus a central brokering position in a process simulation. Persons in brokering positions typically have relational skills: seeing things from multiple perspectives, understanding multi-professional language, and moving across different situations and contexts of activity (see also Boland and Tenkasi 1995, 350, Hakkarainen et al. 2004b, 93). A facilitator is an expert of her own area and her knowledge is structured as a large, multi-level interlaced data structure, and her task is to aid the participants to reconstruct their own data structures with the process description and discussions during the simulation (see also Rauste-von Wright et al. 2003, 80–120). Hakkarainen et al. (2004b, 93) emphasize that such a comprehensive personal understanding is associated with the formation of shared meta-knowledge and transactive memory. In process simulations the facilitator learns the actors' competences and attains diversified visual angles into the development. Therefore it is natural for her to encourage the skills of deutero-learning and the formation of meta-knowledge in the organization, because she is familiar with the knowledge needs of compared to

the existing knowledge level and she has tools and methods to encourage the learning.

Participation and continuous interaction between organizational boundaries

Based on the data in articles 2 (article 2, pp. 117), 3 (table 7, article 3: table 5) and 5 (table 12, article 5: table 2), the interaction between organizational boundaries, i.e. processes, functions, people, operations, and strategy increased during the participative and empowering process simulations.

Interaction and participation are preconditions for empowerment and learning (articles 3 and 5). In a community, it is important to be heard, not only on the cognitive level, but also on the socio-emotional level. Understanding the facts affecting decision-making on all these levels is crucial. In process simulations, the visual process descriptions assist the participants in piecing together and understanding the process under development, e.g. roles and structures, and thus in becoming aware of the change needed, its direction, and the needed actions. Thus, the visual process map and the participating in the process simulation reinforce each other; they act as common and shared cognitive resources on all learning levels, epistemic and socio-emotional, for the actors of the process under development. Arguments and actions resulting from the organizational changes and process innovations are associated with all these learning levels. Especially trust emerging in a community is based on socio-emotional matters.

Proposition 1b:

> Interaction, participation and empowerment do not emerge by themselves in an organization – managerial and leadership skills and methods have fundamental positive or negative impacts on the organization and its development culture. Managerial and leadership skills and methods influence not only the organization and the atmosphere, but also how the process innovations are developed and carried out. From the point of view of the emergence of novel ideas the following factors are essential: cognitive diversity including weak and strong ties within the organization, reflective multiform discussions across the boundaries of the organization and its processes, and the use of various shared cognitive resources.

5.1.3 Creative holism over organizational boundaries

In process simulations both the process description and the case examples (article 1) evolve as a rich picture or story described by Jackson (2006, 2008, see also Boland and Tenkasi 1995, 362–365), which helps to construct a holistic view and to encourage creativity in knowledge building (see also Senge 1990a, b). The process description and the case examples mediated through discussion act as an extended and distributed visual memory aid (section 5.1.1 "Visualization for common concepts and understanding").

Process simulation is a flexible development method. It can have functionalist, interpretive, emancipatory and postmodern elements depending on what kind of viewpoint the facilitator and the process owner want to take (Jackson 2006, 653–654, section 5.1.2 "Empowerment through interaction and participation"). When the process under development is examined without restricting the participants' world view, the overall knowledge of individuals and of the organization increases and novel innovations can be created.

Process simulation can be used independently or as a part of a portfolio of development methods. It can be used as an inspirational and creative element, choices can be made by means of it, it can be used as an aid in implementations, or it can encourage reflection (article 1, article 3: figure 3). Jackson (2006, 648) emphasizes that reflection is an important and distinct phase in an innovation process, but in contrast with his ideas, in process simulations the continuous nature of the collective reflections during the interventions, i.e. process simulations, and between them is stressed (section 5.3.3 "Continuity and collective reflection in process development").

The participants of process simulations reported that the holistic view and common understanding of the business operations and their processes was the most important benefit of the process simulations (table 7, article 3: table 5, Haho 2002, 87). This holistic view, which advances creativity, can be used in many operative and strategic development issues in an organization after the simulation. The holistic view enhances thinking and seeds wisdom; thus it also assists in directing everyone's own work and objectives based on the processes of the organization.

Dialogue between praxis and theory enhances learning, and thus helps in gaining a view of the whole (see also article 2, 114–117, table 7, article 3: table 5, Jackson 2006, 647). Nonaka et al. (2001) noted that integration between contextualization and abstraction is an important part of the innovation process.

Thus, I can hypothesize that a holistic view with theoretical and practical viewpoints is a prerequisite for effective and pioneering process innovations – a prerequisite of both idea generation and implementation.

Continuous reflection between organizational, functional and process boundaries

Article 2 presents the essential principles of process and organization development in strategy and operations through the results of two case studies. In the first case study, the spiral of the strategy and operations, concepts and practice was a learning pattern for realizing the best practices for customer service and for the company's future strategies. Extensive interaction between strategic and operative boundaries during the two-year project led to an organizational learning leap, which provided a durable base for more advanced service, technology and productivity developments. If learning barriers existed in and between interfaces, as in the second case of article 2, they were caused by a lack of holistic knowledge and by weak communication over organizational, functional and process boundaries, especially at the beginning of the development assignments. The results of these case analyses indicate that development in organizations should focus on strategy and process interfaces in operations. Striking results can be achieved by solving the problems in and between interfaces.

Article 3 (table 5) contributes that the second most important benefit of process simulations, as evaluated by the participants, was that the process simulation gave them insights to subprocesses, and subprocesses activities and boundaries. The process simulations effectively facilitated interaction and learning. During the process simulations the abundant interaction between participants reduced ambiguity and resolved multiple open questions for each individual. The participants reported that the open interaction and informal discussions were also among the ten most important benefits of process simulations (table 7, article 3: table 5).

After the second process simulations only 1 % (after the first process simulations 7 %) of the participants perceived that organizational, functional and process boundaries were still an important development subject. Understanding the function of the subprocesses and boundaries was not any more as important a benefit of process simulations after the second simulation as it was after the first simulation (table 8, article 3: table 8). Thanks to process simulation, the interaction over organizational boundaries increased.

Based on the data in article 3, it is clear that the development of process boundaries requires abundant and extensive interaction between individuals. Boundary crossing is a process of breaking the boundaries of one's knowledge and competences by deliberately searching for contacts with another culture or community (Hakkarainen et al. 2004b, 241). It is around boundary objects that communities of practice often gather through organizational boundary crossing (Boland and Tenkasi 1995, 362–365).

In a process simulation the process description acts as a significant conceptual boundary object and the process simulation itself enhances boundary crossing on various levels: between organizations and their functions, between various processes, and between operative and strategic actions as reported in articles 2 and 4 (article 2, 117, article 4, 900). In process simulations, actors, process descriptions, discussions, rules created, and plans presented evolve as boundary objects. Smeds et al. (2006) used the concept of boundary object in their article on the process simulation method, and they have analyzed the process simulation method based on syntactic, semantic and pragmatic boundaries and related boundary objects. They argue that a process simulation applies boundary objects in a systematic way to cross the different boundaries and to facilitate knowledge construction.

Proposition 1c:

> Visualization of the, and empowerment of the organization strengthen the interaction between explicit and tacit knowledge over organizational boundaries and thus, helps the personnel of an organization to gain holistic knowledge and form a common holistic view of the process under development.

5.1.4 Common understanding

Based on the data of this thesis, organizational learning begins with the emergence of common understanding, and in organizational learning the significance of the systemic and holistic view is emphasized as a generator of common understanding in the organization (article 3, 245, article 5, 245, 250). In the organization a common holistic view and thus a common understanding is formulated through 1) common goals and objectives, 2) knowledge sharing and interdependence, 3) shared meaning, 4) common experiences and modes of operation, and 5) trust (Mäkelä 2002). Based on this thesis (article 3, 245, article

5, 245, 250), participation in operations and discussions, as well as visualizing the matters enhance conceptualization and the formation of a holistic view among the organization members. Hakkarainen et al. (2004b, 63) argue that explicating conceptions by writing and visualization helps to overcome the compartmentalization of knowledge (Cherniak 1986, 65–71) and to activate related knowledge.

Even while knowing the hard business objectives and while focusing on the content of the business processes in the simulations, the participants reported that the most important issues that the simulation addressed was the holistic view of the process as well as new ways of thinking, experiencing and learning to understand (table 7, article 3: table 5). These issues indicate how important knowledge sharing and the shared knowledge creation are as a mental pattern and a base for learning.

In the following, it is explained how common understanding in the above five topics is formed (i.e. common goals and objectives, knowledge sharing and interdependence, shared meaning, common experiences and modes of operation, and trust) based on the results of the articles, especially articles 3 and 5.

Common goals and objectives

In the development projects that were studied for this thesis, both hard objectives, related to business development, and softer objectives, related to organizational learning, were set. Typical objectives related to organizational learning were: to gain an overall picture of the process to be developed, to support the design of and experimentation with the new process, to increase the flexibility of the process and its ability to learn and change, and to ensure the implementation of change through empowerment. Objectives related to business development were: to increase profitability, to improve the efficiency of the present process through improvements in lead time, delivery accuracy, quality of operations, and turnover of capital, to minimize work that does not provide added value, to reduce the number of activities in the process, and to create new process rules.

In the case studies it was significant from the point of view of organizational learning that the objectives were set from both business and learning points of view. The organizational learning objectives highlighted for all participants that organizational learning was a goal during the development process. The business objectives were shared by all participants in the development sessions in order to gain common understanding.

Knowledge sharing and interdependence

During the process simulations potential information and knowledge, explicit as well as tacit, was utilized (see also sections 5.1.2 "Empowerment through interaction and participation" and 5.3 "The role of learning paths, collective reflection and continuity in organizational learning"). The process description (article 1, 55) acted as the foundation for explicit knowledge, whereas the case examples and the related discussion represented tacit knowledge. Tacit knowledge as defined by Nonaka and Takeuchi (1995) has a major role in process development. In process simulations externalization is essential, because through it tacit knowledge is formed into a part of the consciousness of the whole organization. Thus externalized tacit knowledge is mediated orally, occasionally also in written form. The development of the organization as a whole and the emergence of process innovations depend on the organization's members' possibilities to gain diversified knowledge (see also Lave and Wenger 1991).

During the process simulations both intangible and tangible learning outcomes emerged, and they led to new learning impacts during the following development rounds (see also section 5.3 "The role of learning paths, collective reflection and continuity in organizational learning"). The achieved intangible outcomes (communication, understanding and new knowledge) accelerated the achievement of tangible business results and created an enduring base and continuous inspiration for the development of processes in the organizations (table 12, article 5: table 2, learning paths I, II and IV, see also Haho 2002, Forssén and Haho 2001). The intangible learning outcomes are crucial for process innovations, especially at the early stages of a process development project.

Shared meaning

In the process simulations, it became apparent that the more people internalize the process and its concepts and rules, the higher the level of knowledge creation they can achieve (e.g. from identifying the process to forming the process rules, from communication to co-operation, from understanding the process to understanding others' priorities) (article 3, 251–259, article 5, 246–247, Haho 2002, 89–90). The significance of matters was shared on an increasingly deeper level when the development projects proceeded. Hakkarainen et al. (2004b, 29) also emphasize that engagement in knowledge work presupposes higher levels of conceptual understanding and a deepening knowledge. In business process development

especially the clarification of the roles was significant. The organizational boundary crossings during the process simulations assist the clarification of roles (see also Hakkarainen, 2004b, 69).

Article 3 also highlighted the concept: *tacit change* (article 3, 245, 254, 258). Tacit change can be characterized as change without conscious effort, and it can appear in any subarea of a development project. In process simulations, the shared tacit knowledge and explicit process descriptions with boundary descriptions of the subprocesses clarify the personnel's ideas of the business operations, processes and objectives (table 7, article 3: table 5). The common experience of the present state and objectives encourages the members of the organization to independent change, as described below.

The common view of the business, its problems and emerging novel potential for development actions serve as a base on which the individuals have the courage to build future development efforts without extra support. They reported: "I believe that no one is making the same mistakes anymore, we have learned a lot.", and "I saw what other people expect from me and others." Also in the case reported in article 5, people changed their work habits to newly learned ones, e.g. one project manager began to plan her next project with the new just learned ideas right after the process simulation session.

The process simulation experiences reinforced and encouraged the personnel for independent development efforts (article 3, 253–254), even long after the simulations were carried out. This is the way how tacit change emerged in organizations during and after the simulations. Tacit change is possible through commonly shared goals and meanings. The shared experience is enough to trigger the change on individual level: people feel encouraged to development actions and decisions after the shared experience. This thesis emphasizes that through learning experiences also tacit changes emerge in operations. Issues dealt with in process simulation sessions were perceived by participants as schemes (Rauste-von Wright 2003, 90–95), which also helped structuring them in the mind. It is easier to make decisions and act when issues are structured as larger subjects.

Common experiences and mode of operations

To gain common experience is only possible through participating in common action. Only through participation in development, understanding the whole and participating in decision making is the commitment to a new approach created. The personnel should be given possibility to plan their own operations, which are

based on commonly accepted strategies and objectives. The factors affected by change must all be included in the development project (see also Porras 1987, 52). During the process simulation, commonly shared experiences create a common view for all participants (articles 1–5). Hence, common objectives are easier to achieve. This result confirms the earlier Finnish results about process simulations (e.g. Haho 1992, Smeds 1994, 1996a, b, 1997b, Ruohomäki 1994, 99–107; 1995a, 2002, Smeds and Haho 1995a, b, Haho and Smeds 1996a, b, Forssén and Hakamäki 1998, Forssén-Nyberg and Kutilainen 1998, Forssén 2002, Mäkelä 2002): process simulation is an effective participative method, which enhances a holistic view, common understanding, learning, and knowledge creation in an organization. Common shared experience also encourages individuals to change their modes of operation independently (see also earlier parts of this chapter).

Trust

The process simulations supported an open atmosphere, where multi-faceted comments from people in different phases of the process under development were revealed (article 3: table 5, 245). Trust is essential in gaining a common understanding of the process under development (see also Siitonen 1999, Mäkelä 2002). Indeed, many factors can affect towards the openness and transparency of the session, e.g. the personality of the facilitator, the general situation of the organization, and the relationships of the actors.

Proposition 1d:

In organizations, a holistic knowledge, and the systemic and holistic view is a generator of common understanding, which enhances organizational learning.

5.1.5 A temporary knowledge creation community for knowledge building

In the following, it is analyzed what kind of knowledge community the process simulation session is and what its role is in individual and organizational learning processes, with its visualizing and participative effect.

Based on the definition of an innovative knowledge community introduced by Hakkarainen et al. (2004b, 109–121), the process simulation can be considered an innovative knowledge community, but temporary. Persons called to a process

simulation have often gathered together in this group combination for the first time, perhaps also for the only time (article 1). Process simulation is a formal community, and its members represent expertise of the process under development and its boundaries. The mission of the process simulation community is to enhance knowledge creation for novel process innovations and promote possible changes in the organization and in its network. Thus, the process simulation session is a temporary knowledge creation community. Smeds and Alvesalo (2003a, 182–192) described the simulation session as a virtual community of practice, when they described the role of a process simulation session between distributed knowledge communities, in cross-site telepresence business process simulations.

When investigating communities of practice, Lave and Wenger (1991, 110–112, 49–52, Wenger 1998, 72–85) emphasized the significance of socialization through a community for learning practical skills. The novices adopt their tacit knowledge and skills from experts by participating in operations as members of communities of practice. The cognitive processes and the common practices of the communities of practice are especially in the novices' learning focus. In the development of the organization and its processes very few members of the organization are experts of (process) development, but all are experts of their own work. In the development of the organization and its processes, the organization and members of the stakeholder groups socialize at least to some extend during the development project and acquaint themselves with the job descriptions and tasks of other members of the process, and thus improve their own expertise of the whole process.

The development and innovation work done during the process simulation becomes identified to certain times and a place, and therefore the arena used is important for the development. The significance of the arena is physical, mental and social.

Even if the process simulation arena is temporary, it is highly influential for knowledge acquisition, participation in knowledge creation processes, and the creation of new knowledge.

The arena of the process simulation is significant for the participants in simulations: it assists in creating connections between the different persons and issues, and it helps in gaining an overall picture and common understanding of an issue by visualizing the process under development through the participants themselves and through the process description. Also the simulation arena as such

acts as an essential visual artifact, which enhances conceptual understanding and knowledge building during the development sessions.

According to article 5, the learning effects created through facilitated lively dialogues in knowledge sharing arenas reinforce single-loop and double-loop learning. Thus the successive development efforts, such as process simulations, become an interactive method for the conscious management of organizational single-loop and double-loop learning (Argyris and Schön 1978) in business process interfaces: they help boundary crossings and they support the changes from team learning to higher level learning in the organization through the dialogue between strategy and operation.

Proposition 1e:

In creating process innovations a temporary knowledge creation community is needed for knowledge building.

5.1.6 The relationships between the learning enablers

Article 2 shows that there are links between diverse learning enablers, i.e. between participation, a holistic view, common understanding, and learning outcomes, but it does not analyze these relationships in more detail. Article 1 adds that the process simulation method enhances common understanding, i.e. the process simulation method is composed of such aspects, which increase common understanding. Yet, article 1 does not analyze this relationship further. Article 3 reports that after increased discussions in the next process simulation rounds, a holistic view among the participants was achieved. This connects the concept of a holistic view with process simulation and its' features: participative and visual. This leads to reflective cycles of negotiation of existing knowledge. Article 3 also recognizes that there is a need for advanced level knowledge creation after the internalization of easier issues. This, in turn, leads to a second reflective cycle, knowledge creation. In this cycle, refined and novel knowledge is built on top of the achieved holistic view.

Thus far, it can be concluded of the relationships between learning enablers that participation and visualization enhance the holistic view. This forms the first reflective cycle called *knowledge negotiation*. An achieved holistic view acts as a source for common understanding and knowledge creation. This forms the second reflective cycle called *knowledge creation*.

Figure 4 describes the relationships between learning enablers and reflective cycles in individual and organizational learning.

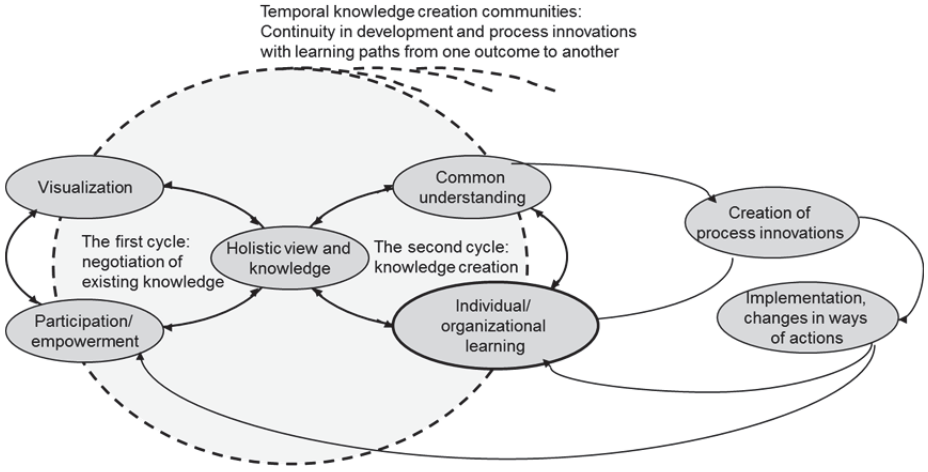

Fig. 5. Learning enablers and reflective cycles in individual and organizational learning.

Proposition 1f:

Learning enablers are related. In organizational learning two reflective cycles are needed. The first cycle, the negotiation of existing knowledge, is composed of interaction between visualization, participation, and the outlining of the holistic view. The second cycle, knowledge creation, interacts between the holistic view, common understanding, and individual and organizational learning.

5.2 Intangible and tangible learning outcomes

In this section, the roles of tacit and explicit knowledge and intangible and tangible learning outcomes are addressed to show the interrelations of the intangible and tangible outcomes in individual and organizational learning in process innovations. The section answers this research question:

- Q2: What kinds of learning outcomes emerge and what are their relationships to learning paths?

5.2.1 Intangible and tangible learning outcomes on the individual and organizational level

Based on the data of this thesis, in process simulations both intangible learning outcomes (soft results) and tangible learning outcomes (hard results) emerged (table 9, article 3: table 9, table 12, article 5: table 2). First, intangible outcomes, i.e. discussions about the general themes began to emerge about the processes and the organization and its strategy. Then people's understanding of the concepts deepened, the overall view clarified, better management routines were suggested, and large amounts of new knowledge emerged. These outcomes also include new ideas about the strategy and operations of the process under development, better ways to manage projects, to utilize human resources, and to solve problems. After this also the tangible outcomes, i.e. defined processes, changed practices, and better business results materialized.

"Shared holistic understanding of the actual process" and "that the innovative atmosphere spilled over into the organization at large" (table 9, article 3: table 9) are examples of intangible outcomes on the organizational level, and similar developments also happened on the individual level. One example of a tangible outcome on the individual level is that one participant began to plan her next project with the help of the tools she had experimented with in the simulation (article 5, 247), after which new management tools and principles became standard on the organizational level (tangible outcome) (article 5, 247).

The importance of the intangible learning outcomes became very apparent in the results. Based on the data the intangible outcomes formed the foundation for the achievement of the tangible business results and for upcoming wider understanding of the business, i.e. for future intangible and tangible outcomes (article 3, 254)

5.2.2 Knowledge creation through and outcomes of interaction

Article 3 (figure 6, 258) shows how tacit and explicit knowledge interact in the process simulations and create intangible and tangible learning outcomes and generate both tacit and explicit change. In article 1, where the process development method is defined, it is explained how the method uses process descriptions and case examples as interactive tools for the personnel's participative analysis of the 'as-is' situation and for envisioning the 'to-be' situation of the process under development. Both the process description and

discussions of the case examples serve as knowledge tools for the creation of new and better processes. Article 1 applies the theory of Nonaka and Takeuchi (1995, 237–238, see also Smeds 1996a, Smeds and Alvesalo 2003a, b) of the knowledge creating company and explains how the different phases of the process simulation method create knowledge through socialization, externalization, internalization and combination. The preparation and realization of the process simulation contains the socialization (sharing of individual tacit knowledge (as defined by Nonaka and Takeuchi 1995) in face-to-face dialogues facilitated in the process simulations) and externalization (creating the present process model) of knowledge. Combination, where explicit knowledge is combined, systemized and refined, is done in the phase of new process design, with change objectives, preconditions, benchmarked practices, as well as other internal and external knowledge. By prototyping the new process design in process simulations, the new knowledge is internalized through experimentation: the new process model is explicated with visual process descriptions and with facilitated discussion of the preconditions and phases of the process. Internalization of the new process design then proceeds through the piloting phase into full-scale enterprise transformation.

Figure 5 explains the interrelations between tacit and explicit knowledge, and intangible and tangible learning outcomes in process simulations. Needed changes in the process and better results in business are achieved through a learning process.

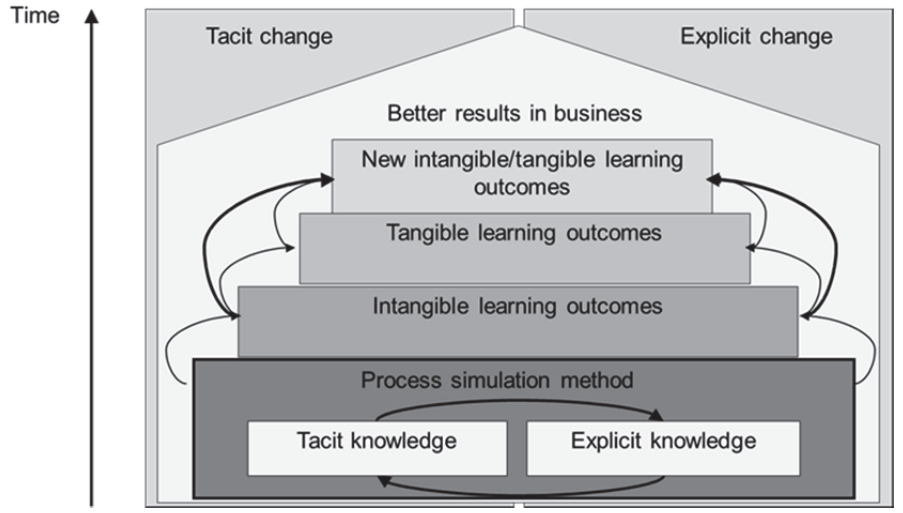

Fig. 6. Interrelation of tacit and explicit knowledge, and intangible and tangible learning outcomes (modified from article 3).

The knowledge needed for the development of the organization is often spread out in different forms, in different places, and with different actors in the organization. The knowledge can be, for example, in the form of experiences, know-how, stories, anecdotes, metaphors, descriptions, diagrams, pictures, patterns or process descriptions (see also Nonaka and Takeuchi 1995, 11–13). According to Lave and Wenger (1991, 110–112, 49–52), the development of the person as a member of the community depends on the person's possibilities to attain relevant knowledge through participating in activities of the community. The same is true for the whole organization: also the development of the organization as a whole – as a sum of its parts – depends on the possibilities of all the members of the organization to attain diversified knowledge, either tacit or explicit.

In process simulations, the process description (article 1, 55) represents explicit knowledge and it serves as a conceptual and visual boundary object (see also sections 5.1.1 "Visualization for common concepts and understanding" and 5.1.3 "Creative holism over organizational boundaries") in the knowledge acquisition, dissemination and creation processes of the individual and the organization. The process has goals, and in the process description there are activities, their interdependences, inputs and outputs and the responsible persons for the activities. The process proceeds by milestones, and it has defined decision

points. The development of the process has its objectives, and the development is goal-oriented. The process description is a necessary element in the process simulation: it outlines effectively the simulated topic and its aspects. The process description shares the meanings and increases the conceptual understanding of the process under development among all participants.

In the process simulations, the discussions related to the case examples (article 1, 56), with the comments of the participants concerning the process description and its activities, represents tacit knowledge. In the process simulation the participants reveal their work through the case examples: what kind of work there is, what kind of tasks belong to it, what is relevant in their work from the point of view of the objectives of the process, how the other actors relate to the tasks, what kind of results emerge from the activity, and what kind of ideas do they have and develop themselves of their activities and of the development of the whole process. (Article 1, 54–57)

In process simulations, the knowledge within process descriptions and the case examples interacts with the related discussions. When the facilitator directs the discussion step by step through the visual process map, the participants' tacit knowledge and the explicit modeled knowledge of the process descriptions meet. The explicit, visually modeled knowledge helps the participants' to illuminate their experience of the tasks and their role in the organization. This is how the participants' socialized tacit knowledge enriches processes, and how this knowledge is externalized for intangible and tangible learning outcomes, i.e. new knowledge about and valuable solutions for the actual processes, or new process designs. Eventually, the process innovations emerge, either tacit or explicit. The cultural and attitudinal changes are many times imperceptible, tacit changes, whereas the process changes are observable, explicit changes.

Tacit knowledge has a significant role in creating process innovations. According to Hakkarainen et al. (2004b, 61), tacit knowledge consists of the cognitive achievements of the individual, social skills and skills to use methods and tools. In process simulations the externalization by which much tacit knowledge is transformed into the awareness of the process development community is fundamental. In process simulations, tacit knowledge is specifically used to find new solutions (article 1, table 9, article 3: table 9, table 12, article 5: table 2, see also Nonaka and Takeuchi 1995, 78–80). The participants adopt the information and knowledge that they learn and develop the process further based on them (article 1, table 9, article 3: table 9, table 12, article 5: table 2). In article 5 (246–247) the examples of the learning paths show how the knowledge became

refined in simulation after simulation into intangible and thereafter tangible outcomes.

According to Lave and Wenger (1991, 90–117), it is impossible to teach tacit knowledge, instead tacit knowledge is adopted by participating (in activities) of the community of practice. The novices adopt and internalize the experts' tacit knowledge and practical experience and at same time they expand their professional identity (Lave and Wenger 1991, 111–112, 52–54). The same happens in process simulations – by participating in development sessions tacit knowledge is adopted and further elaborated on. The participants join into discussions about the tasks, not in the activities themselves. In simulations, the community of practice is not constant, instead it is temporary, and the subject of learning and development is more abstract and knowledge intensive than Lave and Wenger's research subject. Moreover, the participants are all in a way novices; all teach and all learn and all elaborate on new knowledge.

5.2.3 The relationship between intangible and tangible learning outcomes

The most interesting empirical finding (table 9, article 3: table 9, table 12, article 5: table 2) was that even if in the development projects the focus was on the advancements of tangible business goals, the process simulations reinforced the advancements of intangible outcomes. Communication was lively during the development sessions and afterwards about the processes, the organization and its strategy, understanding of the overall view, and achieving new knowledge, such as new ideas about/for the operations and strategy of the process under development and its interfaces. The intangible outcomes helped the personnel to understand and assess the business. This happened, for example, in the case studied in article 5. The intangible outcomes emerged in all five simulations in the case, especially in the first rounds (article 5: figure 2). After the second simulation round the tangible outcomes, i.e. the defined processes, the changed practices, and the business results began to increase gradually. Both the intangible and tangible outcomes led to new learning outcomes – new knowledge and novel process innovations for the business operations, strategy, and even for the culture of the company. Based on the results of article 5 (table 2, learning paths I, II and IV), the intangible outcomes (communication, understanding and new knowledge) accelerate the achievement of tangible business results and create an enduring and continuous base for the development of processes and organizations (see also

Haho 2002, Forssén and Haho 2001), even inspirations for new business areas. Thus, the intangible outcomes are crucial for the development of process innovations, especially at the early stages.

In summary, intangible learning outcomes are preconditions for tangible learning outcomes and they form a foundation for the advancements of future intangible and tangible outcomes in organizations. The intangible outcomes also form a base for the tacit and explicit change of the organization (figure 5). The common understanding of large business process aggregates and other achieved intangible outcomes reinforce the capabilities of the organizations to self-organize, to create novel process innovations, and to implement them. The objectives and strategies of the processes under development became clear for all participants in the simulations, and as a result, the process simulations aided the personnel to focus their own work towards the targets of the organization (table 9, article 3: table 9, table 12, article 5: table 2).

Proposition 2:

To create novel tangible learning outcomes and thereafter process innovations, intangible learning outcomes are needed. The intangible outcomes emerge through interaction between tacit and explicit knowledge, and for this knowledge encounter to occur a temporary knowledge creation community is needed. Additionally, the intangible outcomes form a base for the achievement of future intangible and tangible outcomes in organizations, and the intangible outcomes also form a base for tacit change in an organization.

5.3 The role of learning paths, collective reflection and continuity in organizational learning

This section shows how outcomes and individual and organizational learning processes interact over time and how empowered process development can create double-loop and deutero-learning in an organization. The section answers the question:

- Q3: How do the learning enablers and the learning outcomes mutually create the learning paths, and what are their relationships to each other?

5.3.1 Individual and organizational learning during process development

Article 5 analyzes in what way the individual participants learned, and how the organization learned. The analysis shows that there was a large amount of individual and organizational double-loop learning, i.e. changes in norms, as well as organizational deutero-learning, in addition to the individual and organizational single-loop learning during the project.

One person reported after the process simulation: "As a result of the simulation my contacts with new product development increased, I met various persons, fruitful cooperation developed and so project accounting became easier to approach. And I learned to understand the steps of the new product development process." This is single-loop learning. Process simulation speeded up the learning performance, but it did not change the organizational norms.

Especially the results in article 5 emphasize, how the process simulation gave energy to double-loop learning, i.e. changes in norms followed by changes in tangible strategic and operational outcomes (table 12, article 5: table 2, 246–247, 247–248). The learning of the following type would not have been possible without the systemic consideration of the organization's R&D processes: "Milestone thinking has been awakened only during the past two years. We did not understand the importance of dividing work, and that we should point out the milestones. It wasn't until the past two years that I understood this, either." This example illustrates how the norms changed in the organization. First the individuals begin to understand the importance of milestone thinking, and its positive effects on the throughput time of the R&D process and new product launching. Then in the next steps of the development, in the process simulations the skill of milestone thinking grew stronger among the members of the organization, and after that the organization was ready to implement it as a new norm for R&D work.

The example above shows how a simple intangible operative realization can lead to an important tangible strategic change through the process of double-loop learning, and thus how the change in a norm can lead to changes in the process structure. This is due to that the process simulations increase learning through cross-hierarchical and cross-functional communication by all employees. Intangible outcomes emerge during communication and cause changes in norms and rules. In this example, milestone thinking became a norm in the organization. Furthermore, process simulations increased business process understanding. This

resembles systemic thinking and systemic changes (see also Senge 1990a, b, Jackson 2006). Hence, based on the evidence of article 5, in empowered business process development, double-loop and deutero-learning are common.

Thus, the individuals learned, and all the participants of the process simulations gained common understanding of the topics considered. It can be said that the whole organization learned and that the learning was both single-loop and double-loop learning. The learning was of the double-loop type if the norms changed and single-loop otherwise.

Moreover, there were also changes in the problem solving culture in the reported case organization of article 5: an organization learned how to carry out single- and double-loop learning, and it invented and generalized new strategies for learning (article 5, 249). The case organization was using empowered process simulations systematically to develop its learning skills and making changes in its norms. The organization also changed the traditional customs of decision making to more communicative ones and thus created a more learning way to make decisions. The development culture of the organization transformed, and it learned how to learn (deutero-learning, meta-skills of learning).

Proposition 3a:

In an empowered business process development, double-loop and deutero-learning are common.

5.3.2 Learning paths in knowledge creation – how to learn?

The case study in article 5 demonstrated that communicative learning paths resulted in vast strategic, cultural and operational outcomes in organizations, and thus not only incremental but also radical process innovations. Even if communication is the basis for learning paths, it does not in itself change anything. It is not until there is a shared understanding of an issue that the process of forming learning paths occurs. That is when a fundamental change starts taking shape in an organization (article 5: learning paths I–IV, figure 4.2).

Through rich experiences (see also Kuwada 1998, 725, March et al. 1991: rich description, Jackson 2006, 2008: rich pictures, Leonard and Sensiper 1998, 115–116, Nonaka and Konno 1998, 42–45) of simulated cases, in deep interaction with people in various intra-organizational relationships, as reported in article 5, the company's employees begin to understand the need for formal structures, such as the need for project management in new product development. These

simulation sessions allowed a variety of ideas to be interpreted. Thus, such tacit knowledge (Polanyi 1983), which was hidden in the personal experiences of top management, middle management and other staff came up, and resulted in changes in new product development project execution, and even in basic assumptions (see also Schein 1992, Kuwada 1998, 725) about carrying out projects, business, and strategy. Through this knowledge conversion from tacit to explicit (Nonaka and Takeutchi 1995), the personnel learned from simulated cases and applied the learned experiences to the projects coming next to simulations or to task execution in real business life. For example, milestone thinking was developing simulation by simulation, and finally one milestone, which thus far was considered crucial became obsolete, due to a new approach and cooperation between marketing and new product development (article 5: learning path I)

Individual intangible outcomes and actions gave birth to new results and led to significant patterns of organizational learning, and subsequently successive process innovations (article 5: learning paths I, II and IV). Thus, the intangible outcomes in the early phases of the change project are important. As Mintzberg et al. (1998, 327–328) have expressed – the micro level changes might cause macro level consequences. In the case project, the understanding of the importance of milestone thinking (in the first and second simulations) led to the realization that the management must show interest in the project much earlier than what had been the practice thus far (reflections between the third and fourth simulation), and accordingly the decision-making point changed after the fifth simulation. This example (article 5: learning path I) shows how a simple intangible operative realization can lead to an important tangible strategic change through the process of double-loop learning, and how the change in a norm, i.e. in this example the milestone thinking among the whole organization, can lead to significant changes in the process structure.

Figure 6 explains the interrelations of the operational, strategic and cultural outcomes with intangible and tangible division, and the learning paths in time span from one insight to the next outcomes. The Y-axis shows the level of shared knowledge in the organization. BA1, BA2 and BA3 stand for process simulation sessions. IO means intangible operative outcome, IS intangible strategic outcome, IC intangible cultural outcome, TO tangible operative outcome, TS tangible strategic outcome and TC tangible cultural outcome. This figure has been developed from the empirical results described in figure 2 in article 5. Operational, strategic and cultural learning occurred synchronously with interactive discussions in the simulation sessions, and in the reflections between

the simulations. The strategic and operative outcomes often coincided with these discussions. For the strategic outcomes to emerge, organizational knowledge of operational processes is required. In these learning processes, also the basic assumptions of organizational culture might change as happened in the case reported in article 5. The decision making culture changed to more communicative and collective, which supported the learning processes of individuals and the whole organization.

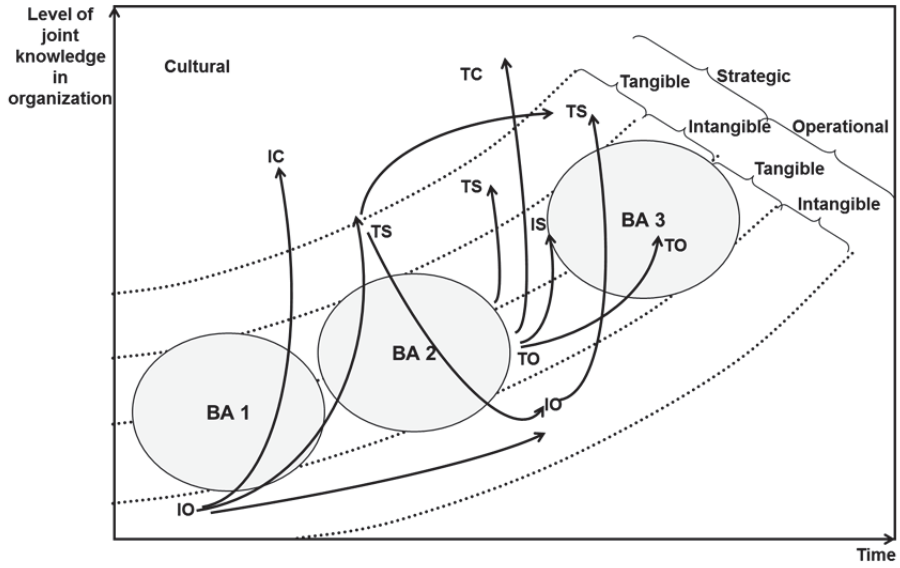

Fig. 7. Learning paths in knowledge creation: the acronyms are in the text above.

Proposition 3b:

To realize tangible business outcomes, the paths of intangible and/or tangible learning outcomes (and thus a large amount of double-loop and deutero-learning) are needed.

5.3.3 Continuity and collective reflection in process development

Article 1 introduces the process simulation method and how the personnel's ability to change is perceived in the method (article 1: figure 6.1, 50). Often in the beginning of the development projects the change capability of the personnel varies markedly – a common pace is missing. On the other hand, it is not

uncommon that the members of the organization internalize the targets of the organization and its strategy differently. The first simulation harmonizes the personnel's readiness for change, after which in the next phases of the process development project a much higher performance level can already be targeted. In general, the optimum performance level is reached in the consolidating phase of change through continuous improvement (figure 7).

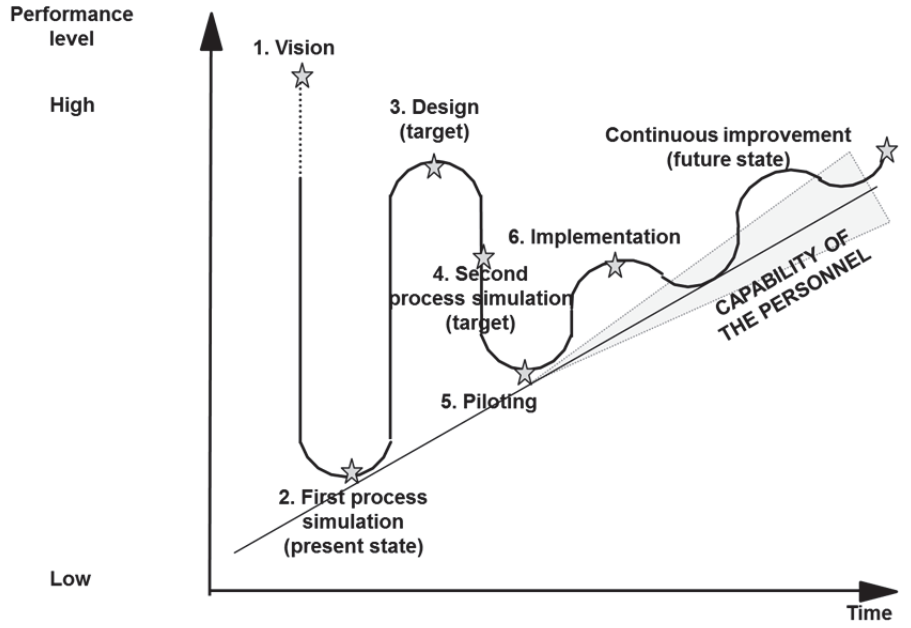

Fig. 8. The development method proceeds at the pace of the personnel's ability to change (Haho and Smeds 1997, 50).

Based on the data and results of article 3, the more people internalize the process where they work, the higher the level of knowledge creation that they achieve (e.g. from communication to co-operation, from understanding the process to understanding each other's priorities). For this higher level internalization they generally needed more than only one collective intervention (article 3, 250–251, 259) – in article 3 there were two process simulations in the reported cases.

In article 5, it has been described, how the intangible outcomes are transformed into tangible results in the progress of process simulations, through which the common understanding of the whole personnel is increasing (figure 8). The case examples of article 5 showed that complex business processes

necessitate views from various perspectives before the picture of the whole process and its significant development points is formed. Also other ongoing development projects – in this case project key performance indicators and team forming – received and sent both information and knowledge for the process simulations (article 5, 250). This and embedded knowledge in human knowing (see also Orlikowski 2002, 249) on how to reflect through informal or formal dialogues during, between and after the development sessions lead to new insights, knowledge, innovations and actions, and even new learning processes (i.e. deutero-leaning) for the company.

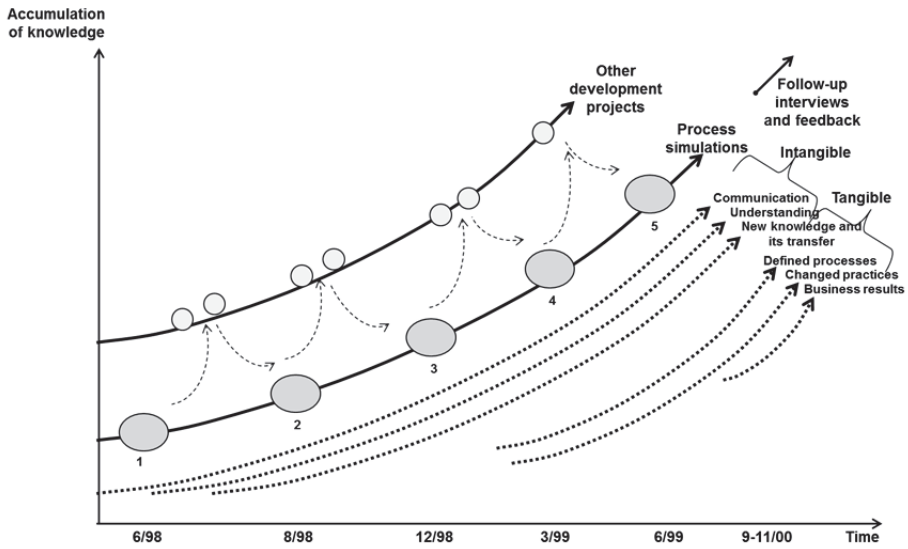

Fig. 9. The role of successive process simulations in organizational learning and development (Haho 2004, 246).

Based on the above presented results, we can firstly conclude that the emergence of an organization's common understanding requires joint meetings, joint interventions, continuity and continuous reflection, so that the knowledge of an organization can spread to all its members, and the objectives and meanings of the process can take shape in the whole organization.

Secondly, an individual's personal work ambitions and objectives affect their change capability and change. The individuals' passion and capability to change and learn set the pace for the change capability of the whole organization. The organization does not have intelligence and capability in the same meaning as the

individual has. Only through the learning of individuals can the organization change. The learning of the organization also offers over and over again new possibilities to debate the common objectives and to create common solutions. The continuum in development: meetings, discussions, and development sessions assure learning and change in the organization.

Reflection reinforces earlier subconscious learning. Through that process, people tend to forget from what context and whom the original idea emerged at an early stage of the development project. Finally, the new knowledge is accepted through a process of communication, understanding and learning. Kuwada (1998, 727) has pointed out that if the new knowledge and learning can get enough support from the organization's internal environment, they will be used frequently. Thus, collective reflections during the sessions are critical for securing good quality implementations of the actions (see also Rauste-von Wright 2003, 66–71, Kolb 1984, Mezirow 1981, 11–14; 1991, 99–117, Norman 1993, 17–28). This is likely to happen if the organization members who have shared the same experiences in simulations, but did not understand their meaning in the beginning, learn the meaning through reflective discussions after and between the sessions. Through such efforts, the new knowledge may become accepted, and can produce new tangible outcomes (learning paths I–IV). If simulations are used recurrently, the method itself serves as a reflection and follow-up tool.

This thesis emphasizes continuous and collective reflections (Rauste-von Wright 2003, 66–71, Levander 2003, 455–461) instead of stepwise reflections (Kolb 1984). The abundant interactions during process simulations, the problems voiced, the ideas presented and their cultivation during process simulations promote continuous and open reflection during each simulation and even in between the development interventions. Reflection during development requires an open, trusting and inspiring atmosphere. Continuous and shared reflection enhances knowledge and skills development, increases motivation, and commitment to the organization's goals and to their implementation. Motivation has both vigor and direction, and it is system oriented (Ruohotie 1998, 36–42). If the development is planned to facilitate continuity, the participants' idea generation, and feedback, the participants become committed.

Proposition 3c:

> The outcomes from the preceding process simulations have a significant role for the next steps in the process of creating process innovations. Thus, in creating process innovations we need a continuum of development and

collective reflection of the outcomes and of the next steps in the development and implementation attempts. (Especially, the intangible learning outcomes maintain the continuity of development.)

5.4 A model for individual and organizational learning in process innovations

This thesis offers a new understanding about the relationships of knowledge, learning enablers, learning outcomes and learning paths, and their roles in process innovations. To conclude, this thesis proposes that knowledge, learning enablers, learning outcomes, learning paths, collective reflection, and continuity in learning form a significant pattern, which enables individual and organizational learning as well as process innovations in organizations. The learning outcomes, either intangible or tangible, generate new outcomes through the next learning paths from one temporary knowledge creation community to another. The learning enablers, i.e. visualization, interaction, participation and empowerment, a holistic view and knowledge with boundary crossings, common understanding, and a temporary knowledge creation community help learning to take place, and continuous collective reflection reinforces the realization of learning results, i.e. outcomes. Figure 9 shows the learning enablers discovered in this thesis producing process innovations in organizations.

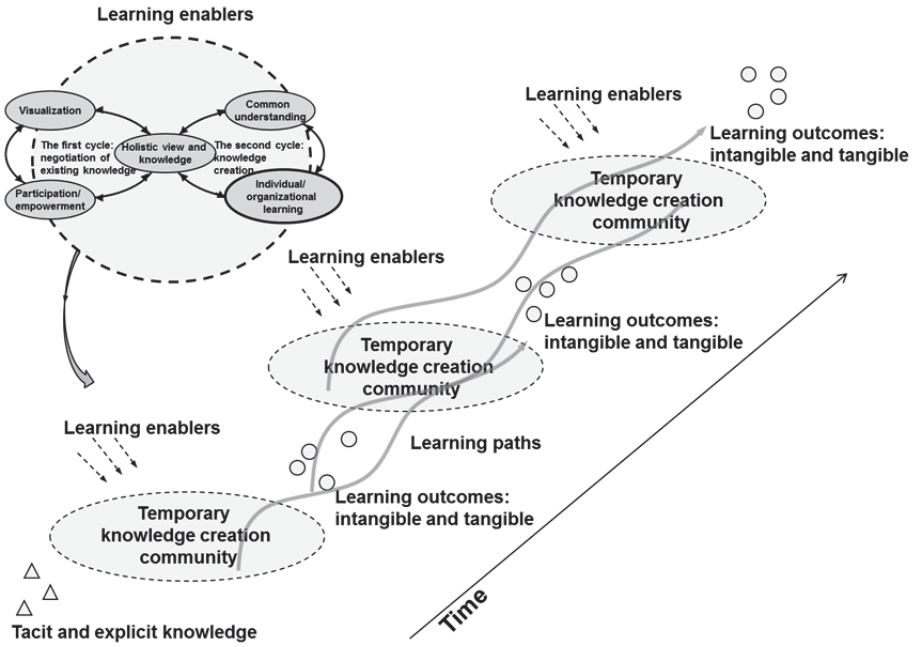

Fig. 10. The roles of knowledge, learning enablers, learning outcomes and learning paths in process innovations.

To achieve valuable process innovations, it is most significant to refine the explicit and tacit knowledge of the organization and individuals into outcomes, either intangible or tangible, and continue this learning path until a holistic view and common understanding of the changes in norms (double-loop learning) of the process under development are achieved, after which systemic process innovations are possible.

After each intervention, it is important to realize what kind of outcomes, i.e. new knowledge, artifacts or actions have been achieved, and build the next steps of interventions on this base. The emergence of changes in norms (double-loop learning) and learning how to learn in organizations (deutero-learning) require as outcomes, in addition to knowledge well-defined artifacts, such as process descriptions, and actions, such as process simulations.

6 Discussion

This thesis focuses on the role of organizational learning related to process innovations, specifically such process innovations that lead to genuine, constructive and lasting organizational change. The phenomena of learning enablers, learning outcomes and learning paths, and their relationships are studied. The data was collected in the context of mainly Finnish process innovations, in which process simulations were used as a method for change. The three main research questions are:

- Q1: What are the learning enablers and their relationships to learning paths? (articles 1, 2, 3, 4 and 5)
- Q2: What kinds of learning outcomes emerge and what are their relationships to learning paths? (articles 3 and 5)
- Q3: How do the learning enablers and the learning outcomes mutually create the learning paths, and what are their relationships to each other? (article 5)

Finally, this thesis seeks also such a model for learning that supports creating process innovations.

The following are proposed as conclusions about the role of learning and development methods in process innovations.

6.1 Theoretical contribution

The theoretical contribution of this thesis is fourfold. The findings give new understanding 1) about learning enablers, their relationships to each other and influence on learning and process innovations, 2) about the role of intangible and tangible learning outcomes in individual and organizational learning processes and 3) about learning paths in process innovations and related change processes. The thesis also defines 4) a model for effective learning processes in change projects concerning process innovations.

6.1.1 Learning enablers

This thesis shows the significance of learning enablers for enhancing process innovations and the interrelations of these enablers.

The findings give a new understanding about learning enablers (section 5.1) in terms of how to improve learning processes in the context of process innovations.

Earlier Finnish studies about process simulations are numerous (those summarized in section 2.5 and especially Piispanen and Pallas 1992, Smeds 1994, 1996a, b, 1997b, Ruohomäki 1994, 1995a, 1995b, 2002, Piispanen et al. 1996, Pankakoski 1998, Forssén-Nyberg and Kutilainen 1998, Forssén-Nyberg and Hakamäki 1998, Forssén 2002, and Smeds et al. 2006), likewise earlier studies of enablers of organizational learning (e.g. Locke and Schweiger 1979, Kanter 1983, Urabe 1988, Lave and Wenger 1991, Nonaka and Kenney 1991, Nonaka 1994, Smeds 1997b, Siitonen 1999, Senge 1990a, Jackson 2006, Klimecki et al. 1991, Hakkarainen et al. 2004a).

Based on the findings of these earlier studies and the findings of this thesis (sections 4.2–4.6 and 5.1), the learning enablers in process innovations are categorized as follows:

- visualization of the process under development
- interaction, participation and empowerment
- a holistic view with organizational boundary crossings, and holistic knowledge of the organization including all aspects (e.g. vision, strategy, goals, and guidelines for process innovations)
- a common understanding of the process under development
- an arena for cross-functional interaction and co-operation

Management and leadership skills are defined out of the scope of this thesis, since they are the necessary foundation of all enablers.

The main conclusions about the roles of these learning enablers in influencing and improving the organizational learning processes in process innovations (section 5.1) are:

1. In achieving process innovations, visualization (i.e. the process descriptions), the participants themselves, and the development arena are essential learning enablers, which enhance conceptual understanding and knowledge building during development sessions. The findings emphasize the importance of the visualization of processes for the formation of a holistic view in process innovations, in contrast to the individual activities or activity systems of Engeström's model (1999a, b). Yet, in his recent work Engeström seeks

dialogue between process enhancement, the radical expansion of object, and community building (Engeström et al. 2010, see also Engeström 2005, 20).

2. This thesis argues that active empowerment of the process actors beyond organizational boundary processes, through participation enhancement with facilitated discussions and case examples, is an important enabler of knowledge creation and learning. This is in agreement with how Argyris and Schön (1978, 17, 19) describe organizational learning as a process mediated by the collaborative inquiry of the individual members. Moreover, the findings emphasize the importance for accomplishing the objectives of practical methods and tools such as facilitated discussions, facilitation, case examples, rich stories, and boundary crossings in participation enhancement.
3. Based on the findings of this thesis, visualization (i.e. the distribution of cognitive processing load between people and artifacts, Hutchins 1990, 191–220, Norman 1993, 139–153, Perkins 1993, 89–90) and empowerment of the organization (analogous with Siitonen 1999: empowerment, and Sfard 1998: socialization to a development culture) clearly strengthen the interaction between explicit and tacit knowledge over organizational boundaries (see also Nonaka and Takeuchi 1995). Visualization also helps the personnel of an organization to gain holistic knowledge and form a common holistic view of the process under development, and to bring forth the goal-oriented changes themselves. The findings emphasize the importance of systemic knowledge creation across boundaries between processes for the formation of a holistic view. This confirms earlier results by others: for example, Senge (1990a, b) and Jackson (2006, 647) have emphasized systemic thinking and a holistic view as a basis for an organization to learn and change. Also Vicente (1999, 2000) argues that a holistic view and cognitive maps are important sources of information and that they direct the objectives of development.
4. This thesis emphasizes the significance of a common understanding for process innovations. In organizations, holistic knowledge and a systemic and holistic view are generators of common understanding, which enhance organizational learning and thus process innovations. The holistic view increases the common understanding of process activities among personnel, and also aids the autonomous planning of work activities. This supports the theory of Klimecki et al. (1991) that mutual understanding is one necessary step before the move from individual learning to organizational learning can be made.

5. This thesis also argues that in creating process innovations a temporary knowledge creation community is needed for knowledge building (section 5.1.5). Temporary knowledge creation communities, such as successive process simulations, are composed for short-term knowledge dissemination and creation. The temporary knowledge creation community allows strong and weak ties between actors (e.g. Granovetter 1973), and thus new ideas meet, which enhances individual and organizational learning and thus facilitates the creation of systemic and good-quality process innovations. The temporary knowledge creation community differs from a community of practice (Wenger 1998, 45–50), a ba (Nonaka and Konno 1998, Nonaka et al. 2000, 15), or an innovative knowledge community (Hakkarainen et al. 2004b, 109–121). The membership of a temporary knowledge creation community is not stable like that of a community of practice, and the participants do not relate to this community for a long time like the members in a ba.

This thesis outlines and draws together learning enablers and their relationships (figure 4, page 136, see also section 5.1). The first reflective learning cycle, negotiation of existing knowledge, which enhances the learning of the individuals participating in development, consists of visualization, participation, and outlining a holistic view. This first cycle of learning – visualization of the process under development, participation, and outlining of the holistic view – boosts the emergence of common understanding.

The second reflective learning cycle, knowledge creation, consists of the cyclic interaction of a holistic view, a common understanding, and individual and organizational learning. Once a common view is shared holistically, common understanding increases, and both the individual and organization learn. Ideally, the second reflective learning cycle should be repeated, in order to deepen the understanding.

The actual organizational learning begins from the formation of common understanding. Common understanding creates learning, ideas and innovations, as well as commitment to changes in operations until changes in the organization culture take place. Systematic reflection on the new ideas, process innovations, and already implemented change engage organizational learning. The replication of interventions reinforces learning how to learn in an organization.

Compared to individual learning, in organizational learning the importance of a holistic view is especially emphasized as it supports the emergence of a common understanding in the organization. Therefore, the visualization of the

process under development and the empowerment of the members of the organization are essential. Klimecki et al. (1991) stress that organizational learning cannot be spoken of until three factors are present: 1) communication and mutual understanding, 2) transparency: making the organizational processes and their activities visible, and 3) integration of group processes into the organizational system, i.e. individuals must be able to integrate their actions as parts of the whole. The results of this thesis (and especially of article 3, tables 4 and 9) show that process simulations as a method enhance the factors emphasized by Klimecki et al. This thesis confirms the theory of Klimecki et al., while it also underlines the impact of learning paths from one outcome to another and that of continuous collective reflection, which maintains organizational learning and learning how to learn.

To conclude, this thesis claims about the learning enablers and their relationships: In organizational learning two reflective cycles are needed. The first cycle, negotiation of existing knowledge, is composed of interaction between visualization, participation, and the outlining of the holistic view. The second cycle, knowledge creation, is composed of interaction between the holistic view, common understanding, and individual and organizational learning.

6.1.2 Intangible and tangible learning outcomes

The findings on this thesis give a new understanding of learning outcomes and their roles in process innovations (sections 4.4, 4.6 and 5.2). This thesis categorizes the outcomes of the learning processes into intangible and tangible outcomes and underlines the importance and the role of preceding intangible learning outcomes, i.e. double-loop and deutero-learning, for the learning processes, because only after double-loop and deutero learning do the norms and methods as well as actions change in the organization.

This thesis proposes that intangible outcomes are needed to create novel tangible outcomes such as a process definition, transformed practices, better business results, and thereafter process innovations. The intangible outcomes, such as communication, the understanding of concepts, and the holistic view emerge through interaction between tacit and explicit knowledge, and for this knowledge encounter a temporary knowledge creation community is needed. Additionally, intangible outcomes form a base for the achievement of future intangible and tangible outcomes and intangible outcomes also form a base for tacit change, such as self-governing development, in an organization.

This thesis emphasizes the role of intangible outcomes in emerging process innovations, and in implementing the intangible outcomes for new operations in the organization. In the beginning of an innovation process, intangible outcomes improve the most. Step by step, tangible outcomes emerge, since the conception of an overall view expands and common understanding about the targets of a process under development emerges. The tangible outcomes as intermediate results are also central, in that they assist in assembling the new intended targets, the process innovations.

Neither research of organizational learning (e.g. Argyris and Schön 1978, Duncan and Weiss 1979, Kolb 1984, Engeström 1987, 1990, 1999a, b, Nonaka and Kenney 1991, Nonaka 1994, Nonaka and Takeuchi 1995, Nonaka et al. 2000, 2006, Nonaka and von Krogh 2009, Scardamalia 2002, Scardamalia and Bereiter 2003, 2006, Hakkarainen et al. 2004a, b, Wang and Ahmed 2003, Bapuji and Crossan 2004), research of process innovations (e.g. Imai 1986, Davenport 1993, Hamel 2000, Tidd et al. 2005, Zwikael and Smyrk 2012) nor research of change and project management (e.g. Nogeste 2006, Nogeste and Walker 2005, 2008, Walker et al. 2008, Yeo and Ajam 2010) pay enough attention to the above mentioned dynamics, or analyze or classify the nature or the role of the outcomes that mediate individual and organizational learning and the emergence of process innovations. In the recent participatory action research (Zuber-Skerritt and Kearney, 2012), there is a study, which has identified the key characteristics of a sustainable learning community with a summary of the results of the learning outcomes. In that, the community learning outcomes are divided into intangible and tangible learning outcomes in common with my study. Indeed, the research of Schein (1996, 229) highlights that researchers have underestimated the importance of culture, shared norms, values and assumptions, i.e. intangible outcomes, in how organizations function and change.

6.1.3 Learning paths and processes

This thesis demonstrates how the outcomes evolve, transform and grow stronger through intervention after intervention, and form paths into individual and organizational learning (chapter 4). The learning paths start from increased mutual process understanding, after which tangible outcomes realize. This finding confirms that intangible outcomes are preconditions for achieving tangible business results.

This thesis shows how outcomes and learning paths interact over time and how empowered process development can create double-loop and deutero-learning in an organization (chapter 4).

Firstly, this thesis demonstrates that intangible outcomes emerge during communication, and that shared understanding and systemic process learning are prerequisites for the process of forming learning paths (continuity in individual or organizational learning from one set of learning outcomes to another). It is through learning paths that fundamental change in an organization occurs, and this results in changes concerning norms and rules (double-loop learning). The tangible outcomes follow changes in norms. Thus, intangible outcomes are crucial for a project, especially in its early stages.

Secondly, this thesis demonstrates how the organization learns to carry out single- and double-loop learning, and to invent and generalize new strategies for learning. Through these learning paths and the continuity of the development, the organization learns to use methods to change the organizational learning culture. Thus, deutero-learning is possible.

Even though the learning models of Scardamalia and Bereiter (2003, 2006), Engeström (1999a, b), Nonaka and Takeuchi (1995, Nonaka 1994) and Kolb (1984) emphasize the continuity of knowledge creation processes, they do not note the emerging outcomes and learning paths nor their effects on the next phases of learning processes and process innovations. However, Engeström (1999b) stresses that after historical and actual-empirical analysis of the subject under development, the focus should move to collectively constructing a vision of the organization's future, and implementing a series of practical changes. Furthermore, Scardamalia and Bereiter (2003, Bereiter and Scardamalia 2006) emphasize that knowledge building advances the understanding of conceptual tools and of a whole series of conceptual artifacts by collaboratively pursuing solutions to problems at more complex levels. This further advances understanding, and consequently there is dynamism in knowledge building, and that can be a powerful motivator for the personnel.

In their article, Nonaka, von Krogh and Voelpel (2006, see also Nonaka and von Krogh 2009, 648) call for an open research agenda and new development around organizational learning theory e.g. the factors that potentially impact the effectiveness of ba, the organization's state of becoming, and the processes of organizational knowledge creation. Therefore, they call for more empirical research, especially with longitudinal designs investigating such factors across organizations. Moreover, Wang and Ahmed (2003) propose larger-scale empirical

research to understand the linkage and relationships of a learning culture and organizational performance. Furthermore, after they reviewed the status of organizational learning in their recent article, Argote and Miron-Spektor (2011) propose further research on the organizational learning processes and their interrelationships.

This thesis applies the concepts of double-loop and deutero-learning by Argyris and Schön (1978), and practically demonstrates what kinds of concepts are needed to realize changes in the norms and learning culture of an organization. Thus, this study enlarges the theory of Argyris and Schön (1978) into the concepts of learning paths, and intangible and tangible learning outcomes. The continuity of learning paths forms double-loop and deutero-learning, which increases the organization's potential for process innovations.

6.1.4 A model for individual and organizational learning in process innovations

This thesis defines a model for effective learning processes in process innovations (section 5.4), and proposes that knowledge, learning enablers, learning outcomes, learning paths, collective reflection, and continuity in learning form a significant pattern, which enables individual and organizational learning as well as process innovations. Implementing this successive intervention model enhances learning.

The continuity of process development efforts, e.g. the successive process simulations first trigger and thereafter sustain individual and organizational single-loop, double-loop and deutero-learning (section 5.3). The successive interventions promote learning how to learn in organizations, i.e. organizations find the best practices for themselves for learning and maintaining systemic skills and a development culture (metalearning). Through deutero-learning, the operations, strategies and even the culture of the organization change. These results verify in practice the theory of Argyris and Schön (1978) of single-loop, double-loop and deutero-learning in the field of process innovations and enlarge their theory of deutero-learning to successive interventions (e.g. repeated process simulations).

6.2 Managerial implications

The contribution of this thesis in the practical and managerial context is concerned with the following issues. This thesis highlights individual and

organizational learning in process innovations, and it also defines the features of an effective method for the creation and implementation of process innovations. The results should be applicable in North and West European commercial organizations.

The findings on the interrelations of diverse learning enablers, learning outcomes and learning paths have significant implications for managers. Firstly, at the highest level, the findings suggest that managers, who are responsible for the development of process innovations, should be aware of that the development interventions need to form a learning path from one intervention to another, so that the whole personnel are able to learn. The continuous development of process innovations is not enough, but a project portfolio is needed to build results effectively.

Secondly, management should consider that intangible outcomes such as a shared understanding and systemic process learning are crucial for a development project, especially in its early stages. Intangible outcomes emerge during communication, and are prerequisites for the process of forming learning paths. It is through these learning paths that fundamental change in an organization occurs, resulting in changes concerning norms and rules (double-loop learning). The tangible outcomes, in turn, follow changes in the norms and rules.

Thirdly, learning enablers and their relationships form significant factors that promote process innovations. A holistic view of an organization and its processes is built through visualization and interaction. This enables common understanding of the development of an organization. Common understanding leads to individual as well as organizational learning, which in turn produces innovation and changes in organizational activities and operations. Collective reflection and continuous development are essential. Doing development and management in this way requires not only courage but also practical development and management skills that enable participation.

Finally, the factors that affect learning and process innovation have characteristics that need to be taken into consideration when planning development methods. The results of this thesis show that, with regard to individual and organizational learning and process innovations, the best results are achieved through consecutive but flexible interventions, e.g. process simulations. Outcomes of the previous interventions and learning paths should be put into focus in the following intervention. The results also show that consecutive process interventions enhance both individual and organizational learning more effectively than one intervention. Continuing interventions should

be planned as project portfolios, which can be altered or redirected during the learning process. Different development methods should take this into account.

The interventions continue: the depicted constructs have been applied in many different ways after the studies of this thesis to solve practical problems in organizations, and thus, the underlying theoretical understanding has broadened.

6.3 Evaluation of this thesis

In this thesis, the reasoning proceeds in an abductive manner, towards the best available explanation, throughout the five articles, and in each article the data was collected based on action research and case studies. Thus, this thesis should be evaluated on two levels: firstly, on the level of research method and reasoning, and secondly, on the level of data collection and analysis methods. In the following sections, the abductive reasoning, which has been selected as the research method, is evaluated from one article to another. Thereafter, the findings and conclusions stemming from each research question are evaluated based on the criteria of qualitative research (Grönfors 1985, Miles and Huberman 1994), as qualitative methods have been used.

6.3.1 Evaluating the research method

The propositions and new theory for individual and organizational learning in process innovations were created in the context of process simulations and based on abductive reasoning, using the analyzed data and findings in each article as the resources for the theoretical framework. Despite the fact that the articles include additional results, only the findings that are relevant to this thesis are reviewed and analyzed, based on the initial theoretical framework (section 2.7). The initial theoretical framework is threefold: it has learning enablers, learning outcomes and learning processes. In this thesis, the initial theoretical framework is further refined according to the results of the research cycles from one article to another. In the discussion of each article (sections 4.2–4.6), the findings are summarized to the extent of the three viewpoints. Thus, both the theoretical and empirical understanding of the research questions increase step by step. Furthermore, in chapter 5 the context-dependent reasoning (see also Ketokivi and Mantere 2010) explains the findings with examples and states the propositions of this thesis. Finally, in chapter 6, the propositions and new theory are connected to the

existing body of knowledge, and the theoretical and practical implications and contributions of this thesis are discussed.

This thesis seeks the best credible explanations for the research questions (section 1.2) based on considerations of epistemic virtues, that is, plausibility and novelty (Ketokivi and Mantere 2010, 321). For all three research questions and their subquestions the answers are searched for equally, yet analyzing a different subset of the articles. Concerning the learning enablers (Q1), all five articles are used to analyze what the learning enablers and their relationships are to learning paths. Sections 4.2–4.6 answer the research questions keeping the inference (findings) and explanation (discussion) separate, but in section 5.1 the practical influence of the learning enablers is dealt with by assessing the inference and explanation simultaneously.

Regarding the learning outcomes (Q2), articles 3 and 5 are used as a resource to analyze what kinds of learning outcomes emerge, and what their relationships are to learning paths in learning processes in the context of process simulations. In this analysis the inference and explanation are assessed separately in sections 4.4 and 4.6 just as in those articles, yet they are interwoven in section 5.2 to explain the significance of the findings and posit the theoretical propositions.

Finally, concerning the learning paths and process (Q3), article 5 is used to analyze how the learning enablers and the learning outcomes mutually create the learning paths, and what their relationships are to each other. In this analysis the inference and explanation are assessed separately in section 4.6 just as in article 5, yet they are interwoven in section 5.3.

Appreciating the methodological incompleteness of induction, it is recognized that there are no universally established or sound principles to govern the practical reasoning process (Ketokivi and Mantere 2010, Toulmin 2003). Knowing its weaknesses and acknowledging its strengths, the inference to the best explanation, i.e. theory, context and researcher variant abductive reasoning has been selected as the reasoning strategy. This type of reasoning process is unpredictable due to a lack of methodological consensus and also due to the challenge of subjectivism. However, the contextualized inference is transparent and openly partial to the explanation, as well as authentic to the data and research process (Ketokivi and Mantere 2010). Thus, abductive reasoning more likely leads to novel as well as plausible claims than the idealized inductive reasoning strategy, which aspires to more generalizable results with explicit and established rules and procedures, in compliance with methodological idealization.

As a research method, abductive reasoning was suitable specifically for this thesis because it allowed new theory to emerge and to become stronger step by step during the research cycles. The principles of abductive reasoning are followed almost throughout the whole thesis. However, some analysis of the data in articles 3 and 5 approached idealized inductive reasoning.

6.3.2 Evaluating the findings and conclusions

This section evaluates where and how the data was collected, how the data was processed, and how the results and the conclusions were drawn. This demonstrates if this thesis fruitfully bridges grounds to elicited claims.

For the data collection, action research and case studies were used. The data was collected during process simulations conducted in mainly Finnish organizations with Finns as the majority of participants. The method of arranging process simulations in cooperation with an organization's personnel resembles the participatory action research approach where research is conducted in close relationship with the organization members studied (Whyte et al. 1991, 269–287). The data represents the views of the persons participating in the process simulations. Since many and quite diverse organizations and several people from each participated, it can be stated that the data represents real views of the organizations, and not only an opinion of a certain group or an exaggerated or biased view. In chapter 4, I give a detailed description of the data, its collection and analysis article by article to make the research process transparent.

In the following, the findings and conclusions are evaluated separately for each research question, since the collection of data differed for each question. In the evaluation process, the criteria presented by Miles and Huberman (1994, 262–277) are adapted, and some of their theories to assess the findings are used. In the assessing, it is also described whether the used data of a particular article and its analysis follows the idealized or the contextualized mode of reasoning (see also Ketokivi and Mantere 2010) to assess the used grounds and warrants. In this thesis, the claims of each article are not used directly as sources; instead the grounds and warrants are the resource for each research question.

The conclusions are drawn based on the data of 34 cases and 99 process simulations of 17 organizations. The cases represent 12 different industries and about 50 processes. The number of cases and that they are from dissimilar industries and processes underline the strength of the evidence. On the other hand, the results could only be generalized to those industries and processes, even

though it could be assumed that the results are also valid in other industries and processes, if the same or similar process development methods are used.

The data was collected in various ways during the process simulations: the participants filled in questionnaires after the simulations, the development ideas were collected, and notes of the development practice were made. Data was also collected before, between and after the process simulations. This data included the researcher's notes, results of the subprojects, and follow-up interviews. Since the data is diversified, it has been possible to compare the self-sufficient data sets inside the cases. This mix of methods and triangulation confirm the validity of the research (Miles and Huberman (1994, 262–277) within the limits of the plausibly applicable field of North and West European commercial organizations.

For the first research question (Q1):"What are the learning enablers and their relationships to learning paths?" the data of all five articles were used.

What the learning enablers are is addressed in all five articles (table 13). Firstly, concerning the significance of the visualization of the process under development, it is justified with the construct (a construct of a process development method, which includes the process simulation method) presented in article 1. The process simulation method and visualization, which belongs to it as an essential part, are described in depth in article 1. In addition to describing the process simulation method and visualization in it, the significance of visualization is emphasized by the observations of the participants (n=218 participants) in the questionnaires after the process simulation day (table 7, also in article 3: table 5).

Secondly, factors concerning interaction, participation and empowerment, creative holism, and common understanding are described in articles 1–4 using diverse data. Article 1 describes how these factors are constructed in process simulations. The importance of dialogue and organizational boundary crossings between strategy and operations for organizational learning is described in article 2 in a contextualized manner, using two descriptive case studies. Table 7 (also article 3: table 5) summarizes 379 answers from participants after the process simulations, and thus answers to the question "What did you achieve with the simulation days or what was the most remarkable issue that the simulation game addressed for you?" The summary is idealized (categorized), and the answers are used to explain the significance of the learning enablers. In article 4, the importance of the above learning enablers is described in a contextualized manner.

Thirdly, article 4 describes how the process simulations proceed as a learning community, in dialogue between operational processes and strategy. Smeds and

Alvesalo (2003a, b) also gained similar results of telepresence in cross-site business process simulations.

Finally, even though article 5 did not focus on learning enablers or their relationships, the findings of the article confirm the earlier findings of this thesis and indicate that learning outcomes and learning paths are also important learning enablers.

In this thesis, the weakest data on learning enablers concerns the justification of visualization. For this reason, the significance of visualization should be examined further. However, learning enabling factors concerning interaction, participation and empowerment, creative holism, and common understanding could be explained well with the data. It can also be mentioned that these factors have been examined in various other studies of process simulations (e.g. Piispanen and Pallas 1992, Ruohomäki 1994, 1995a, 1995b, 2002, Smeds 1994, 1996a, b, 1997b, Piispanen et al. 1996, Pankakoski 1998, Forssén-Nyberg and Kutilainen 1998, Forssén-Nyberg and Hakamäki 1998, Forssén 2001, 2002, Smeds et al. 2006) and that the results of this thesis confirm these earlier findings on learning enablers.

To the research question of learning enablers and their relationships in learning paths, all above mentioned data were used to describe the relationship between learning enablers and learning in a contextualized manner. Furthermore, table 8 summarizes 218 persons' answers to the question "What are the main development issues in the process?" after the first and second process simulations. When comparing these results and the results in table 7, the relationships of some learning enablers could be noticed. This analyzed data and also the researchers' notes and follow-up interviews have been used to confirm the relationship of various learning enablers.

For the second research question, Q2:"What kinds of learning outcomes emerge and what are their relationships to learning paths?" the extensive data of articles 3 and 5 were used. Table 9 (article 3: table 9) collects the short-term and long-term outcomes (results) for intangible, tangible and future outcomes (soft, hard, future results) in 32 case studies. The answers of the participants to the questionnaire after the process simulation, the researchers' notes, and follow-up interviews were used as the data for the table. In table 12 (article 5: table 2) questionnaires, observations of process simulation sessions, discussions with the process development team of the organization, and follow-up interviews of key persons in the project of one case study in article 5, were used to analyze the role and relationships between intangible and tangible outcomes.

For the third research question, Q3:"How do the learning enablers and the learning outcomes mutually create the learning paths, and what are their relationships to each other?" the data of article 5 was used. The data was collected from five process simulations, in which 216 respondents answered questionnaires after the process simulation and 27 respondents also participated in follow-up interviews. The answers of the participants to the questionnaire after the process simulation, the researchers' notes and follow-up interviews were used as the data. Also the results of article 3 support these results.

Finally, the model for individual and organizational learning in process innovations was created based on the results of all articles, and the emerging theoretical results were continuously compared to existing theory according to the principles of action research and abductive reasoning (Argyris and Schön 1991, Ketokivi and Mantere 2010, Paavola et al. 2006).

6.3.3 Researcher effects

Generally it can be noted that qualitative organizational research improves the more the researcher spends time in the studied organization, since this is the only way to get acquainted with the culture and language as well as different situations in the organization.

I have been a consultant, an expert and a facilitator in researched organizations. It is obvious that these roles also affect the final results. I have had very personal experiences of the implementation of the development projects, therefore the understanding of the phenomena is founded on explicit knowledge and accumulated tacit knowledge and experience during projects in 12 organizations, in which 18 cases and 49 simulations took place. The subjectivity inevitably present in action research has thus been alleviated because of the time perspective. The validity of the research is also strengthened by the multi-member researcher–consultant teams, which have participated in the case studies (chapter 4, tables 4, 5, 6, 10 and 11), with whom it has been possible to analyze, interpret and evaluate the results. The representatives of the organizations have also participated in the evaluation process during the research project (chapter 4, tables 4, 5, 6, 10 and 11). Moreover, the co-authors of the studies did action research as well, and spent time in the rest of the companies (7 companies, 18 cases, 52 simulations, of which we have facilitated one process simulation together in one case organization). The active participation of the researchers most probably also

improved openness and trust among the members of the organizations, and thus strengthened data quality.

6.4 Directions for future research

This thesis has discussed learning enablers, learning outcomes and learning paths and provided a model for individual and organizational learning for creating process innovations that lead to genuine, constructive and lasting organizational change. The results that emerged in this thesis are not the only propositions of learning in process innovations. Further research is needed to fully understand what happens during creating process innovations, and what the relationships between learning enablers, learning outcomes and learning paths are. Also, the constructed models should be evaluated with further research.

The thesis has been conducted only in the context of process simulations and mainly on Finnish working environments. Thus, the results should be evaluated with different process innovation methods and in diverse environments including larger international case studies.

The study has been context specific, so new research designs and new environments give rise to new questions, for example, how do different innovation methods influence learning, what are the learning enablers, learning outcomes and learning paths, and are these the same as in this thesis with diverse methods and cultures.

Finally, process innovations differ. What is the role of learning for simple or complex process innovations? Are there differences? How does the subject under development influence learning enablers and learning paths?

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Appendices

Appendix 1: The questionnaire (Article 3)

1. What did you achieve with the simulation days?

_____
_____
_____
_____

2. What are the main development issues in the process?

1. _____
2. _____
3. _____
4. _____
5. _____

3. How could the simulations days be improved and their results developed?

_____
_____
_____
_____

Appendix 2: Evaluation form (Article 3)

Evaluation form

We would like you to evaluate the simulation game day with this form. Please mark how well statements correspond to your opinions (I totally disagree - I completely agree) by circling the right alternative. Explain your answer further, particularly when you disagree.

Thank you for your contribution - the summary of this evaluation will be given to you for further actions !

Minna Forssén
HUT

N.N.
The Company

My role (underline): Player Observer

		I totally disagree	I somewhat disagree	I agree up to a point	I agree	I completely agree
TARGETS						
1.	I gained good overview of the simulated process	1	2	3	4	5
2.	The game increased my understanding of the activites and tasks at other sites.	1	2	3	4	5
3.	The game brought up development needs and ideas well.	1	2	3	4	5
PRACTICAL ARRANGEMENTS						
4.	I received enough briefing information.	1	2	3	4	5
5.	If not, what kind of information would you have needed ?_____					
	_____					
6.	The duration of the game was ok.	1	2	3	4	5
7.	If not, how long should it be ?_____					
	_____					
8.	The room was ok.	1	2	3	4	5
9.	If not, why ?_____					
	_____					
10.	I was satisfied with the visualization material of the game.	1	2	3	4	5
11.	If not, how could it be improved ?_____					
	_____					

	I totally disagree	I somewhat disagree	I agree up to a point	I agree	I completely agree
12. The number of players was ok.	1	2	3	4	5
13. If not, how many players should there be?_____					
_____					
14. The number of observers was ok.	1	2	3	4	5
15. If not, how many observers should there be?_____					
_____					
16. I am pleased with the running of the simulation game.	1	2	3	4	5
17. If not, how could we have improved it ?_____					
_____					
18. I had good opportunity to comment.	1	2	3	4	5
19. If not, how could the discussion have been organized ?_____					
_____					

PARTICIPATION

20. It was useful for me to participate.	1	2	3	4	5
21. The game would also be useful for other employees in the office/company.	1	2	3	4	5
22. For whom ?_____					
_____					

OPEN QUESTIONS

23. What was the most remarkable issue the simulation day addressed for you ?

_____

_____

24. How should the *simulation day* be developed - ideas for improvement?

_____

_____

Appendix 3: The questionnaire (Article 4 and 5)

EVALUATION FORM
PP Commercialization
Simulation game 16.–17.6.1999

In this evaluation form we ask you kindly to evaluate how the simulation game session has helped the PP Commercialization Process in reaching its goals. In most questions you should indicate how well a certain statement corresponds to your opinion. Please use the following scale (1 = I strongly disagree, 2 = I somewhat disagree, 3 = I somewhat agree, 4 = I strongly agree).

Thank you for answering the questionnaire!

SimLab research team

General information

1. Age — under 20 _____
   20 – 29 _____
   30 – 39 _____
   40 – 49 _____
   50 – 59 _____
   over 59 _____
2. Sex — male/ female
3. Highest level of education completed _____

Your history in the company

4. Department/ unit _____
5. Years at company _____
6. Have you worked in PP Development projects at your company? — Yes/ No
7. Your role in the simulation game: — player/ observer
8. Did you attend the simulation game session on
   a) 16.6.1999 — Yes/ No
   b) 17.6.1999 — Yes/ No

Background for participating in the simulation games

9. Have you attended the Rigel information sessions at your company? — Yes/ No
10. Have you attended the process description session of PP

Commercialization process? Yes/ No

11. Have you attended earlier simulation games at your company?

a) 10. – 11.6.1999 (R&D –project; case) Yes/ No

b) 18. – 19.8.1999 (R&D –project; case) Yes/ No

c) 22. – 23.3.1999 (Registration) Yes/ No

1 = I strongly disagree
2 = I somewhat disagree
3 = I somewhat agree
4 = I strongly agree

12. I received enough information about Rigel -project in advance. 1 2 3 4

If not, what kind of information would you have needed? _____

_____

13. I received enough information about PP Commercialization process and its development in advance. 1 2 3 4

If not, what kind of information would you have needed? _____

_____

14. I received enough information about the simulation games in advance. 1 2 3 4

If not, what kind of information would you have needed? _____

_____

The quality of the arrangements and the simulation session

15. The arrangements in the simulation room were good. 1 2 3 4

If not, how should they be changed? _____

_____

16. The visibility during the session was sufficient. 1 2 3 4

If not, how should it be improved? _____

_____

17. The audibility during the session was sufficient. 1 2 3 4

If not, how should it be improved? _____

_____

18. There were too many people in the simulation session considering the size of the simulation room. 1 2 3 4

19. I was satisfied with way how the simulation game was facilitated.

a) on the first day 1 2 3 4

b) on the second day 1 2 3 4

If not, what should be changed? _____

_____

20. The facilitator of the simulation game was able to utilize the process charts and other visual material during the conversation

a) on the first day 1 2 3 4

b) on the second day 1 2 3 4

If not, how should this be changed? _____

_____

21. The simulation game proceeds at a good pace. 1 2 3 4

If not, how could this be developed? _____

_____

22. The duration of the simulation game was sufficient. 1 2 3 4

If not, how long should it have been? _____

_____

Space and learning

22. When I came to the simulation room, the first impression was positive. 1 2 3 4

23. The atmosphere of the game was

a) relaxed 1 2 3 4

b) constructive 1 2 3 4

c) dynamic 1 2 3 4

d) stimulating 1 2 3 4

e) other _____ 1 2 3 4

24. The room arrangements were supportive to the conversation
    a) during the simulation game. 1 2 3 4
    b) during the breaks. 1 2 3 4
25. The visual process maps helped me to understand the PPC process and its interconnections to the other sub processes. 1 2 3 4

Group and learning

27. All necessary people were present at the simulation game. 1 2 3 4
    If not, who should have been present? _____
    _____
28. During the simulation game the interaction between the participants was active. 1 2 3 4
29. All relevant information was exchanged. 1 2 3 4
    If not, what else should have been discussed? _____
    _____
    _____
30. I was able to participate freely in the discussion. 1 2 3 4
    If not, how should the discussion have been arranged? _____
    _____
31. The shared experience of the simulation game enhances the practical work in PP Development. 1 2 3 4
32. The shared experience of the simulation game enhances the further development of the processes. 1 2 3 4
33. The PP Development process has developed remarkably since the first simulation in June 1998. 1 2 3 4
34. The PP Development process has changed remarkably since the first simulation in June 1998. 1 2 3 4

Process modeling and visualization

35. The process maps described well the plans for

a) the PP Commercialization process 1 2 3 4

b) the other sub processes 1 2 3 4

If not, what should be modeled in more detail?

_____

_____

_____

36. In the simulation session the following tools were useful

a) main process map 1 2 3 4

b) operational marketing process map 1 2 3 4

c) strategic marketing process map 1 2 3 4

d) other sub process maps 1 2 3 4

37. The visual process maps helped me to understand the interfaces between the sub processes. 1 2 3 4

What else did you gain from the process maps? _____

_____

_____

_____

38. What kind of benefits would be gained if process maps could be revised in real time during the simulation session? _____

_____

_____

39. What kind of benefits would be gained if alternative process structures could be experimented during the simulation game? _____

_____

_____

40. What should be visualized and modeled better during the simulation game?

_____

_____

Learning

41. The simulation game helped me in forming a holistic view of the functions in the PP Commercialization process. 1 2 3 4

42. I expected a more detailed process simulation in

a) the main process 1 2 3 4

b) the operational marketing process 1 2 3 4

c) the strategic marketing process 1 2 3 4

d) the other sub processes 1 2 3 4

43. The simulation game increased my awareness about

a) the need for collaboration in the processes 1 2 3 4

b) the need for communication in the processes 1 2 3 4

c) the interfaces and interconnections of the activities in the processes 1 2 3 4

d) the need of teams in the processes 1 2 3 4

e) the time dependencies in the projects 1 2 3 4

44. The simulation game pointed well the differences of the strategic and operational marketing process. 1 2 3 4

45. The simulation game helps us to develop the structure of the PP Commercialization process onwards. 1 2 3 4

46. The simulation game helps us to bring new and better modes of operation to the PP Commercialization process. 1 2 3 4

47. I can use in my work the knowledge that I gained in the simulation game. 1 2 3 4

If not, what are the most important obstacles? _____

_____

_____

48. I believe that the ideas that have resulted from the simulation game can be used in the development of PP Commercialization process and other sub processes. 1 2 3 4

If not, why? _____

_____

49. I believe that the ideas that have resulted from the simulation game can shorten the time-to-market of new drugs. 1 2 3 4

If not, why? _____

_____

50. The following processes need still to be developed

a) Strategic marketing 1 2 3 4

b) Operational marketing 1 2 3 4

c) Health Economics 1 2 3 4

d) Clinical 1 2 3 4

e) Pre clinical 1 2 3 4

f) Formulation 1 2 3 4

g) Synthesis and production 1 2 3 4

h) Discovery 1 2 3 4

i) Logistics 1 2 3 4

j) Portfolio management 1 2 3 4

k) Decision making 1 2 3 4

l) Other, what? _____ 1 2 3 4

51. This simulation game was useful for

a) Marketing (HQ) 1 2 3 4

b) Marketing (Subsidiaries) 1 2 3 4

c) Clinical development 1 2 3 4

d) Top management 1 2 3 4

e) Strategy of the company 1 2 3 4

f) Operational work of the company 1 2 3 4

g) Other, what? _____ 1 2 3 4

Next steps

52. In your opinion, what are the most important processes to be developed in the future at your company?_____

_____

_____

53. In your opinion, what would be the best enablers in developing and implementing the PP Commercialization process? _____

_____

_____

_____

54. In your opinion, what are the biggest obstacles in developing and implementing the PP Commercialization process? _____

_____

_____

_____

55. Company needs simulation games also in future for

a) decision making 1 2 3 4

b)other, what _____ 1 2 3 4

56. What should be simulated in the next simulation game?

_____

_____

_____

58. What, in your opinion, was the most relevant outcome of the simulation game?

What was the contribution of the game for you personally? _____

_____

_____

_____

_____

_____

Appendix 4: Thematic questions in long-term evaluation interviews (Article 4 and 5)

TKK/ SimLab 18.7.2000

Hyvät Orionilaiset SimLab-simulointipeleihin osallistujat,

SimLab-projektin osana selvitämme haastatteluin Orionissa toteutetun Riegel-projektin ja simulointipelien sekä niihin keskeisesti liittyvien kehityshankkeiden toteutusta, implementointia ja projektin vaikuttavuutta organisaatiossa. Haastatteluista saatua aineistoa tullaan käyttämään SimLab- ja Riegel-projektin loppuraportissa sekä Orionin ja SimLabin yhteistyön kehittämisessä. Aineistoa käytetään myös tutkimusaineistona SimLabissa.

Sinut on valittu tähän teemahaastatteluun ja toivommekin, että Sinulla on aikaa noin 1 ½ tuntia viikolla 35, 36, 37 tai 38, jolloin haastattelut on tarkoitus suorittaa. Päivi Haho tai Riitta Smeds ottavat Sinuun yhteyttä puhelimitse elokuun loppupuolella varatakseen haastatteluajan.

Haastattelukysymykset koskettavat pääpiirteissään alla esitettyjä teemoja. On eduksi, jos ehdit ennen haastattelua lukea teemat läpi ja miettiä oman näkemyksesi valmiiksi.

SimLabin tutkijat

Riitta Smeds
Päivi Haho

ALUSTAVAT HAASTATTELUKYSYMYSTEN TEEMAT

1. Riegel projektin toteutus?
2. Mitä Riegel-projektissa on saatu aikaan?
   - Operatiivinen toiminta/ strategia?
   - Lyhyt/ pitkä aikajänne?
   - Pehmeät/ kovat tulokset
3. Mitä simulointipeleillä on saatu aikaan?
   - Operatiivinen toiminta/ strategia?
   - Lyhyt/ pitkä aikajänne?
   - Pehmeät/ kovat tulokset
4. Suurimmat ongelmat Riegel-projektin aikana?
5. Miten organisaatiomuutokset ovat vaikuttaneet prosessien kehittämishankkeeseen?
6. Mitä ajattelutavan muutoksia on tapahtunut prosessin rakenteessa/ milestoneissa?
7. Mitkä olivat Riegelin tavoitteet projektin alussa? Niiden kehitys ja muuttuminen Riegel-projektin kuluessa?
8. Miten jälkikäteen ajatellen prosessien kehittäminen olisi pitänyt toteuttaa? Mitä on opittu Riegelistä/ simulointipeleistä/ SimLabista?
9. Miten simulointipelejä tulisi käyttää jatkossa?

Original publications

This dissertation includes an extended summary and five appended articles.

I Haho P & Smeds R (1997) The Softmatch-method: Enterprise transformation through simulation games. In: Saunders P & Cox B (eds) The International Simulation and Gaming Yearbook Volume 5: Research into Simulations in Education. London, Kogan Page: 48–63.

II Haho P (1998) Strategy and operation in dynamic interaction. In: Bititci U & Carrie A (eds) Strategic Management of the Manufacturing Value Chain. Proceedings of the International Conference of the Manufacturing Value-Chain August '98, Troon, Scotland, UK. Boston, Kluwer Academic Publishers: 113–122.

III Forssén M & Haho P (2001) Participative development and training for business processes in industry: review of 88 simulation games. International Journal of Technology Management, Special Issue: Implementation of Business Process Innovations 22(1-3): 233–262.

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V Haho P (2004) Paths to Deutero-learning through Successive Process Simulations: A Case Study. Knowledge and Process Management 11(4): 239–251.

Original publications are not included in the electronic version of the dissertation.

463. Reiman, Arto (2013) Holistic work system design and management : — a participatory development approach to delivery truck drivers' work outside the cab

464. Tammela, Simo (2013) Enhancing migration and reproduction of salmonid fishes : method development and research using physical and numerical modelling

465. Yadav, Animesh (2013) Space-time constellation and precoder design under channel estimation errors

466. Schaberreiter, Thomas (2013) A Bayesian network based on-line risk prediction framework for interdependent critical infrastructures

467. Halonen, Niina (2013) Synthesis and applications of macroscopic well-aligned multi-walled carbon nanotube films

468. Remes, Jukka (2013) Method evaluations in spatial exploratory analyses of resting-state functional magnetic resonance imaging data

469. Oravisjärvi, Kati (2013) Industry and traffic related particles and their role in human health

470. Czajkowski, Jakub (2013) Optical coherence tomography as a characterization method in printed electronics

471. Haapalainen, Mikko (2013) Dielectrophoretic mobility of a spherical particle in 2D hyperbolic quadrupole electrode geometry

472. Bene, József Gergely (2013) Pump schedule optimisation techniques for water distribution systems

473. Seelam, Prem Kumar (2013) Hydrogen production by steam reforming of bio-alcohols : the use of conventional and membrane-assisted catalytic reactors

474. Komulainen, Petri (2013) Coordinated multi-antenna techniques for cellular networks : Pilot signaling and decentralized optimization in TDD mode

475. Piltonen, Petteri (2013) Prevention of fouling on paper machine surfaces

476. Juuso, Esko (2013) Integration of intelligent systems in development of smart adaptive systems : linguistic equation approach

477. Lu, Xiaojia (2013) Resource allocation in uplink coordinated multicell MIMO-OFDM systems with 3D channel models

478. Jung, Sang-Joong (2013) Personal machine-to-machine (M2M) healthcare system with mobile device in global networks

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ACTA UNIVERSITATIS OULUENSIS

ISBN 978-952-62-0357-7 (Paperback)
ISBN 978-952-62-0358-4 (PDF)
ISSN 0355-3213 (Print)
ISSN 1796-2226 (Online)

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