LUND UNIVERSITY

A Study of a Hospital Operating Unit as a Foundation for Future Improvements

Rydenfält, Christofer

2011

Link to publication

Citation for published version (APA):
Rydenfält, C. (2011). *A Study of a Hospital Operating Unit as a Foundation for Future Improvements*. [Licentiate Thesis, Ergonomics and Aerosol Technology]. Lund University - Design Sciences - Ergonomics and Aerosol Technology.

Total number of authors:
1

General rights
Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

Download date: 26. Apr. 2024

A Study of a Hospital Operating Unit as a Foundation for Future Improvement

Christofer Rydenfält

Licentiate Thesis 2011

Lund University • Design Sciences • Ergonomics and Aerosol Technology

LUND UNIVERSITY

Copyright © 2011 Christofer Rydenfält

Licentiate thesis
Lund University • Design Sciences • Ergonomics and Aerosol Technology
Sweden

www.eat.lth.se

ISBN 978-91-7473-132-3
ISSN 1650-9773
Publication 43
ISRN LUTMON/TMAT-2030-SE EAT 2011

Abstract

The main objective of the research presented was to gain an understanding of how the dynamics between professionals, tools and objectives work in an operating unit in order to obtain knowledge useful when designing the operating unit of the future with emphasis on the work environment, effectiveness and patient safety. By investigating how different professions in the operating theatre view their work and its dynamics, as well as observing how the work is actually carried out, it is possible to get a conception of the dynamics and motives that determine how the work is constituted. This research explores how different professions view their work by means of an interview study, and how the work is carried out in practice by means of a direct observation study. Together, the results of the studies provide two different perspectives on operating theatre work.

In both studies, the perspectives of the professionals play an important role. How something is perceived influences how we decide to act. To increase the potential for improvement, widening those perspectives plays a central role. By doing so, the practice will in turn appear more complex to the practitioners; there will be more aspects to take into consideration. More contradictions and options will be visible. To improve the practitioners' capability to handle this increased complexity, trust is identified as an important tool. Trust is a mechanism that can suspend doubt or complexity in such a way that it is possible to make effective decisions even when the number of options is too large to handle.

Previous research indicates that surgical teams are not as cohesive as could be expected and that communication failures frequently occur in the operating theatre. The first study presented in this thesis elaborates on how this can come about. It investigates how different healthcare professions in the surgical team orientate themselves towards their task and how this can be affected by the organizational and social context. Virtual reality supported semi-structured interviews were conducted with 15 participants recruited from all personnel categories of the surgical team. Activity theory was used as a theoretical framework to analyze the interviews. The results indicated that poor team functionality to some degree can be explained by different activity orientations between professions, which leads to different views on work activities and tension between them. Social and organizational support structures in the daily practice are pointed out as a means to facilitate trust and experience sharing between professions. This can promote the establishment of a common view among different professionals in the operating team and increase interprofessional communication, hence overcoming communication thresholds in the operating theatre.

To improve safety in the operating theatre, checklists have gained considerable support in recent years, often in the form of a pre-operative timeout. The World Health Organization (WHO) has developed its own timeout checklist, which has been adopted by several Swedish operating units. Previous research indicates that timeout checklists reduce complications from surgery and can even improve the safety attitude of the team members. Thus, the effects of the checklist have been studied, but little research has been carried out on how the checklist is actually used in practice. This is investigated in the second study included in this thesis to determine how the surgical team uses and relates to the checklist as well as to identify and explain deviations from it. Twenty-four timeout procedures of four different, but common, operations were video recorded and analyzed according to a predefined protocol based on the WHO checklist instructions. The results showed that compliance varied between questions. The questions with the best compliance appeared to be the ones that made the most sense and were perceived as the most important by the participants. In half of the observed procedures, personal presentations did not occur and in five of those cases, they were postponed. This indicates that these questions, intended to facilitate communication between team members, were not perceived as contributing to patient safety in any meaningful way. The results also showed that surgeons and anesthesiology personnel dominated much of the timeout. It is likely that the positive effects on patient safety attributed to the checklist can be improved by making the connection between the checklist, communication and teamwork more explicit and by altering the checklist so that the different professions more equally involved.

Sammanfattning

Det huvudsakliga syftet med den presenterade forskningen var att bygga en förståelse för hur dynamiken mellan professioner, verktyg och objekt fungerar på en operationsavdelning, som ett led i framtagandet av kunskap användbar vid design av framtidens operationsavdelning med fokus på arbetsmiljö, effektivitet och patient säkerhet. Igenom att undersöka hur olika professioner i operationssalen ser på sitt arbete och dess dynamik samt igenom att observera hur arbetet faktiskt utförs, är det möjligt att få en förståelse för den dynamik och de motiv som bestämmer hur arbetet konstitueras. Forskningen undersöker hur olika professioner ser på sitt arbete i en intervjustudie och hur arbetet faktiskt utförs i praktiken med direkt observation. Tillsammans utgör resultaten två olika perspektiv på arbetet i operationssal.

I båda studierna spelar de studerade yrkesutövarnas perspektiv en viktig roll. Hur något uppfattas påverkar hur vi väljer att agera. För att öka potentialen för förbättring behöver dessa perspektiv vidgas. Därigenom kommer praktiken att te sig mer komplex för yrkesutövarna, det kommer att vara fler aspekter att ta hänsyn till. Fler dilemman och valmöjligheter kommer att vara synliga. För att förbättra de yrkesutövandes förmåga att hantera den ökade komplexiteten, identifieras förtroende som ett viktigt verktyg. Förtroende är en mekanism som tillfälligt kan upphäva det tvivel som en ökad komplexitet för med sig, och på så sätt göra det möjligt att ta effektiva beslut även när antalet alternativ är för stort för att hantera uttömmande.

Tidigare forskning visar på att operationslag inte är så sammanhängande som det kan förväntas och att det ofta uppstår kommunikationsproblem i operationssalen. Den första studien presenterad i denna avhandling undersöker hur det kan bli så. Den undersöker hur olika professioner i operationslaget orienterar sig själva i relation till sin uppgift och hur denna orientering kan påverkas av den organisatoriska och sociala kontexten. En semistrukturerad intervju genomfördes med 15 deltagare rekryterade ifrån alla personalkategorier i operationslaget. I intervjun användes en virtuell modell av en operationssal som diskussionsunderlag. Verksamhetsteori användes som ett teoretiskt ramverk för att analysera intervjuerna. Resultaten pekar på att dålig team funktionalitet till viss del kan förklaras av olika verksamhetsorientering mellan professioner, vilket leder till olika syn på aktiviteter i arbetet och därmed till spänningar mellan olika professioner. Sociala och organisatoriska stödstrukturer pekas ut som medel för att skapa förtroende och ökat utbyte av erfarenheter mellan professioner. Detta kan i sin tur stödja upprättandet av en gemensam syn på arbetet över professionsgränserna i operationslaget och öka den interprofessionella kommunikationen och därigenom överkomma kommunikationströsklar i operationssalen.

För att förbättra patientsäkerheten i operationssalen har checklistor vunnit ansenligt stöd de senaste åren. Ofta i form av en timeout som genomförs innan operationen startar. Världshälsoorganisationen (WHO) har utvecklat sin egen timeout checklista och denna har implementerats på flera svenska operationsavdelningar. Tidigare forskning indikerar att timeout checklistor minskar komplikationerna vid kirurgiska ingrepp och till och med kan förbättra operationslagets säkerhetsattityd. Effekterna av checklistan har med andra ord studerats men lite forskning har gjorts på hur checklistan faktiskt används i praktiken. Detta undersöks i den andra studien inkluderad i denna avhandling för att skaffa en uppfattning om hur operationslaget använder sig av och relaterar till checklistan samt att förklara eventuella avvikelser från den. Tjugofyra timeouter från fyra olika, men vanliga, kirurgiska ingrepp, videofilmades och analyserades enligt ett fördefinierat protokoll baserat på instruktionerna för WHO:s timeout checklista. Resultaten visar på att överensstämmelsen varierade mellan de olika frågorna. De frågor som hade bäst överensstämmelse verkade vara de som uppfattades som mest viktiga av deltagarna. I hälften av fallen genomfördes ingen personlig presentation av deltagarna och i fem av de fall som där presentation genomfördes sköts den fram till senare i timeouten. Detta tyder på att dessa frågor, med syftet att underlätta kommunikation mellan medlemmarna i operationslaget, inte uppfattas som bidragande till patientens säkerhet på något meningsfullt sätt. Resultaten visade också på att anestesiologi personalen och kirurgen i stort dominerade timeouten. Det är troligt att de positiva effekterna på patientsäkerheten associerade med timeout checklistan kan förbättras ytterligare om kopplingen mellan checklista, samarbete och kommunikation görs tydligare och mer explicit samt genom att checklistan förändras så att de olika professionerna i operationslaget blir mer jämlikt involverade.

Acknowledgements

Although my name is on the cover, the work with this thesis has not been done in a vacuum. Without the support, encouragement and input from other people, this thesis would probably not have seen the light of day. At least not as something that reassembles a licentiate thesis. Friends, family, co-workers, colleagues, along with those who have funded my work and the facilities I am working in, has provided the context that made this thesis possible.

First of all, I would like to thank my supervisors, Professor Per Odenrick and Professor Gerd Johansson at Lund University, Department of Design Sciences and Associate Professor Per Anders Larsson at Helsingborg Hospital. It has been a great pleasure to work with you and I am looking forward to continue doing so for quite a while. You have made me a better researcher since 2008 but I have more to learn.

In addition, I would also like to thank the OpDesign 2012 project steering group members Kristina Åkerman and Åke Johansson.

I would also like to express my special gratitude to the Gorthon Foundation in Helsingborg that has generously funded the research upon which this thesis is based.

I would like to thank my colleagues at the Division of Ergonomics and Aerosol Technology at the Department of Design Sciences for being such a lovely bunch of people, always providing an interesting as well as joyful chat during lunch or coffee breaks.

Special thanks goes to Eileen Deaner for proofreading practically everything I have written that has any sort of relevance, including this thesis, and for giving valuable and developing comments on everything from language to contents.

I would also like to thank Jessika Sellergren for help with the design of the front cover as well as being supportive on issues regarding the layout of the thesis.

Lastly, I would like to thank my mother Kerstin and my father Mats for always being there and giving support no matter what. Finally, I would like to thank my girlfriend Marie for putting up with this slightly crazy eccentric man that I am.

List of appended papers

This thesis is based on the following papers:

Paper I: Rydenfält, C., Johansson, G., Larsson, P. A., Åkerman, K., & Odenrick, P. Social structures in the operating theater: How contradicting rationalities and trust affect work. *Accepted for publication in the Journal of Advanced Nursing.*

Paper II: Rydenfält, C., Johansson, G., Odenrick, P., Åkerman, K., & Larsson, P. A. Compliance with the WHO pre-operative surgical safety checklist: Analysis of deviations and possible improvements. *Submitted to a peer reviewed international scientific journal.*

Other work by the respondent

Rydenfält, C., Johansson, G., Johansson, Å., Larsson, P. A., Odenrick, P., & Åkerman K. (2009). Disturbing events in the operation theatre, a study of variation in perceptions between different professions. *Conference abstract presented at the 3rd NOVO Symposium on Sustainable Nordic Health Care Systems,* Copenhagen, Denmark.

Rydenfält, C., Johansson, G., Johansson, Å., Larsson, P. A., Odenrick, P., & Åkerman, K. (2010). Variationer i synen på rationalitet och behov: En visualiseringsstödd studie av arbetet på en operationsavdelning (Variations in the view of rationality and need: A visualization support study of work in a surgical unit), *Report*, Lund, Sweden.

Rydenfält, C., Johansson, G., Johansson, Å., Larsson, P. A., Odenrick, P., & Åkerman, K. (2010). Different perceptions of the work context within the team: A study of a surgical unit. *Conference abstract presented at GRASP, the 7th Nordic Conference on Group and Social Psychology*, Gothenburg, Sweden.

Lindskog, C., & Rydenfält, C. (2011). Improving innovation capability through education: A study of healthcare leaders. *Poster accepted for the European Health Management Association (EHMA) Annual Conference 2011 "Integration in Health and Healthcare",* Porto, Portugal.

Table of contents

Abstract III
Sammanfattning V
Acknowledgements VII
List of appended papers VIII
Other work by the respondent IX
Table of contents X
1 Introduction 1
1.1 Background 1
1.1.1 Swedish healthcare 1
1.1.2 The case 3
1.1.3 Objectives, aims and research questions 4
1.2 Theory / Frame of Reference 5
1.2.1 Work environment, effectiveness and patient safety 5
1.2.2 Acknowledging complexity 6
1.2.3 Learning at work 7
1.2.4 Activity theory 12
2 Methodology 16
2.1 The research process 16
2.1.1 Where does it fit? 17
2.2 The methodologies applied 18
2.2.1 Interviews 18
2.2.2 Observation studies 18
2.2.3 Considerations regarding analysis 20
3 Summary of papers 21
3.1 Paper I: Social structures in the operating theater: How contradicting rationalities and trust affect work 21
3.2 Paper II: Compliance with the WHO pre-operative surgical safety checklist: Analysis of deviations and possible improvements 22
4 Discussion 25
4.1 Theory discussion 25

4.1.1 The relationship between work environment, effectiveness and patient safety 25
4.2 Results discussion 26
4.2.1 The overall approach in the papers 26
4.2.2 Complexity and trust 28
4.2.3 Visualization, reflection and learning 30
4.2.4 Discussion of methodological considerations 31
4.3 Future research 33
5 References 34

1 Introduction

1.1 Background

Many of the hospitals in Sweden were built in the 1960s and 1970s. During the approximately 40 years that has passed since then, considerable progress has been made in medical science, providing both new possibilities and new challenges. Possibilities in the sense that many conditions previously incurable can now be treated successfully; challenges in the sense that the care provided has become more complex and that the political climate appears to have hardened with demands for higher productivity on behalf of the healthcare providers. Despite these challenges, Swedish healthcare probably never has been better in the sense that it is capable of treating more conditions than ever.

In order to meet the new demands and to take full advantage of the progress made by science, many facilities need to be replaced or modernized. This is especially true for units dealing with specialized care, involving many different specialties and a huge amount of technical equipment. The prime example is the operating unit, with different medical specialties meeting in the operating room, working towards a common goal.

1.1.1 Swedish healthcare

In 2007, 31,6000 people was employed in the healthcare sector in Sweden (Statistiska centralbyrån, 2010), approximately 6.4% of the total workforce. The annual spending on healthcare services in Sweden in 2003 was 9.3% of the gross domestic product (Norbäck & Targama, 2009). The healthcare sector contains some of the most highly trained professions with considerable societal investments in their education.

The national healthcare system as a societal service

The Swedish national healthcare system is a public service and as such, it is of common concern for all citizens. It is in the common interest that the national healthcare system provides effective, safe and affordable care to its citizens. Healthcare professionals have a knowledge monopoly within their areas of expertise (Thunborg, 1999). It could thus be expected that the direct societal influence on medical practice is limited. Instead, society influences the national healthcare system in various ways, mainly through laws and regulations administrated by the Swedish National Board of Health and Welfare and through local county councils[1].

[1] In Sweden, the county council is the political body responsible for providing healthcare to citizens.

Work environment in the healthcare sector

Work in the healthcare sector is dominated by the large responsibility that comes with being responsible for other peoples' lives. Together with societal demands for efficiency, as well as demands for evidence-based practice, this puts great pressure on healthcare professionals, resulting in a psychosocial work environment that sometimes can be described as stressful. Previous research points out the importance of leadership and empowerment for physicians' and nurses' ability to learn to understand and cope with the stressors they meet in their daily work (Arnetz, 2001; Hochwälder, 2007). Previous research also indicates that in Sweden, suicides are more common among healthcare professions than in the average population (Leymann & Gustafsson, 1998; Arnetz et al., 1987). This indicates that the psychosocial work environment of healthcare personnel can be a neglected area.

Patient safety and reporting of incidents

Patient safety is an area which is very well represented in the research literature[2] (see for example (Künzle, Kolbe, & Grote, 2010; Carthey, de Leval, & Reason, 2001; Sammer, Lykens, Singh, Mains, & Lackan, 2010; Hoff, Jameson, Hannan, & Flink, 2004). The literature supports the need for a culture that encourages reporting of and learning from adverse events (Mahajan, 2010; Macrae, 2008). Despite this, studies indicate that the reporting of clinical incidents is less than satisfactory. Catchpole, Bell and Johnson (2008) suggest that as few as one out of five incidents are reported. One possible reason for not reporting incidents and adverse events is the fear for reprisals (Vincent, Stanhope, & Crowley-Murphy, 1999). Another is the lack of tradition and the belief that reporting would not lead to any improvement for the patients (Moumtzoglou, 2010). Another possible explanation suggested by Corvellec (2010) is that what is considered a *risk* depends on what those involved in risk management consider as being of value. Corvellec, who has studied the transport sector, is primarily interested in the values of managers. Healthcare is different in that physicians are schooled to be more or less independent professional actors, responsible for their own actions (Thunborg, 1999; Norbäck & Targama, 2009). Hence, they perform a great deal of self-management.

In the operating room communication failures are pointed out as a major cause of errors (Lingard et al., 2004). The importance of the non-technical skills of surgeons has been pointed out in a review of the literature by Yule et al. (2006), identifying *communication*, *teamwork*, *leadership* and *decision making* as desired skills.

As a means to reduce the number of communication failures and to improve teamwork, a checklist based briefing and debriefing methodology has been

[2] A search for the term "patient safety" in Title/Abstract in PubMed resulted in 9,299 hits (retrieved 2011-05-02).

advocated by researchers and institutions (Lingard et al., 2008; WHO, 2008; Weiser et al., 2010; Haynes et al., 2011; Ahlberg, 2009). The World Health Organization (WHO) has even developed its own checklist and is promoting its use (Weiser et al., 2010; WHO, 2008). An adaptation of the WHO checklist is currently being adopted in Sweden (Patientförsäkring LÖF, Svensk kirurgisk förening, & World Health Organization, 2009; Ahlberg, 2009). The studies of Lingard et al. (2008) and Haynes et al. (2009) show that the checklist methodology actually reduces complications from surgery. Haynes et al. (2011) also suggest that the checklist methodology results in better safety attitudes. One of the main benefits of the checklist methodology is that it facilitates communication (Nilsson, Lindberget, Gupta, & Vegfors, 2010; Ahlberg, 2009). So far, a significant amount of research has been carried out to validate whether the checklist methodology works or not. But little, if anything, has been done to gain an understanding of how a checklist, such as the pre-operative timeout, is used in practice. Consequently, little is known about how the checklist actually is perceived in practice and about what aspects of it contribute to what appears to be its positive effects.

In a study of an operating department, Waring, McDonald & Harrison (2006) showed that not only intra-departmental factors such as adverse events, but also inter-departmental factors such as tight coupling and strong dependencies on other departments can be a threat to patient safety.

1.1.2 The case

The research presented in this thesis has been conducted as part of the OpDesign 2012 project, a joint effort between the Department of Design Sciences at Lund University and an emergency hospital in southern Sweden. The OpDesign 2012 project is funded by the Gorthon Foundation. As the hospital's operating unit facilities, built in the mid-1970s, need to be updated to meet future requirements, the project was initiated to develop and collect knowledge useful when redesigning the facilities as well the organization working in them. The aim is to acquire a good understanding of how to achieve a sustainable working environment for the professionals as well as a foundation for providing safe and effective care to citizens. The prospect of new facilities is viewed as a great opportunity to provide more physical flexibility to the unit and to establish new organizational and social practices and structures that can support or empower the creation of a sustainable working environment as well as safe and effective care.

At present, the operating unit has approximately 280 employees and 11 active operating teams, working in 12 different operating rooms. The unit conducts surgery in a wide range of specialties as well as emergency surgery.

1.1.3 Objectives, aims and research questions

The overall objective of the research presented was to gain an understanding of how the dynamics between professionals, tools and objectives/goals work in an operating unit in order to obtain knowledge useful when designing the operating unit of the future with emphasis on the work environment, effectiveness and patient safety. The focus was on practices in the operating room as this is where the unit ultimately is put to the test and where most of the professionals meet each other. The unit of analysis, however, was not limited strictly to the operating room since what happens on the operating unit level can affect to a high degree how work is conducted during surgery.

Paper I

The study investigated how healthcare professionals involved in surgery orientate themselves in relation their common task and how this orientation can be affected by the social and organizational context of the task. This can in turn shed a light on the potential for improvements.

The research issues were:

- To investigate professional orientation and specialization as factors that influence cooperation between professions in a surgical team.
- To elaborate on how the social and organizational structures of the surgical activity's context, can affect professional task orientation.
- To investigate the value of visualization of authentic existing environments as a tool when reflecting on work.

Paper II

The study explored how operating teams relate to the task of conducting a checklist based pre-operative timeout and to investigate how deviations from the checklist can be explained theoretically in order to identify possible improvements.

The research questions were:

- How does the operating team relate to the task of performing a checklist-based pre-operative timeout?
- How deviations from the checklist, if any, can be explained?
- Are there any changes that would increase the checklist's effectiveness as a means for improving patient safety and the work environment in the operating theatre?

1.2 Theory / Frame of Reference

This section presents a brief theoretical background to provide a better understanding of the philosophical and theoretical considerations on which this thesis is based.

1.2.1 Work environment, effectiveness and patient safety

The OpDesign project is striving to improve the work environment, effectiveness and patient safety of the operating unit of the future. The term *environment,* originally from Latin meaning "in my current place", is defined here as the *surroundings* or *surrounding conditions*. Thus, the *work environment* can be defined as the surrounding conditions at the workplace (Hörte, 2009). *Effectiveness* means to do the right things, in comparison to *efficiency*, which refers to do things right (Nilsson, 2005). In practice, efficiency then means to perform a predefined task to maximize the throughput. Effectiveness, on the other hand, means to make sure that the task performed is really the best way to reach the desired end results in the long term. Both efficiency and effectiveness deal with *productivity*. A common tendency in organizations is to prioritize short-term productivity enhancements in the form of efficiency, over sustainable productivity development in the form of effectiveness. *Patient safety* is a difficult concept to define. The Swedish National Board of Health and Welfare briefly defines it as "protection against care induced damage"(Socialstyrelsen, 2010). In a wider perspective, patient safety would correspond to quality.

The efficiency-thoroughness trade-off (ETTO) principle illustrates that people tend to cope with demands by moving their efforts between efficiency and thoroughness. When there are high demands for efficiency, people tend to be less thorough. This principle should be seen as a trait every human possesses and a strength helping people to make their everyday choices, rather than as a threat to safety (Hollnagel, 2009).

The relationship and interdependence between the work environment and the production system is described in the Goal-Equivalence-Model (GEM) (Akselsson, 1993), where the production system refers to both productivity and product quality. The GEM acknowledges that there is a relationship between work environment and production, and that it is difficult to achieve sustainable success in one of them without also attending to the other. The idea that sustainable work environment initiatives will not be successful if production and quality issues are not addressed is also advocated by the NOVO network, a Scandinavian network community focusing on the work environment in the healthcare sector. The NOVO network illustrates the relationship between the work environment, efficiency and quality as a triangle were all nodes are dependent on each other. Furthermore, the work

environment is seen as an *employee* perspective, quality as a *patient* perspective and efficiency as a *societal* perspective of care (Winkel & Dellve, 2009).

1.2.2 Acknowledging complexity

This section briefly describes the systems perspective or approach to knowledge and in contrast to it, introduces another approach based on complex adaptive systems (Stacey, 2001). These approaches represent two essentially different ways to view knowledge about the world.

In the domains of work science as well as in risk analysis and management, all of which are relevant for this thesis, a systems approach or perspective has gained considerable momentum in recent decades (see, for example, (Senge, 2006; Reason, 1990)). Originating from mathematics and the natural sciences, a systems perspective emphasizes a holistic understanding of a phenomenon rather than a reductionist one (Von Bertalanffy, 1950; Skyttner, 1996).This has implications for the interpretation of causal relations. From a systems perspective it is not a single item that causes an effect but the dynamic interaction between all the entities in the system[3]. A small change in one part of the system can contribute to devastating changes in another. Systems theory distinguishes between open and isolated systems. Where the former is capable of interchange with its surroundings (i.e. other systems), the latter is totally independent and unaffected by its surroundings. A basic assumption of systems theory is that the world is ordered in some way according to some basic law. According to Skyttner, the search for this law is considered the main task for general systems theory (Skyttner, 1996).

Ralph Stacey discusses three types of causality: *rationalist teleology*, *formative teleology* and *transformative teleology* (Stacey, 2001). Rationalist teleology states that the cause of human action is motivation expressed in autonomously chosen goals selected through rational reasoning. Formative teleology is a "systemic theory of causality in which a system unfolds patterns of behavior that are already enfolded in its structure in movement to a mature state that can be known in advance" (Stacey, 2001, p. 27), and the basic law mentioned above should make this possible (Skyttner, 1996). Transformative teleology, on the other hand, states that "the future is understood to be under perpetual construction" (Stacey, 2001, p. 5).

Based on transformative teleology and complex adaptive systems, Stacey built the *complex responsive processes* approach to knowledge creation, which is a connectionist approach. Stating that knowledge does not, as many scholars argue, reside in the individual, but in the process of interaction between agents and the self-referential

[3] This has consequences for the question of responsibility when no single item or actor can be held entirely responsible but, instead, the relations between them.

process of the agent interacting with itself. The most important differences between a complex adaptive systems perspective and the systems approach is that rules in the complex adaptive systems perspective are local, residing in the agent, and that variation in the rules occurs due to random mutation and replication. When interacting with each other, it is the local rules rather than a universal system rule that decides interaction and organization among agents. The rules are constituted so that the agents adapt to each other. The large number of rules and the random mutations cause the system to behave in a nonlinear manner that results in variation. It is this variation that causes knowledge to occur (Stacey, 2001). It is the connections and local rules that decide how the system will evolve: A small number of connections means fewer rules interfering with each other, resulting in more stable behavior. A larger number of connections, however, will lead to more chaotic behavior resulting in rapid and unpredictable development. This development could be constructive or destructive. According to Stacey, knowledge creation is at its best at the edge of chaos in a state where there are enough connections to allow for development but not too many that would cause all structure to disappear. This resembles a state where the behavior is both predictable and unpredictable at the same time (Stacey, 2001).

Richardson, Cilliers, & Lissack (2001) state: 1) that all parts of a complex system are connected, directly or indirectly to everything else and, 2) that "Complex systems are incompressible, that is, it is impossible to have an account of a complex system that is less complex than the system itself without losing some of its aspects" (Richardson et al., 2001, p. 8). The first statement makes it difficult to define boundaries, for instance, when creating a model. There is always more outside the boundaries that is connected to something inside them. As a consequence, any model must be regarded as an approximation and the unexpected must be expected to occur resulting in unforeseen change (Richardson, Cilliers, & Lissack, 2001). This change can, for example, appear as *self organization* among actors, *emergence* of new behaviors or *adaption* of the actor behavior, all of which are behaviors that are said to be characteristic of *complex systems* (Nilsson, 2003).

1.2.3 Learning at work

In this section, theoretical perspectives on learning, considered useful in the work with this thesis are presented. They are not strictly compatible with the complex responsive processes perspective presented in 1.2.2, as they belong to what Stacey calls "mainstream thinking" and place knowledge in the individual rather than in relations (Stacey, 2001). However, in this thesis they serve another purpose: being more action orientated than the complex responsive processes perspective, they are better suited for analyzing work or action. While the complex responsive processes

perspective is better as an outlook on what it is possible to know and knowledge in general.

Argyris and Schön (1996) distinguish between single and double loop learning on the individual level. Single loop learning refers to "instrumental learning that changes strategies of action or assumptions underlying strategies in ways that leave the values of a theory of action unchanged" (Argyris and Schön, 1996, p. 20). In reality, this means the motives behind an action are left unquestioned. Double loop learning refers to "learning that results in a change in the values of theory-in-use, as well as in its strategies and assumptions" (Argyris and Schön, 1996, p. 21). This means that the motives or governing variables behind an action strategy are questioned and as a result, changed. In double loop learning, reflection plays a central role (Schön, 1983) as it requires reflection upon the theory-in-use (see **Figure 1**). This corresponds well with Alvesson and Sköldberg's (2008) definition of reflection as "interpretation of interpretation" (Alvesson and Sköldberg, 2008, p. 20). They state that reflection can be seen as critical examination of one's own interpretations.

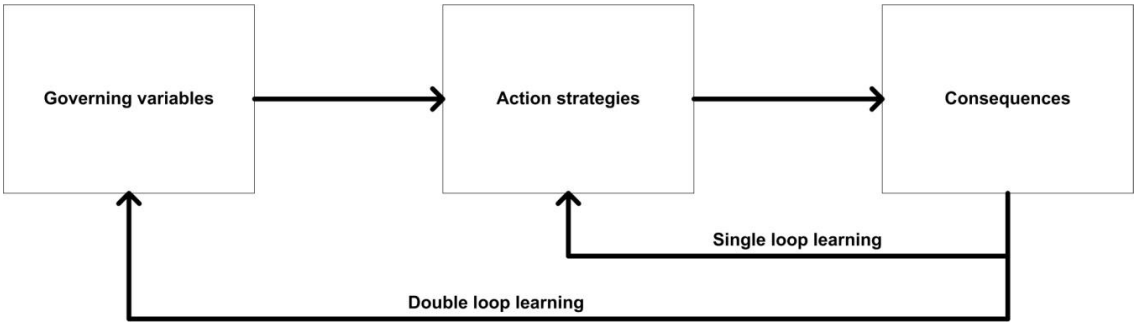

Figure 1. Single and double loop learning. Illustrated freely after Argyris, Putnam & Smith (1985, p. 84).

When discussing theories of action, Argyris and Schön (1996) draw a line between the espoused theory and the theory in use. The espoused theory refers to the explicit official version, constructed to justify an activity, whereas, the theory-in-use refers to the implicit unofficial version, the one that is used in practice. It is the theory-in-use that is used as a tool for interpretation in practice. When feeling threatened, people tend to conform to a particular type of theory-in-use that Argyris and Schön call Model-I. This means that they approach a mindset that inhibits double loop learning by avoidance and defense against inquiry into the ruling values of the theory-in-use. In contrast, Model-II theory-in-use encourages reflection and inquiry into those ruling values. On an organizational level, Model-I and II theory-in-use correspond to O-I and O-II learning systems. An organization with an O-I learning system is largely dominated by Model-I theories-in-use and hence unlikely to succeed with double loop learning. An organization with an O-II learning system is

dominated by Model-II theories-in-use and has the capacity to perform double loop learning (Argyris & Schön, 1996).

Ellström (2010) describes the relation between the logic of development and the logic of production in the innovation process. While the logic of development is based on improvisation, developmental learning and transformation, the logic of production is based on standardization, implementation and adaptive learning. While the logic of development applies an irrational perspective on the world acknowledging uncertainty, the logic of production applies a strictly rational perspective. According to Ellström, the two logics are complementary (Ellström, 1992).

This is similar to Argyris and Schön's (1996) view of learning. The adaptive learning under the logic of production can be compared to single loop learning, consisting of tweaks and improvements without questioning the ruling conditions, whereas, the developmental learning under the logic of development can be compared to double loop learning. There are also similarities between efficiency, single loop learning and the logic of production, on one hand, and effectiveness, double loop learning and the logic of development, on the other (Argyris & Schön, 1996; Nilsson, 2003; Ellström, 2010).

Learning from experience: experiential learning

David Kolb (1984) illustrates experiential learning as a cyclic process (see **Figure 2**). The cycle consists of four steps or approaches to what is being learned: concrete experience, reflective observation, abstract conceptualization and active experimentation. According to Kolb, learning requires both a grasp, a representation of what is being learned, and a transformation, the creation of new knowledge. In Kolb's model, reflective observation and active experimentation are two directly opposite types of transformation, and concrete experience and abstract conceptualization, are two directly opposite types of grasping. According to Kolb, knowledge created when going from concrete experience to reflective observation is divergent knowledge, which can be described as an expansive process associated with creativity. The learner's perspective is widened. Convergent knowledge is created when going from abstract conceptualization to active experimentation. Abstract concepts or theories are being tested by active experimentation, much in the vein of hypothesis testing. While divergent knowledge creation is concerned with finding new approaches to a problem by widening one's perspective, convergent knowledge creation is concerned with narrowing down or converging the options until only one correct answer exists. According to Olsson et al. (2009), an organization needs to be capable of letting its inhabitants be both convergent and divergent in order to be innovative, capable of both creating and questioning structure at the same time.

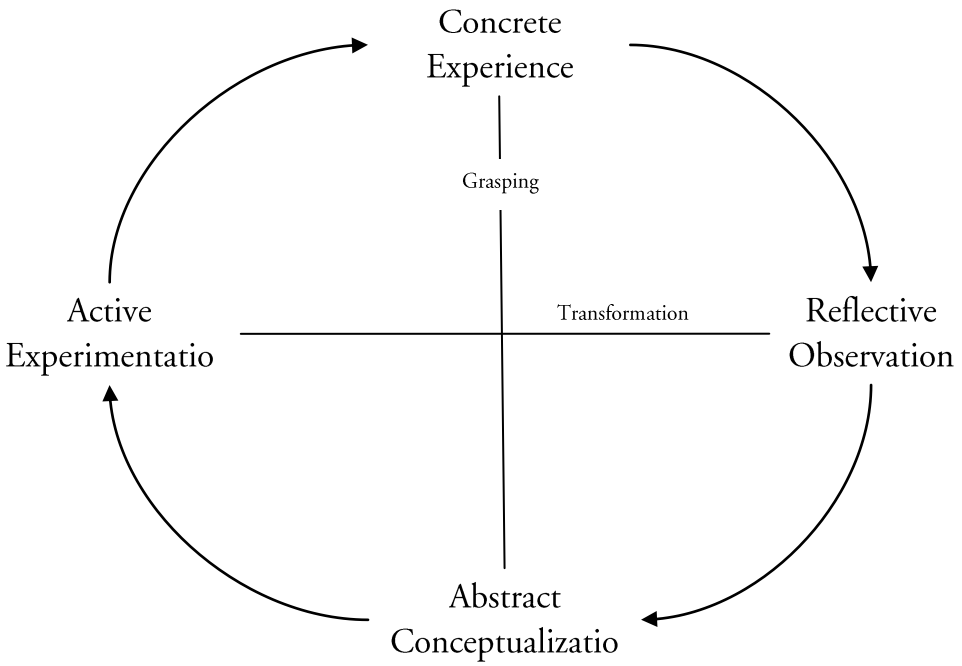

Figure 2. The experiential learning cycle after Kolb (1984).

Kolb's (1984) model contains similarities with the central parts of Argyris and Schön's theories in the form of the role of reflection. Argyris and Schön's (1996) double loop concept requires reflection, which is also a central component when acquiring divergent knowledge in Kolb's model. In a similar fashion, Kolb's (1984) convergent knowledge creation, which is a process by which concepts and theories are being tested, has similarities with Argyris and Schön's (1996) single loop learning. Concepts and or, as Argyris and Schön would call it, theories-in-use are not being questioned in a reflective manner, but rather taken for being true and then tested.

Action learning is similar to experiential learning in that it emphasizes reflection on how things are carried out. But unlike experiential learning, this has to be followed by a new type of action. The learner cannot be passive. This action then should be followed by another round of reflection for action learning to occur. Closely associated with action learning is the methodology of action research that is built on the principles of action learning. Action research is based on close democratic interaction between researchers and the organization studied (Olsson, Wadell, Odenrick, & Norell Bergendahl, 2010). The aim is to create knowledge of academic value while at the same time developing the practice.

The role of relations in the organization: relatonics and trust

In this section, the role of relations in the organization will be described by introducing the concepts of *relatonics* and *trust* (Newell & Swan, 2000; Döös, 2007; Bäckström & Döös, 2008; Bergh, Thorgren, & Wincent, 2009).

Döös introduced the concept of *relatonics* referring to competence-bearing relations in the organization, relations that hold much of the organization's learning and action potential (Döös, 2007; Bäckström & Döös, 2008). Relatonics is defined as "the *composite existence of the interactive processes between human beings that bear the competence of the workplace*". Contacts, connections, knowledge about who is doing what and about who knows what, makes up the relatonics of the workplace. Relatonics always exists in some form but it can be more or less developed, and its development can be more or less supported by the organization. Döös (2007) stresses the importance of the distinction between *arranging learning occasions* and *organizing for learning*. The former refers to reserving time and arranging activities outside the normal work setting with the explicit purpose of learning, whereas *organizing for learning* refers to organizing tasks in such a way that they encourage learning in the daily work situation. This can, for example, be achieved by organizing work processes that afford communication and offer opportunities to see each other in action. Furthermore, work tasks should be designed so that they seem meaningful to the individual and encourage reflection upon the task.

While relatonics is concerned with competence-bearing relations between parts, there are also aspects of *trust* or confidence in relations. While relatonics is concerned with the functional aspects of the relation, trust is about the basis and perhaps the strength of the actual relation. According to Newell and Swan, trust is defined in various ways in the literature but two issues are central: 1) "that trust is about dealing with risk and uncertainty", and 2) "that trust is about accepting vulnerability" (Newell and Swan, 2000, p. 1293). Möllering (2006) defines trust as "an ongoing process of building on reason, routine and reflexivity, suspending irreducible social vulnerability and uncertainty *as if* they were favourably resolved, and maintaining thereby a state of favourable expectation towards the actions and intentions of more or less specific others" (Möllering, 2006, p. 111). In this way, trust via suspension, reduces the complexity of an individual's interpretation of reality. Möllering's definition is also compatible with Newell and Swan's general definition of trust.

Newell and Swan (2000) introduce three types of trust: *companion, competence* and *commitment trust*. Companion trust has a moral dimension in that the parties involved expect honesty and a genuine will to do their respective parts. It is based on friendship and a belief in goodwill between parties. Competence trust is based on

the perception of the trusted parties' competence. This can be established through concrete experience or through contextual cues such as reputation or belonging to a certain group. An example of the latter would be that the trusted party holds a license to practice a craft such as medicine. While companion trust and competence trust can be said to some extent to be based on a belief in the individual, commitment trust is based on formal agreements between parties. Delivery and performance are guaranteed through contractual obligations. In the organization this can be in the form of formal work descriptions regulating the division of labor (Newell & Swan, 2000).

Learning and reflection from visualizations

Visualization has been put to practical use widely in the areas of architecture and urban planning in the form of physical models or virtual 3D models. Research on visualization usage has been conducted in a wide range of areas, but predominately focusing on the evaluation of non-existing environments. It has been used in research on design for physical and cognitive disabilities, workplace design, city planning and participatory landscape planning (Eriksson & Johansson, 1996; Sundin & Medbo, 2003; Westerdahl et al., 2006; Sunesson et al., 2008; Wallergård, Eriksson, & Johansson, 2008). In much of the visualization literature, the spotlight has been put on the virtual environment's usefulness as a tool for communication or reflection on tacit knowledge. While this is a plausible assumption, little has been done to make the connection theoretically explicit.

Nonaka and Takeuchi (1995) investigated how personal or tacit knowledge can be made explicit or shareable by the use of metaphors, analogies and models. In their terminology, the visualization or virtual environment can be seen as a metaphor describing the real world, as an analogy that can be compared to one's impression of the real world. Or, if it is accurate enough, as a model that one can discuss.

1.2.4 Activity theory

When investigating the relations between different groups of actors and their work, it is important to have an analytic framework capable of expressing similarities and differences in orientation towards the work activity and towards each other. For such a framework to be useful, it must acknowledge the psychological and cultural aspects of the different groups' work together. A theoretical framework that accomplishes this is activity theory.

Originally developed by A. N. Leontiev, activity theory as described by Kuutti (1996) is:

> *". . . a philosophical and cross-disciplinary framework for studying different forms of human practices as development processes, with both individual and social levels interlinked at the same time."*

Characteristic for activity theory is that it expands the unit of analysis beyond the human action being studied, to include enough of the action's context to make it meaningful. This unit, the action and its meaning-creating context, is called the *activity* (Kuutti, 1996). The direction of the activity is determined by a *motive*, which both motivates the existence of the activity and drives it forward, always evolving. Because of this, the activity should never be regarded as a static entity or a machine, but as a dynamically evolving development process. The activity does not take place in a closed system, and the meaning-creating context varies as the process goes on. Because of this, it is always important to take the cultural and historical context of the activity being studied into consideration[4].

In the socio-cultural tradition in psychology that activity theory descends from, a central idea is that cultural *tools* or artifacts mediate the experience of reality. In practice, this means that a person never is in direct, un-interpreted contact with the surrounding world. The world is always experienced through some kind of tool (Säljö, 2000). A tool can be both physical and intellectual. The latter can, for instance, be a theory or prejudice about how things are. In this sense, all experiences or observations are theory laden from the perspective of activity theory.

The basic activity suggested by Leontiev consists of two components: the *subject* and the *object*. Mediating artifacts, referred to as *tools,* bind the components together. The subject is defined as an actor or group engaged in an activity. The motive directs the activity of the subject towards an *object*. It is the subject that is motivated holding the motive. The object can be a physical item, inanimate or living, or something entirely psychologically represented, for instance, as a theory or an opinion. The activity *transforms* the object into an *outcome* (see **Figure 3**). Every action performed by the subject upon the object is mediated by tools. The tools provide the subject with the potential to transform the object, as well as the ability to experience it (Kuutti, 1996).

[4] The relationship with the context is rather pragmatic. What helps to make sense of and give meaning to the activity should always be part of the unit of analysis. The rest does not really matter and hence is irrelevant. Of course, this is really a matter of how closely you look. If you look closely enough, everything probably matters.

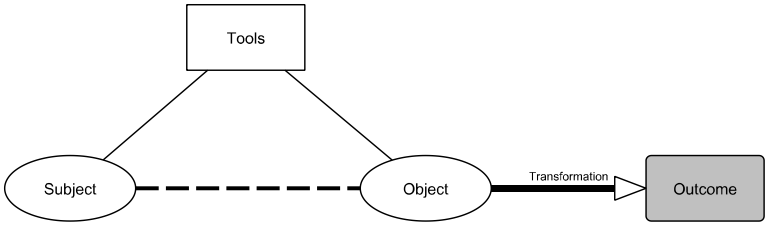

Figure 3. Illustrates the mediated relationship between subject and object in the individual activity (Kuutti, 1996, p. 28)

Leontiev's activity theory is primarily concerned with activities involving only one actor or subject. Engeström (1987) expands Leontiev's activity theory and introduces a framework for the *activity system* of a collective (see **Figure 4**). Engeström adds the component *community*, those actors that share the same object. Engeström also adds the mediator's *rules* and *division of labor*. While tools refer to the physical and psychological aspects of interaction with the surroundings, rules and division of labor deal with the social aspects. Rules are defined as implicit and explicit norms, conventions and social relations within the community, while the division of labor refers to the work organization of the community (Kuutti, 1996). Within the community, the division of labor creates different points of views for different community members (Engeström, 2001).

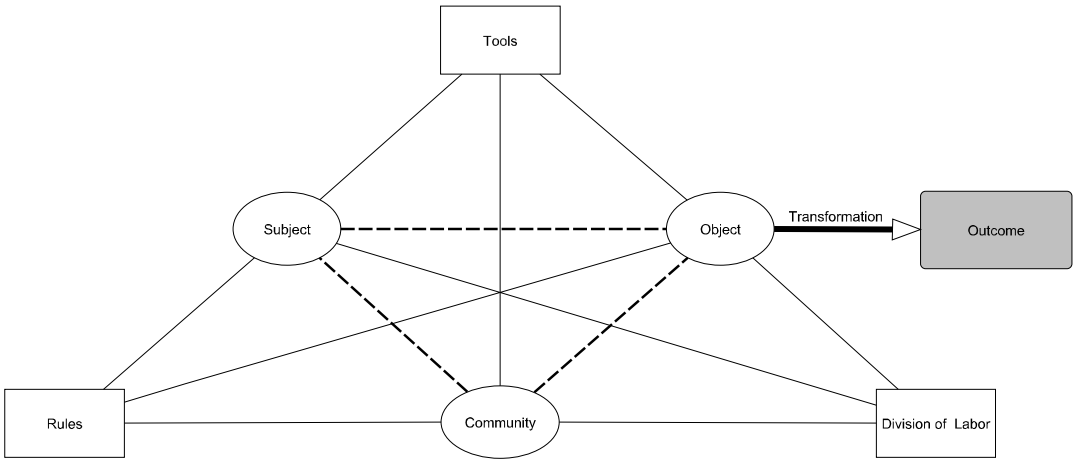

Figure 4. Illustrates the structure of the collective activity system, after Engeström (1987, p. 78), with the mediated relationships between the components illustrated by dotted lines and the mediating relationships by solid lines.

According to Kuutti (1996), the activity system should be seen as a systemic whole which means that every component of the activity system interacts with every other component via all the mediators concurrently. However depending on the research question, certain connections could be of greater interest than others. When studying the interaction between a subject and a computer user interface, the

subject-tool-object relation may be the most interesting connection. While when studying the approach taken by different members of a community when performing an activity upon a common object, the rules and division of labor-mediated actions may be of the greatest interest.

Activity systems are not closed systems; they should not be regarded as isolated units, but as situated in a larger context of interdependent activity systems affecting each other. As previously mentioned, the meaning-creating context of an activity is not cast in stone but evolves. For example, the activity system of a subject can be dependent on a second activity system in which members of the first activity system community also participate. When the community members are affected as by development in the second activity system, the meaning-creating context of the first activity system can also be affected.

Performing analysis with activity theory

In activity theory, the term *contradiction* is used to describe a tension or potential for transformation in the activity system. Hence, when contradictions can be identified between different components in the activity system, they should be seen as potentials for improvement, rather than obstacles (Engeström, 2001). In practice, however, unresolved contradictions are often manifested as disturbances or breakdowns in the activity. By investigating contradictions, it is possible to gain an understanding of the dynamics of an activity system and to find improvement potentials. According to Engeström (1987), contradictions can occur on different levels in the activity system, for instance between components and mediators in the activity system or even between activity systems.

2 Methodology

This section presents the overall research process and approach applied. Then the various methods used for data collection and analysis in the papers are introduced. The focus is on putting the methodology in a larger perspective. The reader is encouraged to read the papers for detailed descriptions of the methods used in the studies.

2.1 The research process

The work in the OpDesign 2012 project that this thesis is based on started in the autumn of 2008. During the first half of 2009, interviews were conducted and the results were presented at conferences, in a report and after further analysis, in Paper I. From December 2009 to November 2010, surgical procedures were video recorded and a small part of each recording ended up as data for Paper II. To become acclimatized to the very special place and practice that surgery is, and to gain basic domain knowledge, the main data collector of the project spent three weeks at the operating theatre studied at the beginning of the OpDesign 2012 project[5]. The overall procedure used in the research is illustrated in **Figure 5**.

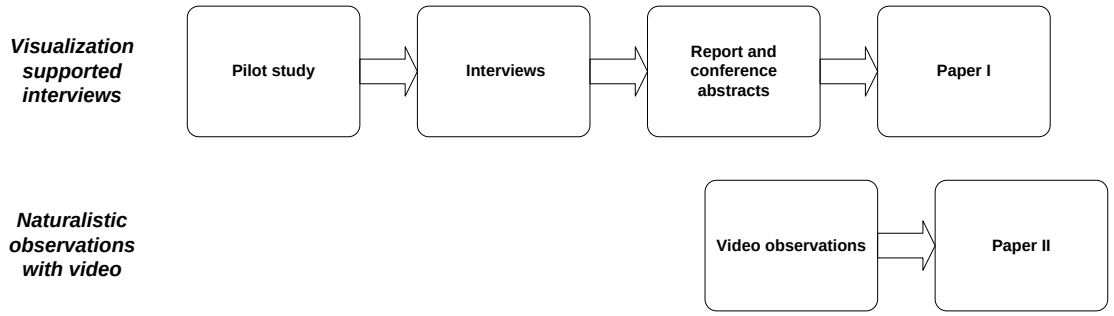

Figure 5. The overall procedure used for data collection and reporting in the thesis research.

The research approach was action oriented as well as explorative. The focus was on how participants do their work and how they really perceive their work activity; not on various espoused theories regarding how the work activity is carried out[6] (Argyris & Schön, 1996). The research process was also influenced by action research in its ambition to continuously provide feedback on the results and data to the practitioners for reflection (Olsson et al., 2010). This was carried out in two ways: 1) two of the co-authors of the included papers worked in the practice and the results were tested on them, and 2) in the case of the first paper, the practicing community was provided with presentations and a report (Rydenfält et al., 2010). An overview of the process used in the papers can be found in **Figure 6**.

[5] In conducting a project like OpDesign 2012, it is crucial to be able to handle the presence of blood and use of various tools on the human body.
[6] The differences between espoused theories and actual practice have, however, been of interest.

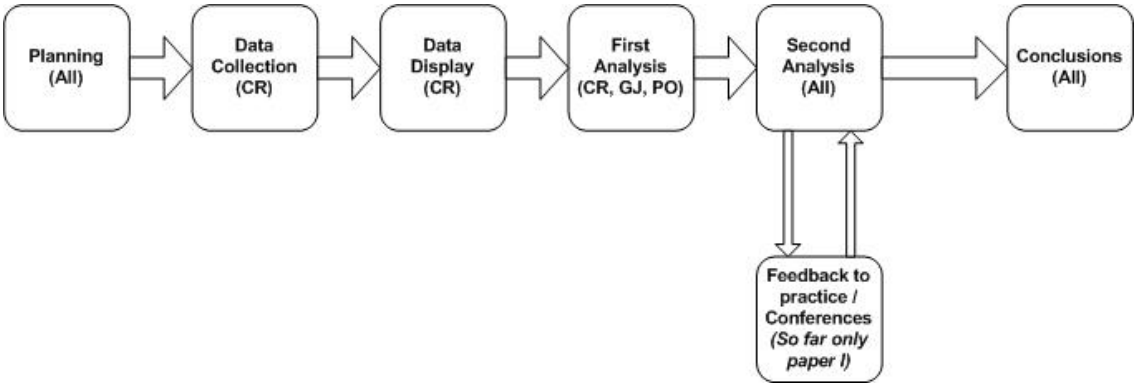

Figure 6. Research process applied in the papers. Abbreviations: All = Christofer Rydenfält, Gerd Johansson, Per Anders Larsson, Kristina Åkerman, Per Odenrick, CR = Christofer Rydenfält, GJ = Gerd Johansson and PO = Per Odenrick.

Both interviews and video recordings were conducted by the same person, who also prepared the data display, that is, transcribed the interviews and provided the initial coding for the video analysis. This was to make sure that the data was collected and prepared in a consistent manner in order to ensure data reliability.

While not being purposefully designed as such, the research presented in this thesis shares some elements with the case study methodology. Yin (1994) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 1994, p. 13). Furthermore according to Yin (1994) case studies are best suited for studies concerned with "how" and "why" a phenomenon appears. Yin (1994) also states that in order to conduct a case study, some theory development prior to data collection is essential.

2.1.1 Where does it fit?

Put in a bigger perspective, the research presented makes up the first half of the author's Ph.D. project within the frame of OpDesign 2012. This licentiate thesis mainly investigates the practitioners' views on how things are and have been by, in effect, looking at the *past* through their eyes, and on how things really are observed to be by looking at the *present* through observations. But the aim of the project is also to look forward, to investigate and contribute to shaping the *future* in collaboration with the practitioners. To achieve this, an action research methodology has been chosen. As the video observation material is huge, containing much more than what has been analyzed and used in the research presented here, further investigations are planned involving such aspect as the ergonomics of work in operating theatres and communication. This bigger perspective on the research process is illustrated in **Figure** 7.

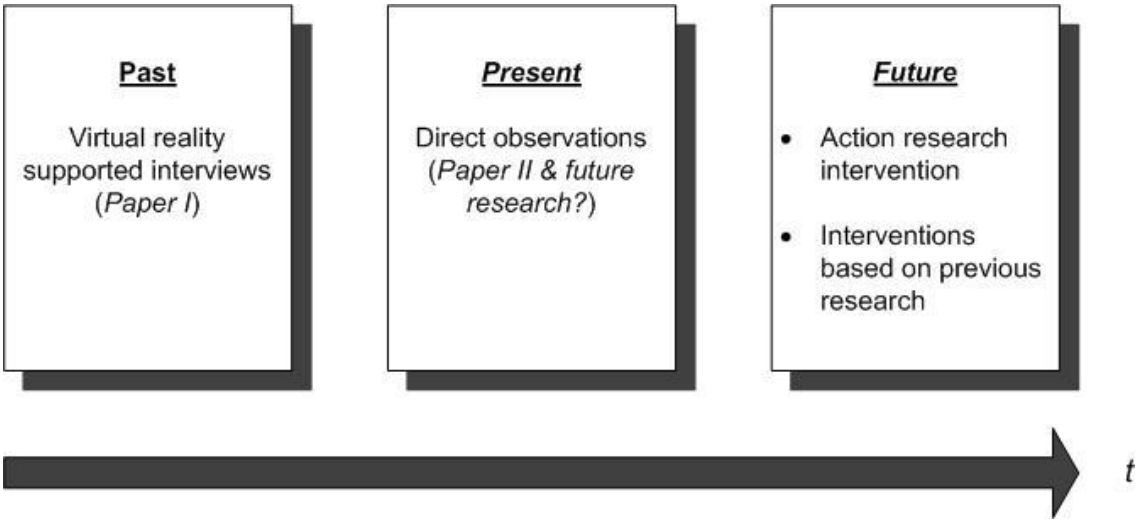

Figure 7. The overall research process used in the OpDesign project.

2.2 The methodologies applied

In the following subsections, the data collection methodologies of the interviews and observation studies applied are briefly described.

2.2.1 Interviews

In the data collection for this study (Paper I) a semi-structured interview with open-ended questions was used (Kvale & Brinkmann, 2009). People from all the five different professions working in the operating theatre were included to capture as much variation in opinions as possible. Kvale and Brinkmann (ibid.) state that study domain knowledge is important to be able to conduct a successful interview. The interviewer must to some degree share the signs and codes (Fiske, 1990) used by the interviewee. Otherwise, the meaning created by the interviewer might not correspond at all to the meaning the interviewee intended to communicate. In this sense, context knowledge is a precondition for a successful study.

In order to assure that the interviewer had the basic domain knowledge required to conduct the interviews, he spent three weeks accompanying the nurses in their routines at the operating department. A pilot study was also conducted, consisting of interviews with four people, after which the questions were revised before the actual interviews were conducted.

2.2.2 Observation studies

According to Patton (2002) benefits from direct observation are that they enable the researcher to better understand the context of study which is essential to gain a holistic perspective. Furthermore, observation is less burdened by previous conceptualization and can be said to be less theory dependent then other methods

where the researcher's interests and hypothesis to a higher degree affects the data collection (Patton, 2002). Another advantages with observations is that it is possible to notice things that might escape the awareness of the participants, or things that the participants are uncomfortable talking about as well to avoid "the selective perceptions of others" (Patton, 2002, p. 264). All of this is hard to achieve in an interview study.

Reactivity refers to research participants changing their behavior because they know that they are being observed. In this research, the goal was to carry out an as naturalistic observation as possible without intervening with the practice (Shaughnessy, Zechmeister, & Zechmeister, 2003). Observations were carried out by videotaping and filling out an observational protocol during a set of complete surgical procedures[7]. During observation, the observer strove to interfere as little as possible in order to stay objective and to avoid bias. Since the observer was present in the operating theatre, used a video camera and could not completely seal himself off socially from the people studied[8], it could not be expected that the observational practice went unnoticed. The role of the observer was rather somewhere between that of the *observer-as-participant* or the peripheral-member-researcher described in Angrosino & Mays de Pérez (2000) and the ideal *complete observer* who has no interaction whatsoever with the context studied. Thus, some reactivity could be expected from the participants (Shaughnessy et al., 2003).

Observation can be carried out on several different levels of abstraction and interpretation. The observations conducted can be divided into two stages: *descriptive observations* carried out in the field represented by a general observational protocol, and *focused observations* carried out when watching the video data (Angrosino & Mays de Pérez, 2000). In the former, the observer took a naïve approach trying to capture as much as possible without interpreting the phenomenon too much. In the latter, the observations focused on the timeout procedure studied with an observation protocol developed to test compliance with the WHO safety checklist that provided instructions for the procedure. The data was then collected from the video recordings using the Observer XT 10™ software developed by Noldus Information Technology. The focused observations were used as data for the study in Paper II.

In observational studies, there is always a risk of *observer bias*, that the observers' expectations and interests affect the results. This can be the case if the study is dependent on the observer's attention to decide what data to collect[9]. According to

[7] Each with a duration of approx. 2 to 5 hours
[8] This would probably have been considered extremely rude.
[9] When taking field notes there is an obvious risk for this.

Shaughnessy et al. (2003), observation bias can be reduced by using automatic recording. When collecting data, the camera was always on during the entire surgical procedure; the observer did not decide when and what to record. However, the placement of the camera could vary from operation to operation for practical reasons.

2.2.3 Considerations regarding analysis

An explorative approach was used in analyzing the interviews. The interviews were transcribed and then cut up into meaningful fragments. The fragments were then analyzed and clustered into themes, without taking the questions in the interview guide into consideration.

Activity theory (described in section 1.2.4) was chosen for further analysis of the strongest themes (Engeström, 1987; Kuutti, 1996; Engeström, 2001). The prime reasons for using activity theory was that it acknowledges the dynamic aspects of group collaboration as well as the perspectives provided by different individual's/profession's motives and interests. It also emphasizes the process of continuous development and the uncertainty associated with highly complex practices. In this sense it allows a transformative teleology (Stacey, 2001). Other strengths are that activity theory is flexible in that the unit of analysis can include everything that is required to make sense of the activity and that it is scalable from a single subject interacting with the surroundings to large-scale activity systems. This makes it well suited for explorative studies. Activity theory has previously been used in a healthcare context by Engeström (2001). It has also been advocated by Varpio et al. (2008) as a possible framework for investigating the connections between interprofessional communication and medical errors.

When analyzing the video data, the focus was more descriptive than explorative. The purpose was to describe how the procedure studied was carried out empirically. Thus the study was based on the formal instructions for the procedure studied (WHO, 2008; Patientförsäkring LÖF et al., 2009). However, in order to acknowledge the complexity of the situation, qualitative descriptions were also assembled from the data. Because of this, the study also had room for phenomenon other than those that could be foreseen and were postulated in the formal instructions.

3 Summary of papers

In this section, the papers included are summarized and the main results highlighted.

3.1 Paper I: Social structures in the operating theater: How contradicting rationalities and trust affect work

In recent years, team communication and cooperation in the operating theatre has been a hot topic in the research literature. Much of the focus has been on identifying problems and solutions rather than on trying to find out how these problems arise in context in the first place[10]. However, it is clear that operating teams are not always as cohesive as could be expected and that communication failures frequently occur.

The aim of this paper was to fill in the gaps on these issues, to explore how cooperation and communication failures occur, as well as to provide a theoretical explanation and suggest paths for improvement. To better understand how cooperation and communication failures occur in surgery, it is important to investigate how professional orientation and organizational structures affect professionals' reasoning and hence their view on what is rational and good practice. To gain insight into these questions, 15 participants recruited from the practice were interviewed, three from each of the five professions working in the operating theatre during surgery (anesthetists, anesthetist nurses, assistant nurses, surgeons, theatre nurses). During the interview, a virtual model of one of the operating units' actual operating theatres was used as a facilitator for reflection (See **Figure 8**). The questions ranged from free reflection on and description of their work tasks to specific questions regarding communication, physical obstacles, routines, challenges at work, disturbances, adverse events, patient safety and the work environment. The results were analyzed using activity theory as an analytic tool and further discussed in relation to the concept of trust.

[10] Consequently, most of the proposed fixes have been retrospective ones such as checklists to avoid known errors, or communication training to avoid communication failure.

Figure 8. Left: The virtual model used during the interview. Right: A screen capture from the actual setup used during the interviews with the virtual model being back-projected on a screen.

The results indicated that there are differences in activity orientation between different professions working in the operating theatre resulting in contradicting rationalities. Consequently, there is a tendency at times to work in parallel instead of together. It is also something that could induce unnecessary tension between professionals working in the operating theatre. Part of this can be explained by the lack of mediating rules in the form of shared social relations, norms and conventions, supporting communication and interaction. There appears to be a threshold prohibiting communication and leading to unnecessary disturbances and misunderstandings. The results also suggested that the participants based their cooperation mainly on commitment and competence trust. To improve communication and cooperation in the operating theatre, the establishment of social relations, norms and conventions across professional borders were identified. Attached to this is the potential of companion trust, which is regarded as a stronger and more resilient type of trust. To achieve this, the organization and the facilities of the activity play a crucial role, providing forums for the establishment of interprofessional social relations as well as trust.

The results also suggested that the combination of a virtual model representing a real work setting and interviews was fruitful.

3.2 Paper II: Compliance with the WHO pre-operative surgical safety checklist: Analysis of deviations and possible improvements

Checklists have gained considerable attention as a means to improve patient safety and communication in the operating room. Previous research suggests that the implementation of the WHO surgical safety checklist has reduced the number of complications from surgery as well as improved the personnel's safety attitudes. The

WHO checklist has been implemented widely around the world. However, little has been done to investigate how the checklist is used in practice. This is crucial in order to understand how the checklist really works and to identify improvements.

The aim of this paper was to investigate how the WHO checklist is used in practice in order to recognize and explain deviations from the checklist and to identify possible improvements. To achieve knowledge about these issues, 24 surgical procedures of four different types were video recorded. The surgical procedures were thyroidectomy, hysterectomy, cholecystectomy and osteo-synthesis of hip fractures. These procedures were chosen because they are commonly reoccurring and can be considered routine. They also provided a reasonable diversity to the data material, representing several medical specialties. The pre-operative surgical safety checklist timeout portion was then analyzed using the Noldus Observer 10™ software. The analysis was based on an observation protocol developed from the Swedish version of the WHO surgical safety checklist. However, some aspects were added such as to investigate what else went on in the operating room during the timeout.

The results showed that compliance varied between the checklist items. The checklist was not followed in its entirety. The best compliance was obtained for items that were considered to be obviously connected to patient safety and focused on information transfer between professions, while the parts of the checklist intended to strengthen the communication and team cohesiveness were often neglected.

Part of the deviations can be explained by the fact that some of the items simply do not make sense in all settings. For instance, if the operating type is "vaginal hysterectomy" there is no need for verifying the place of incision. It is plausible that the parts of the checklist gaining the most attention are those that make the most sense to the personnel. If they cannot see how something increases patient safety, it is likely that they ignore it due to time pressure. The focus on information transfer between personnel and the neglecting of checklist items intended to improve communication, indicate that the checklist was understood as a tool that primarily should improve patient safety by ensuring information transfer about the patient. This suggests that there is a potential for improvement that can be reached by making the links between communication and patient safety more explicitly visible to the operating personnel.

The results also indicated that surgeons and anesthetist nurses dominated much of the timeout, with the others taking a minor role. In order to make the timeout more equal and thus make sure that everyone feels included and free to speak their mind during the timeout as well as the following surgical procedure, it is suggested that a

checklist item focused on the theatre nurse and the assistant nurse work should be added. It is believed that this would make the checklist more balanced.

4 Discussion

The purpose of this thesis was to gain an understanding of how the dynamics between professionals, tools and objectives/goals work in an operating unit in order to acquire knowledge useful when designing the operating unit of the future. The task has been approached from an integrated work environment, effectiveness and patient safety perspective. This is a huge undertaking that by no means can be considered completed in a single thesis, even though the papers included shed some new light on the issue.

The theoretical foundations for this thesis are discussed in the next section followed by a discussion of the results presented in the appended papers, exploring them in a wider context. The applied methodology and future research are then discussed.

4.1 Theory discussion

4.1.1 The relationship between work environment, effectiveness and patient safety

To be able to develop knowledge about the operating unit as a workplace from a work environment, effectiveness and patient safety perspective, it is necessary to investigate how these three concepts are defined and related to each other.

The National Board of Health and Welfare's definition of patient safety as protection against damage is problematic. This indicates that rather than learning how to handle mistakes altogether, barriers should be built to protect against those errors that inevitably will occur. This reflects the systemic approach to safety (Reason, 1990), which relies on the assumption that it is possible to build a system in such a way that errors can be avoided. In practice, however, this is hard, as the work setting has to be approximated by some kind of system model. Since reality does not freely lend itself to such a model, the unexpected still will occur even if the safety barriers of the system appear to be "perfect" (Richardson et al., 2001).

The ETTO principle, Goal-Equivalence-Model and the NOVO triangle indicate that there is some kind of interdependence between the work environment, effectiveness and patient safety (Akselsson, 1993; Hollnagel, 2009; Winkel & Dellve, 2009). How these relationships are constituted is, however, a difficult question. Efficiency in the ETTO principle and the NOVO triangle is only concerned with producing things rather than producing the right things, which would refer to effectiveness. Effectiveness is concerned with doing the right things to achieve the desired effect. The desired effect in surgery must be to make the patients better and that cannot be divided into a quality node and an efficiency node. Both are needed in order to make the activity meaningful. Good quality in the first place

would eliminate the extra work needed due to care induced damages or mistakes. Hence, effectiveness has aspects of quality as well as production. Effectiveness also has aspects of learning in it, as it requires reflection upon what the right things really are (Kolb, 1984; Argyris & Schön, 1996).

The work environment is defined as the surrounding conditions of work (Hörte, 2009). It means that everything that affects the worker while working can be considered as the work environment, both physically and psychosocially. The work surroundings do then also affect quality and efficiency as indicated in the Goal-Equivalence-Model and NOVO triangle (Akselsson, 1993; Winkel & Dellve, 2009). In this sense, the work environment is not only, as is often presumed, something that constitutes the preconditions for the employees' wellbeing and safety at work, but also the context or preconditions for the work itself. This aspect of the work environment contains the tools and affordances that make work possible and enable and constrain it. As a result, work environment, effectiveness and patient safety cannot really be regarded as three equal concepts on the same level. Effectiveness and patient safety together with the wellbeing and safety aspects of the work environment can be considered as goals. Much like the way work environment, quality and efficiency are portrayed in the NOVO triangle as aspects advocated by different groups. But the aspect of the work environment referring to the preconditions for work is clearly on another level preceding the others.

4.2 Results discussion

4.2.1 The overall approach in the papers

Contradicting rationalities between different professions indicates the lack of a common holistic view of work in the operating theatre. Stronger social ties between people from different professions should help them to share their perceptions of the work context with each other, providing a better foundation for consideration between professions. It is also something that could help improve the relatonics of the workplace (Döös, 2007; Bäckström & Döös, 2008). Improved relatonics can make the organization more resilient as it makes it less dependent on the official organizational structure and line of command in order to take action. If the official structure is damaged or unable to attend to issues, a workplace with good relatonics should be able to find ways of its own – to self organize – while a workplace with less well developed relatonics might be paralyzed or fall apart. ***(Paper I)***

The results show that parts of the timeout procedure are neglected in practice. The proposed explanation is that the professionals do not see any use in following the procedure because parts of it do not make sense to them in its current form in their context. Hence, the professionals are not motivated enough to follow it. It does not

fit with their perception of what needs to be done and their main concern is to do a good job, not to perform tasks that are perceived as irrelevant. This is a good example of the ETTO principle working (Hollnagel, 2009). Thoroughness, represented by the timeout procedure, is traded for efficiency, to finish the surgery earlier; not just any aspects of thoroughness, though, but those that make the least sense and are seen as providing the least quality. ***(Paper II)***

In both papers, the results show that the individual's own perspective, motive and sense making are central themes. Thus the suggested improvements has been concerned with altering and widening the professionals' perspective to improve their capabilities for making sense of their work in a broader context and to see the consequences of their actions in a broader context. This is illustrated by emphasizing the creation of forums in the organization for the sharing of norms and conventions, as well as to establish stronger bonds of trust between individuals from different professions and by stressing the importance of clarifying the connection between the checklist and communication and teamwork. ***(Papers I & II)***

In addition to describing and exploring how things are in practice, the approach in the two appended papers has been to some degree purposefully provocative. To open up areas for discussion, aspects that have been largely ignored in the research literature have been identified and made explicit, such as that different professions sometimes apply different rationalities in practice. This results in contradicting behavior or that safety routines, such as the surgical safety checklist, are applied quite differently in practice than intended and described in the instructions. The purpose of this has been to draw attention to aspects of the practice that provide complexity and uncertainty that is often ignored. By asking new types of questions, the boundaries of the current research paradigm applied when studying healthcare is expanded (Kuhn, 1997). ***(Papers I & II)***

With the ambition to contribute in an action research manner to learning in practice, it is important to discuss how people in the practice can learn from the methodology used. From an experiential learning perspective, the results from this research can provide help in grasping the issues investigated by highlighting how things really are. However, in order for learning and improvement to take place, there has to be a transformation as well. In Kolb's model of experiential learning, transformation must come from some sort of action, either by actively experimenting or by actions of thought or reflection (Kolb, 1984). The addition of a new timeout checklist item concerning the assistant nurse and theatre nurse work could help break the dominance of the surgeon and anesthetist nurse in the timeout procedures and make team member participation more equal. This in turn would

affect action, and even though it is not really experimentation, such change would result in new concrete experiences. *(Paper II)*

4.2.2 Complexity and trust

The complexity perspective has been adopted as a way to view knowledge and more precisely what it is possible to know, which is the epistemological side of Stacey's complex responsive processes (Stacey, 2001). For knowledge creation and learning, a more traditional or as Stacey would put it, "mainstream thinking" approach has been chosen as it has been deemed more explanatory of the phenomenon studied.

From a complexity perspective everything is interconnected and interdependent, either directly or indirectly, as already mentioned (section 1.2.2) (Richardson et al., 2001). These connections can, however, be more or less frequent on the local agent level. If they are very frequent, instability or even chaos would occur; if there are few connections, the behavior would be more stable (Stacey, 2001). Seeing the world from a complexity perspective, all situations can be considered as more or less complex and as mentioned before, complex systems are incompressible (Richardson et al., 2001); hence, more or less impossible to determine with the help of a predefined model. In a practice like surgery, with both the unique patient, interdependences between different organizational units and interaction between different team members contributing to uncertainty, the complexity of the practice is evident.

Adopting a complexity perspective means adopting an epistemology, a view of knowledge as always being more or less questionable: It is impossible to be absolutely sure about anything. When, as with healthcare professionals working under high demands for certainty, an action is not considered legitimate until its outcome is determined – evidence based – this kind of epistemological acknowledgement can be problematic. A complexity perspective also conveys that there is always a potential for development. It is impossible to be finished with knowledge creation. The complexity of a situation – the level of interconnectiveness – can be seen as the number of options available. If there are a large number of connections, the options are many and it will become harder to choose. As a result, the corresponding behavior will be more demanding to predict. This kind of situation can result in a dilemma, leading to tension and anxiety that might even make it impossible to decide on how to act. On the other hand, a very small number of options would result in a highly predictable, under stimulated, inflexible and potentially boring practice.

While a complexity perspective increases the number of options, the mechanism of trust reduces them. As mentioned earlier, trust suspends issues of vulnerability and

uncertainty as if they were resolved, in this way it overcomes the tension between perceived complexity and action, making it possible to act (see **Figure 9**) (Möllering, 2006). In this way, high levels of trust make it possible to operate closer to the edge of chaos where the conditions for development are at their best. Trust must first be built to achieve this. It does not matter if it is trust for another person, for a theory or a work method. By providing a stronger fundament of trust, it may be possible to increase the organization's capability to handle complexity, hence to widen its perspective or increase its number of options and become more innovative. It is plausible that within the context of an operating unit, companion trust has the best potential to achieve this, as it appears to be the type of trust least relied on (Bergh et al., 2009; Newell & Swan, 2000). ***(Paper I)***

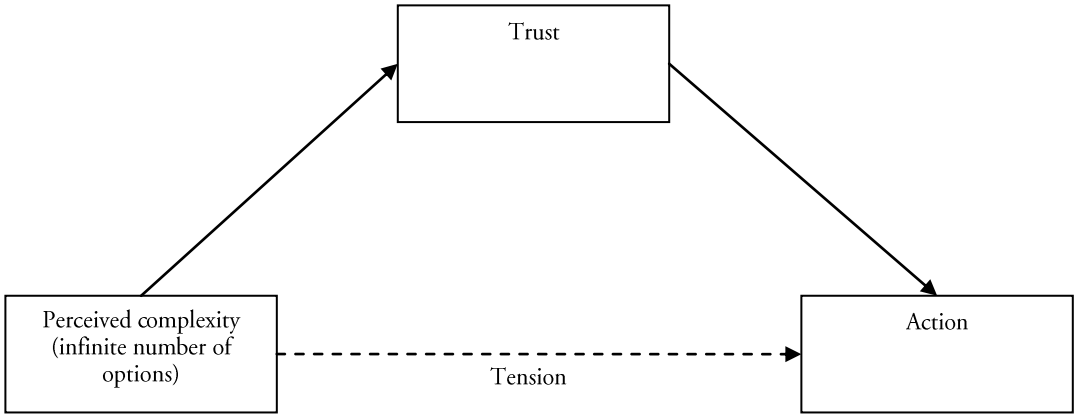

Figure 9. The relationship perceived complexity trust and action

It is crucial to realize that the complexity is already there in practice. The only thing the researcher or practitioner can do is to decide on whether to admit its existence or to ignore it.

There are similarities between the above proposed relation between complexity and trust and relatonics (Döös, 2007; Bäckström & Döös, 2008). From a complexity perspective, a richly developed network of relatonics corresponds to a higher number of connections or options. From a trust perspective, relatonics presumes some sort of trust that the other party is reliable and really has the knowledge it is believed to have. The proposed relation between complexity and trust can also be compared to Olsson et al.'s statement that an organization must, in experiential learning terms, be capable of being both convergent and divergent to be innovative (Kolb, 1984; Olsson et al., 2009). In this case, divergence would be to embrace or acknowledge the complexity of a situation, to genuinely try to see all options available. While convergence, at a certain point, would be to suspend all doubt and tension that the high number of options to choose from elicits and decide on what to do.

In has been suggested in this thesis that there is a need for organizational changes that facilitate a widening of the professional's perspectives and communication as well as the establishment of stronger bonds of trust between professions. In this way, the organization's capacity to come up with new ideas or options is increased as well as its capacity to handle the uncertainty that comes with having more options to choose from. This can be seen as a way to organize for learning and corresponds directly to the argumentation about innovation above (Döös, 2007; Olsson et al., 2009). *(Papers I & II)*

4.2.3 Visualization, reflection and learning

A virtual environment, such as the one used for data collection, could help making tacit knowledge explicit by serving as a metaphor, analogy or a model of a real situation (Nonaka & Takeuchi, 1995). This can be compared to David Kolb's concept of a *grasp* (Kolb, 1984). In order to develop knowledge, what is being learnt about must be grasped by actually experiencing it or by applying abstract conceptualizations already possessed. The virtual environment can be said to provide a grasp. Depending on the accuracy and detail of the virtual environment, this grasp is based on a *concrete experience* or on an *abstract conceptualization*; most of the time it is probably somewhere in between the two. In order to learn from a virtual environment, grasping is not enough. Kolb (1984) states that what is being grasped must also be transformed. As mentioned earlier, transformation can be achieved by either reflective observation or active experimentation. Again, the virtual environment provides a foundation for both depending on how it is constituted. If it is a good representation of the real world, it can work as a model providing grasping by concrete experience, hence working as a facilitator for reflective observation. If the virtual environment is interactive and representative, it can, on the other hand, be used as a tool for active experimentation. In the former, case divergent knowledge would be created according to Kolb (ibid.); in the latter case, convergent knowledge would be created. Divergent knowledge is useful, for instance, when brainstorming and identifying new ideas and convergent knowledge when identifying new paths of action.

In one of the studies, a virtual environment of the participants' actual work setting was used to support an interview about their work (see **Figure 8**). As it was a rather detailed and accurate model, trying to copy the real setting as accurately as possible, it could be said to provide a grasp through concrete experience. As the model was static in the sense that the user only could move around but not interact with it, transformation had to be done through reflective observation. While it is quite obvious that visualization can provide a grasp, the subject of transformation is more difficult. Whether the user decides to use the grasp for reflection or experimentation

or not is much up to the user. While using the virtual environment during an interview, it is possible that the interviewer has an influence on how and if the interviewee participates in reflection based on the virtual environment. The interviewer could both probe or steer the interviewees' reflection in a certain direction and ask questions that might stimulate deeper reflection than could have been achieved without the interviewer.

4.2.4 Discussion of methodological considerations

As previously addressed, some domain knowledge is considered important in order to conduct an interview study (Kvale & Brinkmann, 2009). Yet being too familiar with the context of study and too immersed in the discourse of the object studied could also be a bias. Assuming that all interpretations are theory-laden (i.e. dependent on a priori theory, expectations and prejudices), thinking in the same patterns as the study participants could make it more difficult for the researcher to detach him or herself from the object of study and make an unbiased reflection. In this sense, both bias and understanding can come from the interviewer's domain knowledge. In the interviews, the interviewer had good knowledge about the work environment and patient safety issues the interview was concerned with, while having a rather limited knowledge about the clinical medical aspects of the participants' work. As the unit of analysis was the work environment rather than the medical practice, the interviewer in a sense had good domain knowledge about that area of interest, while still not being too burdened by theory, expectations and prejudices about the medical work being carried out. ***(Paper I)***

As the observer was known and clearly present in the operating theatre during data collection for the observation study, some reactivity can be expected from those observed (Shaughnessy et al., 2003). This reactivity was reduced by the camera always being on during the entire surgical procedure, not putting extra emphasis on specific parts. Reactivity was also reduced since the professionals were familiar with the observer who had been present in the environment off and on for over a year prior to the video observations. They also knew the overall purpose of the observation. It is likely that long observational sessions like the ones conducted provide some habitation on the part of the participants. In the analysis, it is plausible that the strict observational protocol decreased the risk for observer bias. ***(Paper II)***

While being a very efficient tool, quickly providing a great amount of concentrated focused information, interviews always introduce the risk of only giving the researcher access to the espoused theories of the interviewees (Argyris & Schön, 1996). This is because it is the interviewees that make the interpretation of the questions asked. In this way, the interviewee is the one that introduces the largest

risk for uncontrolled bias. The interviewer can also contribute to bias, but that bias is easier to avoid as the interviewer has a direct influence and therefore can be prepared. When using observations, however, it is the observer that makes the interpretation. Even though the participants can contribute to bias if they know that they are being observed, it is the observer that introduces the largest risk for bias. Thus, observation has a much better potential than interviews to shed light on the theory-in-use of the professionals studied, but to a larger degree relies on the observer's own rigor and skill. This said, the two different approaches to data collection used as well as validation by research group members with thorough domain knowledge, can be seen as providing triangulation on the thesis level, by studying the same phenomenon in two different ways with complementary strengths and weaknesses (Miles & Huberman, 1994).

There was only one main data source each in the appended papers: interviews or direct observations. The research group was composed of members from academia with little medical knowledge and members with a background in the medical practice studied. This contributed to the validity of the results.

The most obvious limitation of the research is the narrow field of data collection: all from the same operating unit. Hence, the data and the conclusions can be a product of the specific circumstances at that particular operating unit. On the other hand, highly specialized care, at least in Sweden, is quite homogeneous due to the knowledge monopoly of different professions (Thunborg, 1999). This is also due to the educational system, which resembles a guild like organization, with high emphasis on socialization. Because of this, the results probably have external validity in a Swedish setting. The problems of communication and interaction in the operating theatre investigated has, however, been acknowledged on a large scale even internationally (Lingard et al., 2004; Undre, Sevdalis, Healey, Darzi, & Vincent, 2006; Collin, Paloniemi, & Mecklin, 2010; McCulloch, Rathbone, & Catchpole, 2011), and the roles in the operating theatre are similar around the world, even though the culture is sometimes slightly different. Therefore, it is plausible that even though the results are not entirely uncritically generalizable to an international setting, they can still be of interest to an international audience.

Another limitation is that the conclusions and suggestions have not been tested either as a vehicle of thought or practically by the practice. In order to achieve this, the results must be successfully distributed to practitioners and they must find time to reflect, test and improve their practice in the light of the research provided.

The studies included in this thesis have aspects in common with case study research (Yin, 1994). For one, they are studies of a contemporary phenomenon in its real-life

context. They are also studies of "how" and "why" a phenomenon occurs, and hence deal with questions suitable for case study research. However, they differ from Yin's (1994) definition of a case study as they do not contain any explicit theorization prior to data collection and are thus more exploratory than a case study could be. *(Papers I & II)*

4.3 Future research

1. To increase the practitioners' actual benefits from projects such as OpDesign 2012, they must learn from it and make the results "their own". This can be achieved by conducting "real action research", not only as it was done here by means of feedback results to the organization studied. But also by ensuring that the organization has the resources to reflect and act on the results, and to facilitate and study their reflection and action. This would provide more instances of active experimentation and reflective observation that in turn would result in learning and development, both scientifically and practically. This is something that is already in the works for the continuation of the OpDesign 2012 project.
2. The connection between virtual environments and learning is surprisingly under-researched considering the amount of work carried out in the visualization and virtual reality area, including the development of applications for learning. Further investigation of this connection would be beneficial to gain knowledge about how learning from virtual environments really does occur. This would have a potential to enable the construction of better ways to gain knowledge from practitioners and facilitate learning in a training context.
3. The video material from the operations has considerable potential as it allows for the study of aspects of surgical practice that otherwise are hard to grasp. Further research on how this material can be used to study ergonomic aspects of work in the operating theatre, as well as communication has been planned for the OpDesign 2012 project.
4. Another area for further investigation is how video observations can be used to improve surgical practice form a methodological perspective.

5 References

Ahlberg, J. (2009). Rädda liv och minimera skador - ta en timeout! *Svensk kirurgi, 67,* 254-257.

Akselsson, R. (1993). Kvalitet i produktion och arbetsmiljö. In L.Lennerlöf (Ed.), *Människor Datateknik Arbetsliv* (pp. 61-81).

Alvesson, M. & Sköldberg, K. (2008). *Tolkning och reflektion: vetenskapsfilosofi och kvalitativ metod.* (2. ed.) Lund: Studentlitteratur.

Angrosino, M. V. & Mays de Pérez, K. A. (2000). Rethinking observation: from method to context. In N.K.Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2. ed., pp. 673-702). Thousand Oaks: Sage Publications.

Argyris & Schön (1996). *Organizational learning II.* (Repr. with corrections ed.) Reading, Mass: Addison-Wesley.

Argyris, C., Putnam, R., & Smith, D. M. (1985). *Action science.* San Francisco: Jossey-Bass.

Arnetz, B. B., Hörte, L. G., Hedberg, A., Theorell, T., Allander, E., & Malker, H. (1987). Suicide patterns among physicians related to other academics as well as to the general population. *Acta Psychiatrica Scandinavica, 75,* 139-143.

Arnetz, B. B. (2001). Psychosocial challenges facing physicians of today. *Social Science and Medicine, 52,* 203-213.

Bäckström, T. & Döös, M. (2008). Relatonics - a key concept for networked organizations. In G.Putnik & M. Cunha (Eds.), *Encyclopedia of Networked and Virtual Organizations* (pp. 1367-1374). Hershey: Idea Group Publishing.

Bergh, P., Thorgren, S., & Wincent, J. (2009). Entrepreneurs learning together: The importance of building trust for learning and exploiting business opportunities. *International Entrepreneurship and Management Journal, 7,* 17-37.

Carthey, J., de Leval, M. R., & Reason, J. T. (2001). The Human Factor in Cardiac Surgery: Errors and Near Misses in a High Technology Medical Domain. *The Annals of Thoracic Surgery, 72,* 300-305.

Catchpole, K., Bell, M. D. D., & Johnson, S. (2008). Safety in anaesthesia: a study of 12606 reported incidents from the UK National Reporting and Learning System. *Anaesthesia, 63,* 340-346.

Collin, K., Paloniemi, S., & Mecklin, J.-P. (2010). Promoting inter-professional teamwork and learning - the case of a surgical operating theatre. *Journal of Education and Work, 23,* 43-63.

Corvellec, H. (2010). Organizational Risk as it Derives from What Managers Value: A Practice-Based Approach to Risk Assessment. *Journal of Contingencies and Crisis Management, 18,* 145-154.

Döös, M. (2007). Organizational learning. Competence-bearing relations and breakdowns of workplace relatonics. In L.Farrell & T. Fenwick (Eds.), *World Yearbook of Education* (pp. 141-153). New York, NY: Routledge.

Ellström, P. E. (1992). *Kompetens, utbildning och lärande i arbetslivet: problem, begrepp och teoretiska perspektiv*. Stockholm: Publica.

Ellström, P.-E. (2010). Practice-based innovation: a learning perspective. *Journal of Workplace Learning, 22,* 27-40.

Engeström, Y. (1987). *Learning by expanding: an activity-theoretical approach to developmental research*. Helsinki: Orienta-konsultit.

Engeström, Y. (2001). Expansive learning at work: toward an activity-theoretical reconceptualisation. *Journal of Education and Work, 14,* 133-156.

Eriksson, J. & Johansson, G. (1996). Adaptation of workplaces and homes for disabled people using computer-aided design. *International Journal of Industrial Ergonomics, 17,* 153-162.

Fiske, J. (1990). *Introduction to communication studies.* (2. ed.) London: Routledge.

Haynes, A. B., Weiser, T. G., Berry, W. R., Lipsitz, S. R., Breizat, A.-H. S., Dellinger, E. P. et al. (2011). Changes in safety attitude and relationship to decreased postoperative morbidity and mortality following implementation of a checklist-based surgical safety intervention. *Quality Safety Health Care, 20,* 102-107.

Haynes, A. B., Weiser, T. G., Berry, W. R., Lipsitz, S. R., Breizat, A.-H. S., Dellinger, E. P. et al. (2009). A Surgical Safety Checklist to Reduce Morbidity and Mortality in a Global Population. *The New England Journal of Medicine, 360,* 491-499.

Hochwälder, J. (2007). The psychosocial work environment and burnout among Swedish registered and assistant nurses: The main, mediating, and moderating role of empowerment. *Nursing and Health Sciences, 9,* 205-211.

Hoff, T., Jameson, L., Hannan, E., & Flink, E. (2004). A Review of the Literature Examining Linkages between Organizational Factors, Medical Errors and Patient Safety. *Medical Care Research and Review, 61,* 3-37.

Hollnagel, E. (2009). The ETTO Principle: efficiency-thoroughness trade-off: why things that go right sometimes go wrong. Farnham: Ashgate.

Hörte, S. Å. (2009). Arbete, Arbetsmiljö och Arbetsmiljöarbete. In S.Å.Hörte & M. Christmansson (Eds.), *Perspektiv på arbetsmiljöarbete* (pp. 13-27). Halmstad: Högskolan i Halmstad.

Kolb (1984). *Experiential learning.* Englewood Cliffs, N.J: Prentice-Hall.

Kuhn, T. S. (1997). *De vetenskapliga revolutionernas struktur.* (2. ed.) Stockholm: Thales.

Künzle, B., Kolbe, M., & Grote, G. (2010). Ensuring patient safety through effective leadership behaviour: A literature review. *Safety Science, 48,* 1-17.

Kuutti, K. (1996). Activity Theory as a Potential Framework for Human-Computer Interaction Research. In B.A.Nardi (Ed.), *Context and consciousness: activity theory and human-computer interaction.* Cambridge, Mass: MIT Press.

Kvale, S. & Brinkmann, S. (2009). *Den kvalitativa forskningsintervjun.* (2. ed.) Lund: Studentlitteratur.

Leymann, H. & Gustafsson, A. (1998). *Självmordsfabriken: om de stora risker som sjuksköterskor utsätts för i arbetslivet.* Stockholm: Norstedts juridik.

Lingard, L., Espin, S., Whyte, S., Regehr, G., Baker, G. R., Reznick, R. et al. (2004). Communication failures in the operating room: an observational classification of recurrent types and effects. *Quality Safety Health Care, 13,* 330-334.

Lingard, L., Regehr, G., Orser, B., Reznick, R., Baker, R., Doran, D. et al. (2008). Evaluation of a Preoperative Checklist and Team Briefing Among Surgeons, Nurses and Anesthesiologists to Reduce Failures in Communication. *Archives of Surgery, 143,* 12-17.

Macrae, C. (2008). Learning from patient safety incidents: Creating participative risk regulation in healthcare. *Health, Risk & Society, 10,* 53-67.

Mahajan, R. P. (2010). Critical incident reporting and learning. *British Journal of Anaesthesia, 105,* 69-75.

McCulloch, P., Rathbone, J., & Catchpole, K. (2011). Interventions to improve teamwork and communications among healthcare staff. *British Journal of Surgery, 98,* 469-479.

Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis: an expanded sourcebook*. (2. ed.) Thousand Oaks, Calif: Sage Publications.

Möllering, G. (2006). *Trust: reason, routine, reflexivity*. Amsterdam: Elsevier.

Moumtzoglou, A. (2010). Factors that prevent physicians reporting adverse events. *International Journal of Health Care Quality Assurance, 23*, 51-58.

Newell, S. & Swan, J. (2000). Trust and inter-organizational networking. *Human Relations, 53,* 1287-1329.

Nilsson, F. (2003). A Complex Adaptive Systems Approach on Logistics. Licentiate Thesis, Department of Design Sciences, Division of Packaging Logistics, Lund University, Lund.

Nilsson, F. (2005). *Adaptive Logistics - Using Complexity Theory to Facilitate Increased Effectiveness in Logistics.* Doctoral thesis, Department of Design Sciences, Division of Packaging Logistics: Lund University, Lund.

Nilsson, L., Lindberget, O., Gupta, A., & Vegfors, M. (2010). Implementing a pre-operative checklist to increase patient safety: a 1-year follow-up of personnel attitudes. *Acta Anaesthesiologica Scandinavica, 54,* 176-182.

Nonaka, I. & Takeuchi, H. (1995). *The knowledge-creating company: how Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Norbäck, L. E. & Targama, A. (2009). *Det komplexa sjukhuset: att leda djupgående förändringar i en multiprofessionell verksamhet*. Lund: Studentlitteratur.

Olsson, A., Blomé, M., Kaulio, M., Guve, B., Norell Bergendahl, M., & Odenrick, P. (2009). Organizational factors affecting product innovation capability: Findings from the Med-Tech industry. *In Proceedings of ICED 09, the 17th International Conference on Engineering Design* (pp. 157-168).

Olsson, A., Wadell, C., Odenrick, P., & Norell Bergendahl, M. (2010). An action learning method for increased innovation capability in organizations. *Action Learning: Research and Practice, 7,* 167-179.

Patientförsäkring LÖF, Svensk kirurgisk förening, & World Health Organization (2009). *Bruksanvisning för checklista för säkerhet vid operationer: Säker kirurgi räddar liv - safe surgery saves lives* Geneva: World Health Organization.

Patton, M. Q. (2002). *Qualitative research & evaluation methods.* (3 ed.) London: SAGE.

Reason, J. (1990). *Human error.* Cambridge: Cambridge University Press.

Richardson, K. A., Cilliers, P., & Lissack, M. (2001). Complexity Science: A "Gray" Science for the "Stuff in Between". *Emergence, 3,* 6-18.

Rydenfält, C., Johansson, G., Johansson, Å., Larsson, P. A., Odenrick, P., & Åkerman Kristina (2010). *Variationer i synen på rationalitet och behov: En visualiseringsstödd studie av arbetet på en operationsavdelning* (Rep. No. 33). Lund, Sweden: Lund University, Department of Design Sciences.

Säljö, R. (2000). *Lärande i praktiken: Ett sociokulturellt perspektiv.* Stockholm: Prisma.

Sammer, C. E., Lykens, K., Singh, K. P., Mains, D. A., & Lackan, N. A. (2010). What is Patient Safety Culture? A Review of the Literature. *Journal of Nursing Scholarship, 42,* 156-165.

Schön, D. A. (1983). *The reflective practitioner: how professionals think in action.* New York: Basic Books.

Senge, P. M. (2006). *The fifth discipline: the art and practice of the learning organization.* (Rev. and updated ed.) London: Random House Business.

Shaughnessy, J. J., Zechmeister, E. B., & Zechmeister, J. S. (2003). *Research methods in psychology.* (6. ed.) Boston: McGraw-Hill.

Skyttner, L. (1996). *General systems theory: an introduction.* Basingstoke: Macmillan Press.

Socialstyrelsen (2010). Patientsäkerhetslagen. *Svensk författningssamling, 659.*

Stacey, R. D. (2001). *Complex responsive processes in organizations: learning and knowledge creation.* London: Routledge.

Statistiska centralbyrån (2010). *Statistisk årsbok för Sverige: (statistical yearbook of Sweden 2010).* Stockholm: Statistiska centralbyrn.

Sundin, A. & Medbo, L. (2003). Computer Visualization and Participatory Ergonomics as Methods in Workplace Design. *Human Factors and Ergonomics in Manufacturing, 13,* 1-17.

Sunesson, K., Allwood, C. M., Paulin, D., Heldal, I., Roupé, M., Johansson, M. et al. (2008). Virtual Reality As a New Tool in the City Planning Process. *Tsingua science and technology, 13,* 255-260.

Thunborg, C. (1999). *Lärande av yrkesidentiteter : en studie av läkare, sjuksköterskor och undersköterskor*. Linköping : Linköpings universitet, Department of Education and Psychology.

Undre, S., Sevdalis, N., Healey, A., Darzi, A., & Vincent, C. A. (2006). Teamwork in the operating theatre: cohesion or confusion? *Journal of Evaluation in Clinical Practice, 12,* 182-189.

Varpio, L., Hall, P., Lingard, L., & Schryer, C. F. (2008). Interprofessional Communication and Medical Error: A Reframing of Research Questions and Approaches. *Academic Medicine, 83,* 76-81.

Vincent, C., Stanhope, N., & Crowley-Murphy, M. (1999). Reasons for not reporting adverse incidents: an empirical study. *Journal of Evaluation in Clinical Practice, 5,* 13-21.

Von Bertalanffy, L. (1950). An outline of general system theory. *The British Journal for the Philosophy of Science, 1,* 134-165.

Wallergård, M., Eriksson, J., & Johansson, G. (2008). A suggested virtual reality methodology allowing people with cognitive disabilities to communicate their knowledge and experiences of public transport systems. *Technology and Disability, 20,* 9-24.

Waring, J., McDonald, R., & Harrison, S. (2006). Safety and complexity: Inter-departmental relationships as a threat to patient safety in the operating department. *Journal of Health Organization and Management, 20,* 227-242.

Weiser, T. G., Haynes, A. B., Lashoher, A., Dziekan, G., Boorman, D. J., Berry et al. (2010). Perspectives in quality: designing the WHO Surgical Safety Checklist. *International Journal for Quality in Health Care, 22,* 365-370.

Westerdahl, B., Sunesson, K., Wernemyr, C., Roupé, M., Johansson, M., & Allwood, C. M. (2006). Users' evaluation of a virtual reality architectural model compared with the experience of the completed building. *Automation in Construction, 15,* 150-165.

WHO (2008). *Implementation manual WHO surgical safety checklist 1st edition - safe surgery saves lives.*

Winkel, J. & Dellve, L. (2009). Preface. In Jörgen Winkel (Ed.), *Abstract book: 3rd NOVO Symposium* (pp. 2-3). Copenhagen: National Research Centre for the Working Environment (NRCWE).

Yin, R. K. (1994). *Case study research: design and methods*. (2. ed.) Thousand Oaks,Calif: Sage.

Yule, S., Flin, R., Paterson-Brown, S., & Maran, N. (2006). Non-technical skills for surgeons in the operating room: A review of the literature. *Surgery, 139,* 140-149.