Escalation: Explorative studies of high-risk situations from the theoretical perspectives of complexity and joint cognitive systems

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Escalation

Explorative studies of high-risk situations from the theoretical perspectives of complexity and joint cognitive systems

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Abstract:

The main aim of the research is to explore different aspects of organisational resilience in escalating situations, with an investigation of both theoretical and practical implications. From the platform of an explorative approach, this study makes use of naturalistic research in the domain of health care and experimental simulation studies, in order to establish a broad theoretical framework vis-à-vis the processes of escalation. Rather than treating notions of crisis as processes taking place outside the organisation, the thesis outlines a view of escalation as an inherent part of organisational reproduction and structure, rooted in historical relations of power and professional identities. The thesis goes on to look at pragmatic implications in areas such as the establishment of efficient coordination structures in escalating situations, and team performance assessment.

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Summary

The starting point of this thesis is the recognition that there is a knowledge gap concerning the current understanding of the processes which come into play as a crisis escalates in different high-risk industries. A knowledge base does exist with regard to how to manage crisis once such a situation has been defined, but the processes by which a situation changes from normal to non-normal, and from there to pathological and potentially to a state of crisis, are still relatively unexplored.

The main aim of this thesis is to explore different aspects of organisational resilience in escalating situations, dealing with both theoretical and practical implications. An understanding of the processes in play during escalating situations is important for the development of new concepts in team training, for the development of routines aimed at ensuring effective coordination in escalating situations, and for guiding future research in the field.

With the problem of escalation being relatively uncharted territory, I have chosen to apply an explorative approach, in which different studies are conducted in different environments using different methods and techniques, in the aim of substantiating, and communicating, a broad and transparent understanding of the processes that take place as a situation escalates.

One study conducted for this thesis investigates the interactions in escalating child-birth situations between midwives, junior physicians, obstetricians, operation ward staff, paediatricians and paediatric nurses. From the findings of the study the conclusion is drawn that, given the complexities of obstetric practice, there is a need for strategies which complement the existing normative, compliance-based best practice-guidelines, in order to further enhance operational resilience through methods aiming at enhancing organisational diversity. The more theoretical conclusions drawn in the study are related to how situations of escalating crisis offer important moments for the reproduction and confirmation of organisational structure, as well as to how an understanding of the historically rooted relations of power and entrenched professional identities can contribute to an understanding of escalating situations in organisations such as health care providers.

Another study aims at identifying, using mid-fidelity simulation, what coordination strategies can be established in the management of escalating situations. By selecting teams with differing experiences of the domain in which the simulation takes place as

well as of crisis management, the study triggers different coordination strategies for dealing with escalating situations. The conclusion of the study is that proactive coordination in managing escalating situations is established in those teams which focus on developing an understanding of the different team members' roles and needs, as well as on sharing overall aims, rather than in teams where the focus is on the development of detailed plans of action.

This simulation study highlights a further question, namely that of the academic basis for team performance assessment. Building on the conclusion that existing methods for team performance assessment tend to focus on the behaviour of individuals rather than on the joint cognitive activity of the team as a whole, the study develops and tests a protocol in which team performance is studied by assessing the level of team control.

The studies conducted for this thesis appear to converge on a central finding: in the organisations and teams studied, resilient performance in escalating situations can be seen to be an emergent property of the interactions, relations and coordinative strategies amongst a multitude of actors, rather than being the result of heroic achievements or "correct decisions" on the part of single actors.

Sammanfattning

Utgångspunkten i denna avhandling är att det finns en kunskapslucka gällande förståelsen för de processer under vilka en kris trappas upp i olika typer av högriskorganisationer. Tidigare studier fokuserar till stor del på hur en situation ska hanteras när den väl blivit definierad som en kris, men den process under vilken en situation går från normal, till onormal, till akut och eventuellt kris, är fortfarande relativt outforskad.

Syftet med forskningen är att, genom en ökad kunskap om upptrappning av kris, skapa en förståelse för vilka processer som kan leda till framgångsrik koordinering och hantering av upptrappande krissituationer. Sådan förståelse är viktig för utvecklingen av nya koncept för träning av team, för utvecklingen av rutiner med syfte att skapa god koordinering, samt för att ge upphov till vidare forskning på området.

Då problemfältet upptrappande kris är relativt outforskat används en explorativ ansats, i vilken flera olika nerslag görs i olika miljö och med olika metod, för att skapa och förmedla en bred förståelse för de processer vilka pågår under en upptrappande kris.

En delstudie i avhandlingen är att, under upptrappande förlossningssituationer, studera interaktionerna mellan barnmorskor, underläkare, specialister inom förlossningssjukvård, operationspersonal, barnspecialister och sjuksköterskor. Utifrån studiens resultat dras slutsatser gällande balansen mellan å ena sidan tilltron till rutiner och procedurer, grundade i medicinsk ideologi av *best-practice,* och å andra sidan vikten av att skapa en miljö genomsyrad av *diversitet* där en bredd av hanterinsstrategier etableras, bland annat genom att skapa en miljö där allas röster uppmuntras. Mer teoretiska slutsatser dras också gällande hur upptrappande kriser är viktiga tillfällen för en organisation som sjukvården att bekräfta sin organisatoriska struktur, samt hur en förståelse av historiskt rotade maktstrukturer och professionella identiteter kan bidra till kunskapen om hur kriser trappas upp i organisationer som sjukvården.

En annan delstudie syftar till att, genom simulerade spel, belysa frågan om vilka olika koordineringsprocesser som kan användas i hanteringen av upptrappande krissituationer. Genom att välja team, med olika erfarenhet av såväl den domän i vilket simuleringen utspelar sig som av krishantering, triggas olika sätt att koordinera teamets medlemmar i upptrappande situationer. Studiens slutsats är att proaktiv

koordinering i upptrappande situationer etableras av team som i en decentraliserad miljö fokuserar mycket på att förstå varandras respektive roller och behov, samt delar övergripande mål, snarare än kommer överens om detaljerade handlingsplaner.

Studien med simulerade spel ger upphov till ytterligare en frågeställning gällande hur teamarbete bör utvärderas. Utgångspunkten är att befintliga metoder för utvärdering studerar beteende på individnivå snarare än teamets arbete som helhet. I studien tas ett verktyg fram med hjälp av vilket teamarbete studeras genom att uppskatta teamets grad av kontroll.

Avhandlingens övergripande slutsats är att en organisations motståndskraft i upptrappande situationer är ett resultat av interaktioner, relationer och koordineringsstrategier mellan en mängd aktörer, snarare än av enskildas aktörers hjältedåd, eller ”korrekta” beslut.

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While being in name the individual author of this thesis, I have benefited greatly from the efforts of many. A large number of people have contributed, inspired me, helped me out, welcomed me on their ward (as a researcher, that is), asked interesting questions, and provided me with the confidence to summarise the process in this thesis. This collective aspect not only made this research process possible but also meant that it was great fun.

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Starting my PhD studies in 2008, little did I know that in the process I would gain friends for life located all over the world. Roel and Eder, sharing an office with you guys was the best (and indeed the most hypoxic) time of my years as a PhD student. Not only did we become close friends, but also great academic colleagues, developing an ethos which took me to a higher academic level. I am sure we will always find ways to maintain that environment of friendship and intellectual challenge.

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Chapter One

Introduction

This introductory section contains a background to the research carried out, containing the starting point of the research, an introduction to the scientific field, as well as listings of the appended papers on which the thesis is based and publications related to the research process. The section concludes with an outline of the thesis.

Background

The main aim of this thesis is to explore different aspects of organisational resilience in escalating situations, investigating both theoretical and practical implications. This central aim was formulated when conducting research into methods (and educational approaches) for team training in high-risk industries. When considering the potential of addressing what are called *generic team competencies* (such as communication, information management, and decision-making) by means of high-fidelity simulators (Caird, 1996), researchers at Lund University School of Aviation (LUSA) initiated research into new methods for training teams to deal with unexpected and/or escalating situations (Bergström, Dahlström, Dekker & Petersen, 2011; Dahlström, Dekker, van Winsen & Nyce, 2009). Financed by the Swedish Emergency Management Agency (SEMA)[1] and VINNOVA, the researchers at LUSA began studying the potential of new simulation methods for team training. The specific focus selected for the work was to use simulated scenarios in the study of tempo changes, investigating situations going from normal operations to situations of abnormality and potential crisis. The research suggested that the unpredictable and complex nature of such *escalating situations* poses a severe threat to the ability of an organisation to detect, prevent, prepare for, manage and recover from disruptive events (Bergström, Petersen & Dahlström, 2008; Dekker, Dahlström, van Winsen &

[1] Subsequently financed by the Swedish Civil Contingencies Agency, which was established 1 January 2009 to replace and subsume the Swedish Rescue Services Agency (SRSA), the Swedish Emergency Management Agency (SEMA) and the Swedish National Board of Psychological Defence.

Nyce, 2008; Dörner, 1996; Strohschneider & Gerdes, 2004; Woods & Patterson, 2001). Further, these initial studies suggested that studying teams as they endeavoured to cope with escalating situations in experimental settings would lead to insights concerning the generic skills that might keep organisations as prepared for the unexpected as possible. It was against the background of these findings and suggestions that the research scope for my thesis was defined.

Research on questions relating to team training for high-risk environments typically positions itself within the broad research field called *systems safety*. Systems safety, in turn, includes different epistemological approaches such as *human factors and ergonomics*, *joint cognitive systems theory*, the *organisational sciences* and, since 2004, *resilience engineering*. These approaches are all rooted in differing scientific paradigms which draw on differing epistemological assumptions. Team performance is typically studied through applying approaches from the research fields of human factors and ergonomics. These fields typically derive their epistemological stance from the paradigms of information processing and cognitive psychology – leading to studies of team performance which focus on cognitive aspects, such as the behaviour and attitudes of individuals (Flin & Martin, 2001; Helmreich, Merritt & Wilhelm, 1999). Joint cognitive systems theory, which is further outlined in chapter three, was introduced as a reaction and alternative to research rooted in the disciplines of human factors and ergonomics as it aimed to locate cognition "in the wild" rather than "in the mind" (Hollnagel & Woods, 1983; Hutchins, 1995a).

The organisational sciences approach views the problem of organisational safety from several different theoretical perspectives. Such perspectives include models of safety and risk as 1), the management of energy to be contained (Haddon, 1980); 2), structural components of complexity (Perrow, 1984); 3), safety as the result of processes such as organisational redundancy and spontaneous reconfiguration of roles in complex situations (Rochlin, La Porte & Roberts, 1987); 4), risk as a gradual acceptance and normalisation of deviance (Pidgeon & O'Leary, 2000; Starbuck & Milliken, 1988; Vaughan, 1996); and 5), and safety management as a control problem in environments which pose multiple (and opposing) goals (Rasmussen, 1997). Finally, resilience engineering was introduced as a new terrain of study in order to emphasise the positive aspects of performance variability, for instance in terms of human adaptability, in complex high-risk environments (Hollnagel, Pariès, Woods & Wrethall, 2011; Hollnagel, Nemeth & Dekker, 2008; Hollnagel, Woods & Leveson, 2006a).

Following an initial literature review of crisis management in general and escalation in particular, I concluded that processes related to the build-up of crisis in organisational settings have not been extensively covered by the scientific community, and also that the nature of the problem itself has not generally been well specified. These observations contributed to choosing an explorative approach. The explorative

approach provides the researcher with tools for substantiating, and communicating, a broad and transparent understanding of a problem by highlighting it from different angles, and integrating different methods and different implications of the studies conducted. I concluded at an early stage that looking at team performance through experimental studies alone would cover no more than a narrow part of the problem of escalation. This led me to include other spheres of study, directed towards studying escalating situations in naturalistic work contexts (as outlined further in chapter two, below). During the research process my focus gradually shifted from classical human factors studies of team performance to studies epistemologically rooted in complexity theory and "cognition in the wild", i.e. the theoretical fields of joint cognitive systems and resilience engineering. The theoretical framework of the research carried out is further outlined in chapter three, below.

Scientific Publications

Appended Papers

This thesis is based on a synthesis of five papers which have all been submitted to peer-reviewed scientific journals. The papers are listed below. To date, three of the papers have been published and two are under review.

Paper I Bergström, J., Nyce, J. M., Dekker, S. W. A., & Amer-Wåhlin, I. *The Social Process of Escalation: A promising focus for crisis management research*. Submitted as a "debate paper" to a peer-reviewed journal.

Paper II Dekker, S. W. A., Bergström, J., Amer-Wåhlin, I., Cilliers, P. (2012). Complicated, Complex and Compliant: Best practice in obstetrics. *Cognition, Technology and Work*. doi: 10.1007/s10111-011-0211-6

Paper III Bergström, J. Dahlström, N. Henriqson, E. Dekker, S. W. A. (2010). Team Coordination in Escalating Situations: An empirical study using mid-fidelity simulation. *Journal of Contingencies and Crisis Management*, 18(4), 220-230, doi: 10.1111/j.1468-5973.2010.00618.x

Paper IV Palmqvist, H., Bergström, J., Henriqson, E., (2011). How to Assess Team Performance in Terms of Control: A Protocol based on Cognitive Systems Engineering. *Cognition, Technology and Work*. doi: 10.1007/s10111-011-0211-6

Paper V Bergström, J., Nyce, J. M., Dekker, S. W. A. *The Emperor's New Clothes: Organization Science and the notion of sensemaking*. Submitted as a "Speaking out paper" to a peer-reviewed journal.

Related Publications

Bergström, J., Henriqson, E., & Dahlström, N. (2011). From Crew Resource Management to Operational Resilience. In E. Hollnagel, E. Rigaud, & D. Besnard (Eds.), *Proceedings of the 4th symposium on Resilience Engineering, Sophia-Antipolis, France, June 8-10 2011.* Paris: Presses des Mines

Larsson, M., Grunnesjö, E. & Bergström, J. (2011). What Counts as a Reasonable Extent? - A systems approach for understanding fire safety in Sweden. *Journal of Risk Research*, doi: 10.1080/13669877.2011.643478.

Bergström J., Dahlström N., Dekker S. W. A., & Petersen K. (2011). Training Organizational Resilience. In *Resilience Engineering in Practice: A Guidebook*, Hollnagel E., Mcdonald N., Woods D. & Wrethall J. (Eds), Ashgate Publishing Company.

Bergström, J., Dahlström, N., van Winsen, R., Lützhöft, M., Dekker, S. W. A., & Nyce, J. M. (2009). Rule and Role Retreat: An empirical study of procedures and resilience. *Journal of Maritime Research,* 6(1), pp 75-90.

Bergström, J., Petersen, K., & Dahlström, N. (2008). Securing Organizational Resilience in Escalating Situations: Development of skills for crisis and disaster management. In E. Hollnagel, F. Pieri, & E. Rigaud (Eds.), *Proceedings of the third resilience engineering symposium, sophia-antipolis, france, october 28-30, 2008.* Paris: Presses des Mines.

Dekker, S. W. A., Jonsén, M., Bergström, J. & Dahlström, N. (2008). Learning from Failures in Emergency Response: A series of empirical studies. *Journal of Emergency Management,* 6(5), pp 64-70.

Dahlström, N., Laursen, J. & Bergström, J. (2008), *Crew Resource Management, Threat and Error Management and Assessment of CRM-Skills – current situation and development of knowledge, methods and practice.* Report for the Swedish CAA. (Originally written in Swedish, but also translated into English by the Swedish CAA). Lund: Lund University.

Thesis Outline

This thesis is based on the five appended scientific papers. The main body of the thesis can be seen as a holistic synthesis and summary of the research process which generated these papers. Chapter Two outlines three research themes and their related research questions. Chapter Three defines the theoretical framework within which the research was conducted. Chapter Four complements chapter Three by outlining the epistemological framework of the research, and describing the scientific methods and techniques used to shed light on the research questions. In Chapter Five the research

findings and their implications are outlined, first in relation to the five papers appended to this thesis, and then in relation to the research themes and questions. The chapter also includes a holistic summary of the findings related to the main aim of study. Chapter Six then applies a meta-perspective to the research process and outlines some potential future areas of research based on the findings. Chapter Seven formulates conclusions in the form of a short bullet list.

Chapter Two

Three Research Themes with related research questions

The main aim of this thesis is to explore organisational resilience in escalating situations, investigating both theoretical and practical implications. Since the starting point for my research was that the nature of escalation in organisational settings has not been particularly well specified in previous research, I have elected to adopt an explorative approach. The explorative approach allows for research characterised by *epistemological pluralism* (Healy, 2003), both when it comes to what kind of research questions to ask, and with regard to what research design to use in order to answer those questions. In short, studying a given problem from different perspectives, using a range of methods and taking on board different implications, facilitates the establishment of a broad understanding of the problem and the development of methods for dealing with the problem in practical ways in different settings.

With the aim of suggesting both theoretical and practical implications in specific as well as in general terms, I have delineated the following three themes to guide the formulation of research questions as well as research design: 1), the theorisation of escalation as a social and organisational process; 2), the interpretive study of escalating situations in different contexts; and 3), the development of methods for assessing team performance in escalating situations.

The following presents the three themes in outline, together with their related research questions.

Research Theme One: Theorising Escalation

Building on the initial conclusion that the problem of escalation in organisational settings has not been clearly specified or closely studied in previous research, the first research theme aims at developing a theoretical framework to guide further discussions on and studies of escalation. The development of a theoretical framework is based on a review of the literature as well as on the findings of the studies

conducted within the second research theme of this thesis (which is concerned with studying escalation in work contexts). A specific work context studied in this thesis is health-care provision, and the development of a theoretical framework of escalation is therefore based on a review of the literature that deals with clinical emergencies. The reason for choosing health care as the domain of study is because of factors such as the frequent dynamics by which different actors constantly shift between tight and loose coupling, the different power relations seemingly inherent in the organisational structure, and the cultural imperatives and strong narratives governing the divisions between the different professional identities. In the literature, dealing with crisis management in the health-care sector, the concepts of emergency and crisis are typically treated as binary processes. This implies an analytical focus accorded to situations defined as emergencies or situations that are not, rather than any processes that might take place in the span between a situation defined as normal and a state of emergency. The first research theme in this thesis therefore focuses on establishing a theoretical framework for describing the social process of escalation, and for discussing the significance of existing theoretical concepts held to have explanatory power with regard to emergency management operations. The first specific research question related to the theme is the following:

Question 1a: Are there aspects, relevant for understanding processes of escalation, that are not covered by previous research into clinical emergencies? If so, how can those aspects be scientifically investigated?

Exploration of this first question, which concerns theorisation surrounding the concept of escalation, inevitably leads to a scientific discussion of a specific theoretical notion: the notion of *sensemaking*. This concept has been accredited with major potential for scientific explanation of social and organisational phenomena observed during crisis management operations. Hence, the development of a theoretical framework for analysing organisational resilience in escalating situations needs to relate to the explanatory potential of sensemaking theory. The question needs to be asked as to whether sensemaking theory could help to explain mechanisms of organisational resilience, or the lack thereof, in escalating situations. Focusing specifically on the breakdown of sensemaking in crisis situations, and acknowledging how appreciated the theory of sensemaking is in the community of organisational and administrative science, the research question related to the explanatory potential of sensemaking in understanding escalating situations is the following:

Question 1b: What is the academic basis on which sensemaking has been so readily embraced by the community of organisational science?

Research Theme Two: Interpretive studies of escalation and their normative implications

The second research theme involves interpretive studies of escalating situations in simulated as well as naturalistic environments. By connecting the interpretive results to the theoretical framework (as developed in Theme One, above), it is possible to derive normative implications which may enhance organisational resilience, primarily in the domains embraced by the research activities but also, by extension, in other complex high-risk areas.

The naturalistic domain chosen for the research is health care, and the specific escalating situation studied is when a child-birth situation goes from being normal, to being non-normal, pathological, moving towards an emergency situation, potentially requiring the solution of performing an emergency Caesarean section. A central decision in such an escalating situation is the intervention decision - i.e. the decision to call a colleague for help (Cuvelier & Falzon, 2008). Because of a belief in complexity theory to offer a framework with possibilities of interpreting such decisions in a different light than traditionally have been done, data from the interpretive studies is analysed through the lens of complexity theory in order to answer the research question:

Question 2a: What theoretical as well as practical implications can be drawn from analysing escalating situations in health care through the theoretical lens of complexity theory, and in what way do such implications differ from prevailing dogmas?

The research question implies a balance between *interpretive* and *normative* conclusions. I have examined the nature of escalation in the specific context, with my interpretation informing the understanding given to escalation as a theoretical concept. However, this understanding is also of pragmatic use, owing to its potential to guide strategies for managing escalating situations in the context studied. This reasoning emphasises the balance between the way research *interprets* how things are, and the *normative* conclusions that can be drawn regarding how things ought to be[2]. The same applies to the second research question included in the research theme. It was assumed that teams from different backgrounds would choose different strategies for coordinating their actions to manage escalating situations. However, the nature and outcome of different coordination strategies seemed to have been left relatively unexplored by previous research. Furthermore, on the basis of a review of the

[2] This balance is further outlined in Chapter Four.

literature, I was able to conclude that studies into team performance in emergency situations typically have their epistemological roots in theories which focus on the behaviour of individual team members, rather than on their efforts to interact, collaborate and coordinate their actions in order to reach overarching goals. Hence, an experimental study was set up to answer the following question:

Question 2b: How do different coordination strategies affect the level of team control in escalating situations?

The formulation of research question 2b assumes that there are different coordination strategies to be observed in studies of escalating situations. This assumption has above all been reached as the result of a process in which the research question was re-defined following preliminary studies which suggested that there are indeed different coordination strategies that can be triggered through selecting teams with different backgrounds. Instead of limiting the analysis to descriptions of coordination processes, question 2b steers the enquiry towards the *outcome* of the processes observed; this has normative implications in terms of identifying which coordination strategy is most efficient, as gauged by outcome.

Research Theme Three: Team Performance Assessment

During the process of conducting studies to answer research question 2b, it became evident that known methods for assessing team performance derive from the paradigms of information processing and cognitive psychology (Bergström, Henriqson & Dahlström, 2011). A third theme for this thesis has therefore been defined with the normative aim of developing a generically applicable method for team performance assessment, in which the team cognition process is located in the joint cognitive processes of coordination rather than in the respective minds of the individual team members. The research question asked is the following:

Question 3: How can the academic and empirical basis for the assessment of team performance in escalating situations be enhanced towards a focus on macro-cognitive features of work?

Chapter Three

Theoretical Framework

This chapter presents an outline of the theoretical framework for this thesis. The initial section introduces the process which is particularly in the spotlight – i.e. escalation. This is followed by the delineation of a theoretical framework for discussing organisational resilience in escalating situations which draws on complexity theory, joint cognitive systems theory, and resilience engineering.

The Concept of Escalation

There is no existing extensive research base on the topic of escalating situations in complex organisations, which is why one of the primary aims of this thesis is to help fill that gap. The main writing in which the process of escalation is made explicit is a study by Woods and Patterson (2001), which highlights escalating situations with regard to "clumsy use of technology".

What is interesting about how Woods and Pattersson introduce the concept of escalation is that they use it to describe the process which *precedes crisis*. They describe "the escalation principle" in the following way:

> The concept of escalation concerns a process – how situations move from canonical or textbook to non-routine to exceptional. In that process, escalation captures a relationship – as problems cascade they produce an escalation of cognitive and coordinative demands which brings out the penalties of poor support for work. (Woods & Patterson, 2001, p. 291)

Woods and Patterson describe the process of escalation in technical terms, as "a cascade of effects in the monitored process". In this sense escalation becomes a situation *outside* the organisation, demanding a coordinated response by the organisation, rather than a process taking place *within* the social structures of the organisation. However, once a response to the escalating situation is initiated, that response influences the nature of the unfolding situation. The main implications from Woods and Patterson's discussion concern the design of technological systems for

monitoring and responding to the flow of data (Woods & Patterson, 2001; Woods, Patterson & Roth, 2002). By shifting the focus to escalation also towards social processes, my thesis aims to illuminate implications in terms of interventions directed towards social and organisational structures.

While it has not been labelled as research into the process of escalation, a certain amount of research has also been conducted into the mechanisms by which social processes come to a distinction between normal and non-normal, between problem and crisis. Within the field of health care, researchers have invested a lot of effort in developing normative or objective criteria for when to call for help in particular situations (Benner, Malloch & Sheets, 2010; Holmes, Murray, Perron & McCabe, 2008; Santiano et al., 2009) and in framing standardised communication protocols to overcome communication barriers of gender or hierarchy when situations need to be labelled in a particular way (Mackintosh & Sandall, 2010). Organisational scientists have also described how the language used to describe a given situation is a more relevant subject for analysis than an endeavour to try to establish any "correct" view of a situation (Grint, 2005; Janis, 1982). Finally, a seminal piece when it comes to describing the build-up of crisis in a social unit is Weick's narrative of the Mann Gulch fire (1993), which describes the interplay of social structure, leadership and meaning as a situation deteriorates. Weick's narrative was important for the establishment of sensemaking as a topic of organisational study. In my thesis, research question 1b focuses solely on reviewing the concept of sensemaking.

Further development of the theory base relating to escalation as a social process is the scope of Research Theme One in this thesis. The research contributions are outlined in Chapter Five.

Complexity Theory

The development of complexity theory

Complexity theory can essentially be seen as a synthesis of the post-modern ideas which emerged within several different scientific disciplines during the 20th century. What these post-modern ideas have in common is that they are all reactions to *reductionist* assumptions such as the view that the world is explainable by mathematical laws; the belief that it is possible to formulate final and non-controversial conclusions (truths); and the assumption that the functioning of the whole can be described by studying the functioning of the constituent components. It was during the period of European *Enlightenment* in the 17th and 18th centuries that many of the scientific (and reductionist) methodological ideals, as we still know them today, were developed. Indeed the period is often labelled the s*cientific revolution,* which in turn paved the way for the *industrial revolution* of the 19th century.

In the field of safety studies, the reductionist standpoint implies that the safety of a whole system is to be understood in terms of the safety of each individual component within that system, and that there is always symmetry between cause and effect in any safety-critical system. This symmetry implies that any professional (such as the well-educated medical doctor) should – on the basis of their knowledge of 1), the present condition of, and 2), the laws of motion for that specific system – be able to foresee any future damage that could be caused to that system. It also implies that by tracking back in time, it should be possible to identify the single *cause* (the non-functioning component) of any malicious event (Dekker, 2010). These *Newtonian*[3] assumptions tend to mean that safety enquiries are reduced to hunts for broken components (technical or human). This reductionist thinking also emphasises the idea of the *self-contained individual*, independent of the world in which she/he acts, making it easy to frame any accident analysis in terms of human behaviour causality (such as error, violation, bad judgement, insufficient situational awareness, or failure of leadership, seductively accessible as retrospective evidence) (Dekker, 2005; Dekker, 2011a; Dekker et al., 2011).

Complexity theory emerged as a reaction to the reductionist approaches to science. In mathematics, scientists like Henri Poincaré started to argue there were problems with Newtonian cause-effect driven mechanics by emphasising sensitivity to initial conditions (i.e. that a small effect in input can have huge effects on the output). Poincaré and his contemporaries marked the starting point, in the late 19th century, of the critical questioning of causal predictability as an ideal (Érdi, 2008). The models developed were still *deterministic*, in the sense that they still viewed the final state as determined by the initial condition, but they were no longer modelling the world as *predictable*, recognising the high level of uncertainty concerning initial conditions. A field in which this mathematical sensitivity to initial conditions is evident is meteorology. Edward Lorenz, known for coining the expression *butterfly effect* (which essentially implies that a hurricane in southern USA could be causally explained by the fluttering of a butterfly's wings in northern Norway) built on Poincaré's approach when, in the 1960s, he formulated the theory of non-periodic flows in meteorology (Lorenz, 1963). In physics, Einstein's theory of relativity together with the development of quantum mechanics triggered the development of post-modern physics. The quantum mechanics researchers, such as Max Planck and Niels Bohr, showed how the Newtonian paradigm, which explains the whole reductively via the behaviour of the constituent components, falls short in explaining behaviour at the subatomic level, because:

[3] "Newtonian science" is a common label for the reductionist thinking which embraces the idea of symmetry between cause and effect, as well as the laws of motion which are assumed to explain such cause-effect relationships (Dekker, Cilliers & Hofmeyr, 2011).

> At the subatomic level the interrelations and interactions between the parts of the whole are more fundamental than the parts themselves. There is motion, but ultimately, no moving objects; there is activity but there are no actors; there are no dancers, there is only the dance. (Capra, 1982, p. 92).

Following the examples set in mathematics and physics, in the middle of the 20th century, scholars from other disciplines began to question the reductionist ideals of the Enlightenment. In biology Ludwig von Bertalanffy founded *General Systems Theory*, concluding that while the (fundamentally Newtonian) laws of thermodynamics might work for closed systems, they do not apply when it comes to understanding open systems, such as ecosystems (Skyttner, 2005). In the field of neural science the psychiatrist Ross Ashby founded *Cybernetics* (Ashby, 1957), an interdisciplinary field with several applications, and formulated his famous *Law Of Requisite Variety*[4] (Ashby, 1958). The field of cybernetics is interesting because of its view of knowledge, which does away with the Cartesian notion of *dualism*, of the split between mind and matter, so crucial for the reductionist theory of the self-contained individual (in which the mind is self-contained and not inter-related with matter). Through studies of intelligence in neural networks a new view of knowledge was developed, which emphasised that:

> …knowledge is intrinsically subjective; it is merely an imperfect tool used by an intelligent agent to help it achieve its personal goals. … Such an agent not only does not need an objective reflection of reality, it can never achieve one. Indeed, the agent does not have access to any "external reality": it can merely sense its inputs, note its outputs (actions) and from the correlations between them induce certain rules or regularities that seem to hold within its environment. Different agents, experiencing different inputs and outputs, will in general induce different correlations, and therefore develop a different knowledge of the environment in which they live. There is no objective way to determine whose view is right and whose is wrong… (Heylighen, Cilliers & Gershenson, 2007).

In parallel with the cybernetics movement, scientists like Herbert Simon began questioning the Cartesian ideal of rationality. Based on studies in the fields of artificial intelligence and economics, Simon concluded that there is no cognitive system that can have full knowledge about a decision problem. Simon coined the term *bounded rationality* to explain how rational actions are rational only within their

[4] The "law of requisite variety", emphasising that "only variety can destroy variety" (Ashby, 1958), implies that in order to respond to the variety of potential system states, any actor needs as many degrees of freedom in their arsenal of response strategies as the system can present situations.

specific context – i.e. how rationality is always contingent on the specific context (Simon, 1982).

Principles of Complexity

The discovery of mathematic sensitivity to initial conditions, the emergence of quantum mechanics, general systems theory, cybernetics, and artificial intelligence, are some of the movements that have laid the ground for what is today labelled *Complexity Theory*. Using the words of Heylighen, Cilliers and Gershenson: "Complexity science is little more than an amalgam of methods, models and metaphors from a variety of disciplines rather than an integrated science" (Heylighen et al., 2007). To describe complexity theory in terms of scientific *facts* concerning how to understand (and measure) a complex system would be self-contradictory[5]. Instead, complex systems are often described in terms of a number of principles which explain why complex problems are so inherently difficult. Two of the complexity researchers who work to formulate such principles are Scott Page and Paul Cilliers. A synthesis of the principles they outline (mainly the principles of locality, emergence, openness, diversity, variability, path dependence and non-linearity) is outlined in the following.

The locality principle implies that all actions in a complex system are local. What each actor in the complex system does makes sense in the local conditions in which the actor operates, but the actor is not able to know the full effects of its actions. Actors respond locally to local information regarding locally changing conditions by *adapting* their coping strategies within an inherently uncertain environment. There is no single actor with knowledge of the entire complexity of the whole system, because that would imply the paradox of that actor needing to be as complex as the system itself (Cilliers, 1998; Dekker, 2011a). The locality principle implies that each actor in a complex system *controls* little, but *influences* everything.

The locality principle of complexity theory implies that the macro-behaviour of the system *emerges* from micro-behaviour, but not through direct control. The principle of emergence is based on the central tenet of general systems theory, which states that the behaviour of the whole is not reducible to the behaviour of the constituent components (or actors) (Heylighen et al., 2007). With regard to analysis of the emergent behaviour of the whole, complexity theory asks students of complex systems to turn their focus towards *interactions* and *relationships*, i.e. the local interactions which influence the behaviour of the whole (Larsson, Grunnesjö & Bergström, 2011).

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[5] The cybernetics (or even post-modern) view of scientific knowledge, being a part of the complexity movement, denies the potential of claiming such authority.

Just like general systems theory, complexity theory suggests that any attempt to draw a boundary around a complex system will represent an analytical sacrifice made by the one drawing it. Complex systems typically interact with their environment, and pressures from the surroundings affect the local adaptive strategies used by the system's actors. In Cilliers' words: "…because complex systems are open systems, we need to understand the system's complete environment before we can understand the system, and, of course, the environment is complex in itself. There is no human way of doing this." (Cilliers, 2005, p. 258).

According to complexity theory a complex system is not efficient when it follows design criteria and procedures. Efficiency in complex systems emerges from the *diversity* and *variability* of potential responses (Cilliers, 2010; Page, 2007). Indeed this principle is an application of Ashby's Law of Requisite Variety, which in organisational sciences is sometimes developed further into the *Law of Requisite Imagination* (Westrum, 1993) – implying that in order to respond to the various conditions that might emerge in a complex system, the actors of the system need to have the ability to imagine the implications of all the potential ambiguities, uncertainties and goal-conflicts that the dynamics of the system can hold. It is its diversity which equips a complex system with the *adaptive capacity* to cope with disruptions, conflicts and rapidly changing conditions. Indeed, complexity does not imply *chaos*. The adaptive capacity of a complex system can be seen as embodying a high level of *order*. Complexity researchers often emphasise that complexity is what happens between order and randomness, between tight and loose coupling, to use the terminology of Perrow (1984). Heylighen, Cilliers and Gershenson state the following:

> In a truly complex system … components are to some degree independent, and thus autonomous in their behaviour, while undergoing various direct and indirect interactions. This makes the global behaviour of the system very difficult to predict, although it is not random. (Heylighen et al., 2007).

The principle of *path dependence* implies that complex systems cannot be understood without understanding their history.[6] Their past is co-responsible for their current condition, and any description of a complex system that does not consider history must be seen as a snapshot rather than a description of complexity (Cilliers, 1998, p.

[6] The reader may find this formulation of what "understanding" complex systems entails theoretically problematical. Indeed, complex systems are defined by the impossibility of fully grasping their complexities. However, Cilliers (2005) argues that the principle of not being able to understand a complex system in all its complexity does not imply that we should not make efforts to understand as much as possible while acknowledging the limited and contingent frameworks from which we generate our understanding. To Cilliers, complexity does not imply relativism or nihilism. It implies the need for modesty about the knowledge that we have.

4). The historical dynamics of the system should be described as *non-linear* with great asymmetries between input and output; and what seems like a local quick-fix (such as one ward at a hospital switching from one casebook system to another) may in fact have major effects on the emergent behaviour of the whole.

One pedagogical approach to discussing complexity, which is used in this thesis, is to distinguish *complex* from *complicated* (Dekker et al., 2011). While complex systems are described using the principles outlined above, complicated systems are, rather, describable from a reductionist perspective. A merely complicated system (e.g. a machine) is fully describable in terms of the rules governing its workings. It can be controlled using pre-defined design rules for how it is supposed to operate under all possible circumstances. Order ensues from having the complicated system following one best method of operation, and the main aim of the complicated system is to operate *reliably,* which essentially is the same thing as operating *safely.* The complicated system is safe when it is reliable, and it is reliable when it follows the design rules. This distinction between complicated and complex is operative in this thesis in connection with the interpretation of best practice in health care (see Chapter Five and paper II).

Joint Cognitive Systems

The theoretical school of Joint Cognitive Systems (JCS), or Cognitive Systems Engineering, is a product of what is sometimes called the *second cognitive revolution*. The seminal piece defining the theoretical focus on joint cognitive systems was written by Hollnagel and Woods (Hollnagel & Woods, 1983) almost 30 years ago, and several books outlining the theory have been written since (Hollnagel & Woods, 2005; Woods & Hollnagel, 2006). The JCS theory was introduced as an alternative to the information-processing paradigm for interpreting human cognition which was the prevailing school in the study of cognitive psychology in the late 1970s and early 1980s. From the information-processing perspective, the focus of study is on the micro-processes of the human mind. The human mind is analysed as an information processor, or a stimuli-response system, with internal (cognitive) processes seen as being a reaction to an input and generating an output. This view makes a lot of sense if one is to perform a study of processes such as short-term memory in a controlled laboratory environment. Moreover, the research field of human factors has practised this view of *cognition in the mind* widely, with considerable scientific effort being put into describing internal cognitive processes such as *situation awareness* (Endsley, 1995; Endsley, 1988; Endsley & Connors, 2008), *complacency* (Parasuraman, Molloy & Singh, 2009), and *mental workload* (Dahlström & Nählinder, 2009; Parasuraman, Sheridan & Wickens, 2008).

The researchers who founded the school of JCS argued that the information-processing paradigm fails in describing the macro-cognitive processes of work. In short, they argued that the information-processing paradigm does not consider the context and joint interactions of human work. Instead of analysing cognition as a property of the human mind, they argued that cognition must in fact be studied as a goal-driven process situated in the work being conducted. Hutchins, an anthropologist and pilot, studied cognition as distributed in the work performed by all the actors in a cockpit (pilot flying, pilot non-flying, and the technological artefact) (Hutchins, 1995b). He changed the object of study from *cognition in the mind* to *cognition in the wild* (Hutchins, 1995a).

Two important concepts for this thesis are the JCS interpretations of *coordination* and *control* and the relationships between them. Put briefly, the theoretical understanding of these concepts as applied to the answering of research questions 2b and 3 sees control as an emergent property of coordination efforts between the actors of a JCS. Klein, Feltovich, Bradshaw and Woods (2004) have identified three primary requirements for successful coordination in joint activities: *interpredictability, common ground,* and *directability*. According to Klein et al., *interpredictability* refers to the ability to predict the actions of other parties involved in the joint activity, including aspects such as making one's own action predictable to others and sharing estimations of the time and skills needed to perform a certain action. The second requirement for successful coordination, *common ground,* is defined by Klein et al. as: "the *pertinent* mutual knowledge, mutual beliefs and mutual assumptions that support interdependent actions in some joint activity" (p. 146). Klein et al. point out that *common ground* is "not a state of having the same knowledge, data and goals. Rather, common ground refers to a *process* of communicating, testing, updating, tailoring, and repairing mutual understanding" (p. 146). Klein et al. agree with Christoffersen and Woods (2003) in stating that *directability* is a central aspect of team resilience, but also emphasise that *directability* is central to the interdependence of actions in the joint activity. Klein et al. (2004) label the carrying out of these requirements as a *choreography*, stating that "the choreography for carrying out these requirements involves coordinating a series of phases, and it is accomplished through employing various forms of signalling and the use of coordination devices, all of which incur coordination costs."

In the studies included in this thesis, the output of any given coordination process is described in terms of *control.* When it comes to the human influence on the task to be performed, JCS theory has adopted a cybernetics approach, defining control in terms of its circularities of feedback and feed-forward. This approach combines Hutchins' view of distributed cognition with the cybernetic concept of regulation (Ashby, 1958)

and the "perceptual cycle" of Neisser (1976), to provide a functionalist approach to control[7]. In this sense, control "happens" during the interaction of "human–task–artifact"; it is goal-oriented and influenced by the context in which the activity in question happens (Bergström et al., 2011; Henriqson, van Winsen, Saurin & Dekker, 2010). This is the reasoning on which the view of control as the emergent result of coordination is based. More instrumentally defined, Hollnagel and Woods (2005) distinguish between four *control modes*. In the *scrambled* mode the choice of the next action is random, a trial-and-error type of performance: "This is typically the case when situation assessment is deficient or paralysed" (p. 147). The second control mode is the *opportunistic* mode in which "planning or anticipation is limited, perhaps because the situation is not clearly understood or because time is limited. An action may be tried if it is associated with the desired outcome, but without considering whether the conditions for carrying it out are met" (p. 147). In the third control mode, the *tactical,* control is established by adhering to prescriptive rules and procedures. The final control mode described by Hollnagel and Woods is the *strategic* mode, which is characterised by a longer time-horizon and a management process which looks ahead, towards high-level goals. In the strategic mode, "the dominant features of the current situation, including demand characteristics of information and interfaces, therefore have less influence on the choice of action" (p. 147).

The school of JCS became a new focus of study in the field of human factors research, stimulating the development of new ways of analysing cognition (Neisser, 1976), decision-making (Hutton & Klein, 1999; Klein, 1998; Lipshitz, Klein, Orasanu & Salas, 2001) and the interactions between humans and technological artefacts in joint cognitive systems (Cook & Woods, 1996; Crandall, Klein & Hoffman, 2006; Hoffman, Crandall & Shadbolt, 1998; Miller, Patterson & Woods, 2006; Naikar, Moylan & Pearce, 2006; Woods, 2003). In addition, debates were initiated concerning the validity of the models which had been adapted from the cognitive constructs of the information-processing paradigm (Dekker & Hollnagel, 2004; Dekker & Woods, 2002; Dekker, 2003; Dekker, Nyce, van Winsen & Henriqson, 2010; Moray & Inagaki, 2000).

JCS, in the way it locates the target of analysis in the naturalistic macro-processes of work rather than in any internal cognitive process of individual human beings, provides the basis for the view of teamwork and organisational performance applied in this thesis as outlined below.

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[7] This functionalist approach distinguishes the JCS view of control from a Cartesian dualistic view in which control would be seen as an internal process of the human mind. The JCS approach locates the notion of control instead at the macro level of the cognitive system, asking the observer of control to seek the processes which establish a certain level of control in interpretations of interactions between actors, rather than in the behaviour of individuals.

Resilience Engineering

In the same way as the theory of joint cognitive systems, resilience engineering was suggested as an alternative to currently prevailing paradigms. In the case of JCS the old paradigm was the information-processing paradigm of cognitive psychology. Resilience engineering was in turn formulated as an argument for a coherent set of theories to describe systems safety using terms adopted from complexity theory[8], instead of applying the reductionist Newtonian approach of investigating broken parts (errors, violations, misconduct, recklessness).

Resilience engineering was defined as a field of study at a symposium held in Sweden in 2004, and defines a new perspective on the realm of systems safety. The main ideas were laid down in a book published two years later (Hollnagel et al., 2006a), and from then up until the publication of this thesis another three symposiums have been held, with the research contributions being edited for collected publication in books (Hollnagel, Pariès, Woods, Wrethall, 2011; Hollnagel et al., 2008). A reader noting the references given may now have observed that it was basically the same group of people introducing the new view of systems safety as had, 20 years earlier, introduced the new view of cognition theory. Where they in the previous instance had been impatiently unhappy with the way classic cognition theory had been used to describe human work in highly technological environments, they were now becoming impatiently unhappy with the way safety, risk and accident causation were understood by the community of systems safety analysts.

The meaning of the label *resilience* is different in different schools. In mechanics the resilience of a spring is determined by how well it absorbs energy when stretched out and how well it releases the same energy once tension is removed. In ecosystems theory, resilience refers to the ability of the ecosystem as a whole to adapt to, and absorb, disturbance and disruptive events. These two interpretations of ”resilience” are highly different: the first one implies “bouncing back from diversity” (Hale & Heijer, 2006, p. 35), while the second one rather implies the adaptive capacity of the system, a capacity that might well be interpreted as rooted in the diversity of the system. Adapting in order to survive does not however necessarily imply that the system is the same after the disturbance – in fact, viewed in terms of complexity thinking, systems constantly adapt and change while constantly interacting with their environments. Adapting this view of resilience to high-risk organisations implies

[8] The notion of complexity was introduced to the field of systems safety via Perrow’s *Normal Accident Theory* (Perrow, 1984). Even though Perrow saw complexity and coupling as two separate and stable system properties, rather than seeing the dynamics of coupling as an important aspect of complexity, this seminal work is important for understanding the path dependency of systems safety thinking.

making a distinction between *reliability* as the collective *property* of all reliable components, and *resilience* as a *capability* of the system as a whole. In that sense the concept of resilience has more in common with a concept such as sustainability than with the concept of reliability.

The main standpoint of the "resilience movement" is that risk and safety are both products of the same kind of processes – namely, *performance variability in complex systems*. The local adaptive capacity of the system's actors guarantees safety in the dynamic world of an open system and is at the same time a source of risk. In complexity terms, *safety and risk are both emerging properties of performance variability* (Patterson, Cook, Woods, Render & Bogner, 2006) and no accident can be understood in terms of errors, violations, misconduct or recklessness. Instead, resilience engineering implies that accidents might occur even when all actors behave exactly as expected (and implicitly or explicitly required).

Resilience engineering emphasises Rasmussen's theory (Rasmussen, 1997)[9] of the goal-conflicted competitive environment in which many high-risk systems try to optimise their performance (balancing the goals of becoming faster, better and cheaper with staying safe) (Hale & Heijer, 2006; Woods, 2006). Any account of an accident that aspires to credibility in the eyes of resilience engineering researchers will need to consider *path dependence,* i.e. the system's history of trying to optimise itself and survive in such a complex, goal-conflicting environment (Dekker, 2006; Dekker, 2011a; Pidgeon & O'Leary, 2000; Starbuck & Milliken, 1988; Vaughan, 1996).

With the argument that risk and safety are emerging properties of the same kind of processes, resilience engineering thinkers ask their peers to turn their analytical focus to all those complex situations when things go right, when the adaptive capacity of the system ensures safety (Hollnagel, 2006; Hollnagel, Woods & Leveson, 2006b). In the work of outlining a theory for how this is to be effected, recommendations from the school of *High Reliability Theory* (Rochlin et al., 1987; Weick & Sutcliffe, 2007) are co-opted into resilience engineering thinking (Dekker & Woods, 2010; LaPorte & Consolini, 1991) in order to enrich the consideration of what kinds of *sacrificing decisions, organisational redundancy* and *institutionalised discussion of risk* might guarantee resilience in complex environments.

[9] This seminal paper's approach to safety as a control problem can be seen as an application of the control-theory branch of cybernetics.

The Synthesis: Operational Resilience in Complex Organisations

Complexity theory, joint cognitive systems theory and resilience engineering form the theoretical framework for the analysis of the research questions.

When it comes to analysing organisational resilience there are clear differences in the focus of study depending on which cognitive paradigm the researcher represents. The study of the human as a stimuli-response system (the information-processing perspective outlined above) puts the focus on individual human behaviour, such as making correct and rational decisions on the basis of optimal information processing that is rooted in accurate awareness of the situation, assertive communication and effective interaction between leaders and followers. The research field of *human factors* typically adopts information-processing constructs, using different techniques to assess organisational behaviour (Dekker & Lundström, 2006; Flin & Maran, 2004; Flin & Martin, 2001; Flin, O'Connor & Crichton, 2008; Flin, O'Connor & Mearns, 2002; Helmreich et al., 1999; Thomas, Sexton & Helmreich, 2004). Examples of this include the use of behavioural markers (such as NOTECHS, KSA markers), and different forms of Line Operations Safety Audit (LOSA), where the primary concern is with counting and categorising errors (Bergström et al., 2011; Hollnagel & Amalberti, 2001); while other work focuses more on measuring participant attitudes (Alvarez, Salas & Garofano Christina, 2004).

The alternative approach to understanding sharp-end work in safety-critical systems adopted in this thesis, is based on the perspectives provided by complexity theory and cognition understood as a phenomenon distributed among the actors engaged in a specific context (Fiore, 2004; Hutchins, 1995a). The focus of study is on the complexity and coupling of interactions in joint cognitive systems. This approach represents a move away from a concern with human cognition and behaviour analysis, in favour of the study of organisational capacity to adapt and coordinate in a given (complex and potentially escalating) situation. From the perspective of complexity, team performance is an emergent property of the process by which a system composed of physically separated elements and artefacts (e.g. different wards at a hospital or different aircrafts on approach to an airport) shifts from loose to tight coupling, from high autonomy to high interdependence, in a short span of time (such as when different hospital wards which normally function relatively autonomously become highly interdependent in response to an escalating situation) (Dekker, 2011b; Snook, 2000).

Furthermore, from the approach of analysing cognition as a distributed phenomenon, the focus shifts from the human being as an information-processor to the work in which humans engage together with other team players, such as people (spread over hierarchical boundaries) and technological systems (Woods, 2003). By choosing not

to concentrate on the behaviour of separate individuals, the focus of the thesis is shifted to the study of cognition as distributed in the entire system that is engaged in a particular work situation (Hutchins, 1995b). This is effected by using theoretical constructs aimed at describing macro-cognitive features of the joint cognitive systems under study. Examples of such constructs are coordination and control (as outlined above).

When it comes to studies of teamwork, attempts to take a more holistic approach to team performance have tended to focus on the construct of shared mental models (Klimoski & Mohammed, 1994; Kraiger & Wenzel, 1997; Orasanu, 1990). Other approaches towards investigating the macro-cognitive features of a cognitive system from a holistic perspective include studies of team knowledge as a macro-cognitive property rather than as the collective knowledge of the individual team members (Cannon-Bowers, Tannenbaum, Salas & Volpe, 1995; Cooke, Salas, Kiekel & Bell, 2004). As yet, not many methods have been developed for the study of such holistic team knowledge, but those that do exist are typically primarily focused on investigating the level of consensus among team members and on establishing whether their course of action is perceived as right or wrong (Cooke et al., 2004). The question remains, however, as to whether the level of consensus in the team can be taken as a sure indicator of effectiveness. It is a question which is the subject of further study in this thesis.

It has by now probably become clear that in this thesis the interest lies not in observing human behaviour *per se*, nor in deconstructing human work in the light of motivationally-based models or concepts such as situation awareness, complacency, or human error. Instead, the analytical interest focuses on the complexities facing sharp-end operators in their day-to-day work in systems that may be interpreted as complex and dynamic, and on the emerging macro-results generated by different processes of coordination and interaction amongst different actors in complex situations. I will be investigating joint cognitive performance within a macro-cognitive interpretive framework of coordination and control. The social processes of escalation will be studied in terms of complex interactions, relations, performance variability and diversity. My work views safety and risk in escalating situations as: emergent properties of local interactions; expressions of the shift from loose to tight organisational coupling; and manifestations of relations.

Chapter Four

Research Process

This chapter presents a summary of the research process. It begins with an overview of the entire process. This is followed by a description of the epistemological framework, which is then connected to the methodological approaches used to explore the research questions.

The research process summarised by this thesis can neither be described as perfectly iterative, with the themes informing one another as they lead up to the final conclusions, nor perfectly chronological, with the themes researched in a chronological order. A more accurate description of the explorative research process would be as a web of relationships between the main research aim, the fields of study, the types of questions asked in the studies, the result implications and the three themes. In the process of studying the questions it became evident that additional questions were needed, and when certain of the themes were being explored, conclusions could be drawn from research into the others.

Balancing Interpretive and Normative Conclusions

Throughout the explorative research process summarised in this thesis a variety of methodological approaches have been applied. The conclusions drawn can be grouped into two main categories: *interpretive* and *normative*, and several of the research questions asked have both an interpretive and a normative dimension in their quests for answers. The normative conclusions aim at creating change through improved practice, methods or design. For example, a research question such as question 2a in this thesis requires a normative answer by the way it requires the researcher to seek practical and pragmatic implications. So does research question 3 calling for an answer in terms of a suggestion of "how to do it". However, any normative answer needs to be based on conclusions in terms of the interpreted meaning of what is seen, heard and told in the research process.

The quest for balance between normative claims and interpretation highlights the ethical dimension of conducting research in complex environments. In neither case

can the researcher claim to be fully detached from the conclusions or, to put it in another way, that the conclusions drawn are objective and universal. The term interpretation has been chosen consciously with the purpose of highlighting this ethical dimension of the research. An alternative methodological label could have been "descriptive". However, a researcher who called the conclusions drawn *descriptions* rather than *interpretations* could be seen as claiming authority to draw universal and final conclusions about the phenomena under study.

The Greek philosopher Aristotle highlighted this epistemological conflict as early as 2400 years ago. He distinguished between the three intellectual virtues *episteme* (universal, invariable, and context-independent scientific knowledge), *techne* (the art of using epistemic knowledge in design), and *phronesis* (the analysis of values, of whether things are good or bad for man). 2000 years later the scientific revolution broke out through the Enlightenment movement of Western Europe. Rationalists, such as Spinoza and Descartes, questioned the power of the church and crown by claiming every man's ability to reason his way to universal truths (such as the Newtonian laws of motion or Euclid's axioms). Other thinkers, such as Bacon, Locke and Hume, questioned the rationalist ideal by claiming that the only way to draw conclusions is through our sensory experience; they represent the epistemological school of *empiricism*. Aristotle would call both these approaches intellectual quests for *episteme*: the search for universal, scientific knowledge independent of context or values. Somehow the third intellectual virtue, that of *phronesis*, got lost in the enlightened search for universal, scientific truths (Flyvbjerg, 2001).

The aim of establishing universal truths, initially practised in the natural sciences, was also adopted as an ideal when the scope of a new, social, science was formulated in the late 19th century. One of the pioneers of sociology, Emile Durkheim, suggested that the aim of the social sciences should be to uncover the universal "social facts" underlying human nature[10]. The nature of human institutions was to be *explained* in terms of the social facts discovered through scientific practice (Durkheim, 1972). Another of the sociological pioneers, Max Weber, took a contrasting view. Where Durkheim saw causal laws and facts of human nature, Weber saw historically evolving social contexts that could never be reduced to causal explanations. Rather than explanation, the aim of the Weberian approach to social enquiry was interpretation (Runciman, 1978). According to Weber, the complexity of meaning overwhelms any

[10] Durkheim did not formulate this new science to distinguish the social sciences from the natural sciences, but from the psychological sciences. The social world, Durkheim argued, is independent of individual minds, and social phenomena (social facts) can be explained in the same way as can natural phenomena.

attempt at a causal explanation, making it impossible for the scientists to detach themself from the social phenomena under study.[11]

In the spirit of Weber, many contemporary thinkers have also criticised those who view social science as governed by a "technological rationality" (Angell & Straub, 1999) that has been borrowed from the natural sciences. For example, Latour (1987) denies the potential of the social sciences to uncover a "real world" beneath layers of physical/biological/social/cultural dust. Instead, he describes the scientific process in sociology in terms of negotiating controversies and constructing stories – i.e. the "facts" are *constructed* rather than uncovered. Healy (2003) makes a similar point, arguing that "knowledge does not so much reflect a state of the world but acts to shape it in ways that both facilitate and constrain action" (p. 690)[12]. Flyvbjerg (2001) argues for the need of *phronesis* in social enquiry, with phronesis operationalised in the following way:

> Phronesis is that intellectual activity most relevant to praxis. It focuses on what is variable, on that which cannot be encapsulated by universal rules, on specific cases. Phronesis requires an interaction between the general and the concrete; it requires consideration, judgment, and choice. More than anything else, phronesis requires experience. (p. 57).

However, Flyvbjerg is not happy with the incorporation of phronesis into social enquiry alone. To make contemporary social science matter (to use the words of his book title) Flyvbjerg argues that it also needs to include issues of power. When studying the relationships in which values are negotiated, we should not only ask what is good or bad for men, but also who gains. Note how Flyvbjerg turns the scientist's interpretation of the social phenomena under study into a matter that belongs in the ethical domain. A similar argument is made by Cilliers (2005), who states that no scientist can claim the ability to draw final or universal conclusions, choices have to be made, and in making choices the scientist cannot avoid entering the normative and ethical domain (a fact which also emphasises the power of the researcher).

The works of Weber, Latour, Flyvbjerg and Cilliers form the epistemological framework of this thesis. This epistemological framework was described at the beginning of this section as embodying a balance between interpretive and normative claims. The discussion above makes it clear that the scientist's interpretations, too, have a normative (and ethical) dimension, which means that it is hard to draw such

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[11] The conflict between the Durkheimian and the Weberian approach to the social sciences is further outlined in Chapter Five.

[12] It is also noteworthy how these *post-modern* claims relate to the cybernetic movement outlined in Chapter Three.

boundaries. However, as outlined above some of my research questions are described as entailing a clear directive to seek a normative answer, while other questions have been formulated as a request for a more interpretive answer. The most important point to make is that both the interpretive and normative approach highlight the role (and power) of the researcher as ethically responsible for the conclusions drawn. Furthermore, this epistemological framework allows interpretive conclusions to co-exist in tandem with (modest) normative implications.

Methodological Approaches

The main methodological approaches for the work underlying this thesis have been naturalistic research and experimental studies.

Naturalistic research is an interpretive approach which seeks to describe the ordinary daily life of people representing a particular naturalistic[13] context. The overall questions asked by the naturalistic research approach are: *What is going on here and why?* The aim of naturalistic study is to make visible, and compare, the patterns of thought, meaning and practice in which the social actors in the naturalistic context being studied engage (Creswell, 2007; Fetterman, 1998). The naturalistic approach is well-suited to the explorative nature of research initiatives which seek to test a small number of initial hypotheses (Kushner & Norris, 1980; Smith, 1981). The approach is appropriate for the analysis and comparison of various staff perspectives on escalating situations in health care, where these perspectives are to form the basis of a model for discussing escalation as a central concept in crisis studies. Throughout the research process, the two main techniques used in studying the naturalistic context of healthcare were observational studies, and interview studies.

The experimental field studies in controlled environments were conducted with two purposes: firstly, to deepen the existing knowledge concerning escalation management; and secondly, to evaluate a proposed method for team performance assessment. The controlled field study is well-suited for evaluating an initial thesis (e.g. that teams from different backgrounds manage similar situations differently), but also for drawing conclusions which may be interpretive (e.g. interpretations of the different coordination strategies that different teams use) or normative (e.g. interpreting which strategy results in the "most successful" outcome).

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[13] At this point it is appropriate to give a brief explanation of the label *naturalistic.* A naturalistic study focuses on studying people in their *natural* environment rather than in a laboratory or any other context designed by the scientist in order to test a certain hypothesis. An entire theoretical school based on naturalistic research (and named accordingly) is that of *naturalistic decision-making*, which focuses on how experts make decisions in their domain of expertise (Lipshitz et al., 2001).

The following presents outlines of the different naturalistic research approaches adopted, and of the experimental studies carried out.

Observing Naturalistic Work

For the researcher seeking to study escalating situations in a naturalistic setting, health care offers a unique platform for data collection (Buckle, Clarkson, Coleman, Ward & Anderson, 2006; Carayon, 2010; Cook, Noyes & Masakowski, 2007; Cook & Woods, 1994; Plsek & Greenhalgh, 2001; Woods, Dekker, Cook, Johannesen & Sarter, 2009; Xiao, Hunter, Mackenzie, Jefferies & Horst, 1996) with its different actors constantly shifting between tight and loose coupling, with gaps in the continuity of care (Cook, Render & Woods, 2000), with the different power relations inherent in all normal as well as non-normal work (Amalberti, Auroy, Berwick & Barach, 2005; Donahue, Miller, Smith, Dykes & Fitzpatrick, 2011), and with the existence of cultural imperatives and strong narratives governing the divisions between the different professional identities (Dekker, 2007; Dekker, 2011b; McDonald, Waring & Harrison, 2006). One area offering ambiguous safety-critical situations is obstetrics. In the Swedish hospitals studied, the nursing speciality of midwifery has significant medical authority, with midwives conducting much of their work independently in normal situations – but at the same time, situations arise which require a decision to be made as to whether to call a resident (junior physician) for help. The making of this decision (which is the first step in qualitatively changing the organisation managing a specific situation) has been studied in specific detail in the first and second research theme of this thesis.

Participant observations help the researcher to gain understanding of a particular naturalistic context (Wax, 1985) by answering the question: *What do they do?* For my study of escalating situations in obstetric care, participant observations were conducted in several different settings. The task was to track the daily practice of the actors involved in assisting child-birth: midwives (where I observed aspects such as their construction of situations as normal or non-normal, the occasions when they call for help from other professionals, their narrativisation of their own and others' professional identities); resident obstetricians (e.g. their balance between autonomy and the need to bring in additional expertise); attending obstetricians (e.g. how they construct a call from a resident as legitimate or not, their management of information received from other members of the team); and anaesthetists and others.

The study was mainly conducted at a mid-size Scandinavian hospital. I carried out my observations during a period of intense weeks of round-the-clock presence, during which I was able to move freely between operating theatres and labour wards, following normal as well as non-normal labour, elective as well as emergency Caesarean sections (CS). I functioned as an outsider researcher in the sense of not having a professional background within medicine but within the field of human factors and systems safety. My aim was to interpret the complexities of normal, as well

as non-normal, work in obstetrics. During the field study, notes were taken on the observations made as well as on the informal conversations that were held with midwives, resident and attending obstetricians, anaesthesiology nurses, anaesthesiologists, operation nurses and assistant operating nurses. In addition, a co-author and thesis co-supervisor spent time on surgical wards, and were present when policies relating to hand washing were introduced and policed.

Interview Studies

Formal as well as informal interviews enable researchers to ask and answer the questions: *What do they say?* and *How do they reconstruct?* How do the representatives of different professions talk about their respective roles, tasks and needs in escalating situations? How do they see each other's roles, tasks and needs? Is there a divergence between what they say and what the researcher interprets in observations? A further important function of interviews is that, by asking follow-up questions, one can clarify certain actions (for example by asking "Why did they do what they did?") or attitudes (Hoffman et al., 1998; Klein, Calderwood & MacGregor, 1989).

As with the observation study outlined above, the interview studies were conducted with health-care personnel. What was said complemented what was observed, and this contributed to a richer interpretation of the nature of the process of escalation in the setting of health-care work.

In connection with a training course for dealing with emergency obstetrical situations, semi-structured narrative interviews were conducted with four Scandinavian midwives. In the interviews, which were conducted in a focus group and led by me together with one of my assistant supervisors who is also a specialist in obstetrics, the midwives were asked to give their own narratives (and reflect on each other's narratives) concerning non-normal labour situations. Specifically, the interviews probed the complexities of the intervention decision to call a doctor (most often the junior resident on duty) for help. In close connection with the field study, semi-structured interviews were also conducted with five midwives, two attending obstetricians, four anaesthesiology nurses, three anaesthesiologists, one operation nurse, one resident, and one assistant operating nurse. These individual interviews asked the respondent to recall specific situations, focusing on the role of the respondent in an escalating labour situation, and on any difficulties that the respondent perceived vis-à-vis team coordination in such situations (Hoffman et al., 1998; Klein et al., 1989).

Focused interviews were conducted in order to answer the question: "How do they reconstruct?". After a serious incident at a Scandinavian university hospital I was invited to participate in two debriefing sessions with those involved in the case (including three midwives, two attending obstetricians and one assistant nurse). During the two debriefing sessions I was able to ask questions, listen to the

participants' narratives, and give my own reflections to what I heard and request feedback on those reflections. The debriefing sessions made it possible to use a very specific (and recent) case as a means of interpreting the complexities and uncertainties that prevail as a situation escalates in the health-care setting.

The data analysis was conducted by comparing and contrasting the interpretations made of the data gathered through observations, interviews, and debriefing sessions. In this process patterned regularities were interpreted and related to existing theory on best-practice management of normal as well as non-normal situations in health care. The process of presenting data, interpreting regularities and relating the findings to the existing scientific literature involved myself as well as several assistant supervisors and co-authors who engaged in data-analysis meetings, follow-up searches through the literature, and formulation of theory.

Experimental Studies in Controlled Environments

Two experimental studies were conducted. The first of them (which used a mid-fidelity simulation) had the aim of triggering and interpreting different coordination strategies in escalating situations (Research Theme Two) and the second (an emergency staff exercise) aimed at testing a method that had been developed for team performance assessment (Research Theme Three).

The simulation study was designed with the aim of having the potential to trigger different coordination strategies by asking teams to manage unexpected and escalating situations in a simulated environment. The teams were therefore selected to allow for differences in terms of the level of domain expertise and of experience in crisis management. The different strategies adopted by the teams to manage the unexpected and escalating situations triggered through the simulation design were then interpreted in terms of their methods of coordination and resulting levels of control.

Varying the level of expertise addresses the point made by Woods (1992) that research concerning people working in complex and dynamic systems "must use a different subject population than the typical subject of psychology experiments – either experienced, domain knowledgeable practitioners, people who are similar to this group […] or people who contrast practitioners on some important dimension." Varying the level of expertise in simulated scenarios is an approach that has also been practised by Dörner (1996) and Schragen (1997). For my study of different team coordination processes in unexpected and escalating situations, participants were selected based on two criteria: domain expertise and crisis management experience.

Table 4-1. Selection of participating teams based on their domain experience and experience of crisis management (III, p. 222).

Team	Domain expertise	Crisis management experience	Number of teams
Maritime crisis management instructors	Yes	Yes	Two
Professional seafarers	Yes	Some	One
Maritime students	Yes	No	Four
Civilian crisis managers	No	Yes	Four
Air Traffic Control students	No	No	One
Pilot students	No	No	Four

The specific simulation method was chosen so that it met the criteria of: triggering the participants to collaborate outside known procedures and routines; establishing a high degree of uncertainty; creating the feeling that the actions chosen by the participants really affected the unfolding of events; and, most importantly, providing scenarios which, as the situation escalated, demanded increased levels of collaborative effort (rooting this demand in the *escalation principle* as outlined in Chapter Three). The simulation method chosen was a mid-fidelity ship's bridge simulator. The term "fidelity" refers to how closely a simulation imitates reality – essentially, how naturalistic it is. Fidelity does not necessarily reflect the level or degree of technology (Dahlström et al., 2009; Hughes & Rolek, 2003). The simulation used was complex but not photorealistic or three-dimensional. However, all the structural and major technical aspects of a ship were included in the simulation – for example, it included conditions like passengers, sea, weather, and other traffic. All 193 of the ship's crew members and 300 passengers were simulated individually, using a coarse human-factor model (Strohschneider & Gerdes, 2004). The simulation provided data to the participants in the form of computer printouts. There was no visualisation of the simulation beyond blueprints and maps.

Simulation sessions were performed with teams of between five and seven participants acting in different roles as the crew on the bridge of a passenger cruise vessel caught in a stormy night on the Atlantic Ocean (Bergström et al., 2008; Strohschneider & Gerdes, 2004). The roles (e.g. Captain, Chief Officer, Chief Steward, Chief Engineer, etc.) were outlined in printed descriptions of the overall responsibilities of each role. The participants themselves allocated the roles within their team. During the simulation the participants experienced different types of events that demanded their

intervention to prevent the already difficult situation from escalating beyond their control.

Each team went through two simulation sessions lasting for an average of three hours each, in what was a two-day programme with one simulation session each day. After the first session, long debriefing sessions were held focusing on the participants' own reflections on their performance. Between the sessions the facilitators also led discussions about different aspects of the management of unexpected and escalating situations, with particular focus on the participants' experiences from the first session.

The simulation sessions and the debriefing sessions were video-recorded. A qualitative method was used to analyse team coordination in escalating situations, applying the language for describing requirements for successful team coordination formulated by Klein et al. (2004). Performance outcome was interpreted by labelling the coordination strategies in terms of the control modes *scrambled, opportunistic, tactical* and *strategic*, as described by Hollnagel and Woods (2005).[14] The analysis was focused on the coordination processes the teams used to maintain an optimal level of control, particularly during the situations when the simulation triggered increased team member interaction.

Design of Team Performance Assessment Protocol

When evaluating the simulation study it was concluded that the assessment approach based on qualitatively describing coordination strategies did not meet the requirement of being generalisable amongst evaluators (since it required a high level of theoretical knowledge to use), and could therefore not be suggested as a method that could give comparable results between different studies (i.e. if the studies were not performed by the same researchers/evaluators). Against this background, and also in light of the need for establishing a method for team performance assessment in contemporary theories focusing on the macro-cognitive features of managing safety-critical situations, Research Theme Three was defined with the aim of developing a method for team performance assessment using a design science approach. To make it possible to instrumentalise the theory into an evaluation method, the Contextual Control Model (Hollnagel & Woods, 2005) was chosen to form the theoretical base of the method. This constraint was chosen on the basis that the model represents a sort of operationalisation of the JCS view of control, coupled to qualitative indicators of the four control modes.

Put briefly, the design science approach requires any design (in this case, of a method for team performance assessment) to be based on a number of design criteria, and once developed, to be tested and evaluated in terms of the potential for meeting the

[14] These theories are further outlined in Chapter Three, above.

design criteria (Brehmer, 2008; Gregor & Jones, 2007; Hevner, 2007; March & Smith, 1995). The design criteria chosen stated that the method for team performance assessment should:

- be used to assess performance in its natural context
- be generic
- be user-friendly
- be easy to update
- give comparable results

Joint cognitive systems theory was used as the "kernel theory" (Gregor & Jones, 2007), defining the epistemological basis of the design. The method developed in order to meet the design criteria was based on Hollnagel and Woods' (2005) characteristics for the four control modes described in the COCOM model. The characteristics were divided into observable and non-observable, and all observable parameters were related to the main parameter for control: available time. The method developed divided the assessment procedure into an observation analysis and a participant questionnaire.

The method was tested in a pilot study with 22 participants who all participated in a nine-week course for rescue-service incident commanders given at the Civil Contingencies Agency College at Revinge, Sweden. They were experienced fire fighters and had also worked as fire officers at a lower level for several years. The participants can be described as highly experienced in terms of on-scene incident command, but with less experience in the role requirements of commanding staff with responsibility for supporting the on-scene personnel. They were divided into two groups with eleven members each. The division was made by the instructor responsible for the course and was based on the participants' domicile: the eleven members of Group 1 were working at fire services in northern Sweden, while the eleven members of Group 2 were based in southern Sweden.

The overall aim of the task for the specific scenarios studied was for the team to act as commanding staff supporting the rescue service personnel on the accident scene. The commanding staff were said to be working from a remote head office and they could not visit the scene in person. To get information about the case they would have to communicate by telephone or radio with the staff on scene. They could also seek information from other sources, such as obtaining information about the weather from the meteorological institute. Two scenarios (A and B) were used and each group played both scenarios.

Following data collection two analyses were carried out: the observation analysis and the questionnaire analysis. In the final labelling of control modes for each time-interval of the exercises, the observation analysis was given equal weighting with the

questionnaire analysis. The results of the sessions were presented in diagrams illustrating how the interpreted control levels changed over time in a given scenario.

Finally the results were reviewed in the light of the design criteria, to evaluate which aspects of the method lived up to the criteria and which aspects did not.

Methodological approaches connected to the research questions and appended papers

Table 4-2 gives an overview of the research process. The table summarises the connections between research themes, questions, methods and the particular papers used to address the questions.

Table 4-2. Overview of the research process.

Research Theme	Research Question	Research Method	Paper
Theorising escalation	1a	Scientific debate based on literature review and the naturalistic research.	I
	1b	Scientific debate based on literature review	V
Interpretive studies of escalation	2a	Naturalistic research: observations, semi-structured interviews, focused interviews	II
	2b	Qualitative interpretations of coordination strategies used during mid-fidelity simulation-sessions	III
Team performance assessment	3	Design science, pilot study in simulated environment	IV

Chapter Five

Research Contributions

This chapter is divided into three sections. The first section briefly summarises the research contributions put forward in the five papers appended to the thesis. In the second section each research question is addressed separately for a more thorough description of the particular research contributions coupled to each of the questions. This second section also takes a step beyond the specific answers to the research questions by going on to outline the implications of the answers given. Finally, the third section propounds a more holistic synthesis, in which the different research contributions are discussed together in terms of the knowledge added to our overall understanding of organisational resilience in escalating situations.

Research contributions in relation to the appended papers

Paper I: The social Process of Escalation: A promising focus for crisis management research

This paper is written in the form of a scientific debate. The main target group is researchers (and practitioners) of crisis management in the health-care domain, but the paper is also written in language accessible to students of crisis management in domains outside of health care. The aim of the paper is to outline a theoretical framework and a research agenda which focus on the social processes of escalation in complex environments. A review of the literature focusing on health-care crisis leads to the conclusion that the notion of crisis is typically treated in binary terms ("on" or "off") with crisis management defined in terms of recovering from a loss of control. With this conclusion as the starting point a new field of study, that of the social processes of escalation, is sketched out. Establishing a theoretical framework based on

preliminary findings from studies of escalating situations in obstetric care,[15] it is suggested that while some theoretical perspectives tend to over-simplify the issue of escalation, others have the potential to shed light on its complexities. When viewing the emergence of a crisis management system, for example in an obstetric escalation, through a social-constructionist lens, we are enabled to construct the definition of a situation as normal or non-normal in terms of an exercise of power in itself. Consequently, escalating situations offer important moments for the reproduction and confirmation of organisational structure, as well as to how an understanding of the historically rooted relations of power and entrenched professional identities can contribute to an understanding of escalating situations in organisations such as health care providers. This underlines the fact that there are many ways in which the social process of escalation is an interesting field of study for future health-care crisis research.

The author's contributions: I played a *major* role in planning the study, in conducting the analysis and in writing the paper.

Paper II: Complicated, Complex and Compliant: Best practice in obstetrics

Based on the conclusion in Paper I – that distinguishing between normal and non-normal is a central aspect for understanding the social processes of escalation – Paper II illuminates this *intervention decision* from the perspective of complexity theory (see Chapter Three). The theoretical framework consists of an outlining of the main differences between complicated and complex situations. The paper initially points out that intervention decisions in the field of obstetrics are typically discussed in terms of normative guidelines for defining best practice in any given situation (by using words like *proper* reading of evidence in a given situation). Using data gathered from naturalistic research in different settings connected with obstetric care, it is argued how a decision often described in complicated terms (rather than complex) – namely, the midwife's intervention decision to call a doctor for help – can in fact be interpreted as highly complex. Returning to the principles of complexity and compliance it is argued that, given the complexities of obstetric practice, there is a need for strategies which complement the existing normative, compliance-based best practice-guidelines, in order to further enhance operational resilience. The search for an *objective decision criterion* can be complemented with means to embrace the *diversity* of practitioners who deploy differing and mutually sensitive repertoires for responding both to what they see as evidence, and to each others' constructions of

[15] Derived from the Latin word for midwife (*Obstetrix*, in itself derived from *obstare:* to 'stand before') obstetrics is the health care speciality concerned with pregnancy and child-birth (normal as well as non-normal) (Drife & Magowan, 2004). The two specialised categories of practitioners within obstetrics are midwives (specialised nurses) and obstetricians (specialised medical doctors).

and concerns about such evidence. With this as the paper's main conclusion, there is also an acknowledgement of the usability of compliance-based strategies (such as going through a time-out checklist before a surgical operation) in situations that can be interpreted as complicated rather than complex.

The author's contributions: I played a *major* role in planning the study and in gathering the data. I conducted the analysis together with the co-authors. The first author wrote the first version of the paper (I consequently played a *moderate* role in that process). I then played a *major* role in finalising the paper and in rewriting it after the first review.

Paper III: Team Coordination in Escalating Situations: An empirical study using mid-fidelity simulation

The aim of paper III is twofold. The study conducted for the paper is first of all a study of different strategies for coordinating the actions of participants engaged in managing escalating situations. But the study should also be viewed as part of a process of developing a language and methodology for team performance assessment. Initially carried out as qualitative narratives (Bergström et al., 2009) and framed as assessments of non-technical *generic competencies* for crisis management (Bergström et al., 2008), the investigations presented in this paper are used to introduce the language of joint cognitive systems theory (see Chapter Three) into the interpretation (and assessment) of the strategies used by different teams to manage unexpected[16] and escalating situations. This is effected by describing the coordination strategies of the different teams participating in the study in terms of the three requirements for successful coordination outlined by Klein, Feltovich, Bradshaw and Woods (2004) (described in Chapter Three).

In the experimental study the following four control strategies were interpreted by the researchers observing the different teams' management of the simulated escalating situations: 1) the consensus strategy, in which all team members made the decisions together after having informed each other of the latest unfolding of events; 2) the hierarchical strategy, in which a team leader was assigned the task of making all the important decisions, with information-sharing strategies adopted accordingly; 3) the rigid coordination strategy, in which the participants adhered strictly to predefined descriptions of roles and tasks; and finally 4) the proactive coordination strategy, characterised by a flexible and goal-driven process.

[16] "Unexpected" in the meaning that the teams were aware that they were going through a training program focusing on escalating crisis situations, but did not know what kind of situations might arise in the particular scenario.

With the description of the four coordination strategies being the main contribution of Paper III, it is also concluded that the method used for the assessment is not transparent enough to be suggested as a preferable approach in future studies. The result is unarguably the product of the individual researchers' interpretations of the observations made (which in itself is only to be expected, see Chapter Four), but when there is little transparency in how the interpretations are actually made it becomes a greater problem. It is this conclusion which defines the scope of Paper IV.

The author's contributions: I played a *major* role in defining the scope of analysis, conducting the data collections, analysing the data and writing the paper.

Paper IV: How to Assess Team Performance in Terms of Control: A Protocol based on Cognitive Systems Engineering

Two conclusions regarding team performance assessment were drawn in the process of conducting the study for Paper III, outlined above. The first conclusion was that the method used to qualitatively describe strategies for coordination and their resulting level of control was not transparent enough for it to be possible to propose it as generally applicable in similar studies. The second conclusion drawn was that there have been few scientific studies published which aims at establishing methods for assessing team performance rooted in joint cognitive systems theory. The scope of Paper IV is, consequently, to develop such a method. Using a design-science approach, a team performance assessment method is designed using Hollnagel and Woods' (Hollnagel & Woods, 2005) operationalisation of *Control* (the COCOM-model) as tool of analysis. The COCOM-model describes control in terms of four levels, with parameters encompassing the number of goals, sense of time, evaluation of potential outcome of actions, and the selection of next action. A division of these parameters into the two categories of *observable* and *non-observable* forms the basis for two evaluation tools: an observation analysis and a participant questionnaire. Both these evaluation tools require answers to questions linked to the COCOM parameters, and by giving equal weight to the data from each evaluation they may be synthesised into a specific control mode for a given time-interval. The team performance assessment method was used in a pilot study to evaluate its potential for addressing the design criteria that were originally defined. The conclusion is drawn that it is indeed possible to assess team performance based on an operationalisation of the joint cognitive systems construct of contextual control. It is concluded, further, that the method is successful in changing focus from individual behaviour to team activity, and that it is possible to interpret differences between different teams in terms of control levels in a given scenario.

The author's contributions: I played a *major* role in defining the scope of the study. I played a *minor* role in designing the assessment protocol and conducting the pilot study, and I played a *moderate* role in writing the paper.

Paper V: The Emperor's New Clothes: Organisation science and the notion of sensemaking

Paper V presents a theoretical discussion concerning the use of *sensemaking* as a theoretical construct for explaining crisis management-behaviour. The starting point of the analysis is that the organisational science community has embraced the notion of sensemaking as a valuable notion not only for organisational crisis management but also for organisational life in general. The question asked in the analysis is *Why*? What makes the concept of sensemaking so valuable to organisational scientists? What knowledge gap does it fill, or what scientific conflict does it resolve? The paper introduces several seminal writings, including Weick's narrative describing how the loss of sensemaking caused the death of thirteen fire fighters in the Mann Gulch fire disaster in 1949 (Weick, 1993). This analysis is effected in the form of a discussion of where, in the original epistemological debate on social science (that of Durkheim's explanatory science and Weber's interpretive science), the concept of sensemaking can be positioned. The conclusion is drawn that sensemaking as a concept promises both explanation and interpretation to the social science community. Sensemaking is described as a theoretical field of study; it is a social construction (i.e. an interpretive model), at the same time as it can be described as a mechanism linking micro and macro, individual and organisation (i.e. an explanatory model). This is not only seen in the original writings in which sensemaking is outlined as a promising concept, but also in its applications in the organisational sciences. The conclusion that can consequently be drawn is that sensemaking has been so readily embraced by the community of organisational science because the concept offers an end to a classic conflict of the social sciences. Using the model of sensemaking obviates the need to choose between explanation and interpretation: the concept of sensemaking offers a co-existence, rather than conflict, of the two.

The author's contributions: I played a *major* role in conducting the literature review, defining the scope of study, conducting the analysis and writing the paper.

Addressing the Research Questions

Addressing research question 1a

Papers I and II form the basis for answering the first question coupled to the research theme of establishing a theoretical framework for escalation: *Are there aspects, relevant for understanding processes of escalation, that are not covered by previous research into clinical emergencies? If so, how can those aspects be scientifically investigated?*

The first step in seeking an answer to the research question is a review of how the notion of health-care emergency has been investigated by the scientific community. Secondly, the findings of the literature review are contrasted with the scientific

interpretations made using the naturalistic research approaches (described in Chapter Four). In this process the following three aspects, seemingly not well covered by the previous literature, are analysed: 1) the complexity of escalation; 2) the power relations of escalation; and 3) the narrativised identities of health care. Thirdly, a scientific agenda is outlined for how to shed further light on these issues. Some of the questions raised have also been covered further in the thesis work (e.g. through studying research question 2a).

The review of the literature on health-care crises concludes that the notions of *emergency* and *crisis* are commonly described in binary terms. Going from normal operations to emergency is viewed as something that occurs in a clear transition between system states (Runciman & Merry, 2005). However, few references make this definition of the state of emergency explicit. Instead, most of the research into health-care crisis focuses on the more pragmatic and normative issue of *management processes* in the state of emergency. Such management of non-normal situations, as with most health-care work, is typically described in terms of the need for best-practice guidelines and compliance-based routines (Greene, 2009; Holmes et al., 2008; McDonald & Harrison, 2004). The kind of best-practice guidelines suggested in the health-care domain (and more specifically in the domain of obstetric care) are more *proper* reading of evidence, or the *appropriate* implementation of interventions to prevent further harm (Benner et al., 2010), sometimes even with suggested penalties for failure to adhere to the best-practice guidelines (Wachter & Pronovost, 2009). What the value-laded terms *proper* and *appropriate* actually mean is typically defined *ex post facto*, i.e. the evidence gets constructed in a particular way based on the outcome rather than the intention of the action (Dekker, 2011b; Dekker, 2007; Dekker, 2009; Hugh & Dekker, 2009). Crisis management guidelines in terms of *best practice behaviour* typically take the form of developments and adaptions of team training concepts, often with their origin in aviation (Flin & Maran, 2004; Hamman, 2004; Helmreich & Schaefer, 1994). These concepts emphasise training of *non-technical skills* such as leadership (Künzle et al., 2010), situation awareness (Endsley, 1995; Wright, Taekman & Endsley, 2004), communication and decision-making (Flin, 1996; Flin & Martin, 2001; Flin et al., 2008; Flin et al., 2002; Yule et al., 2008; Yule, Flin, Paterson-Brown & Maran, 2006). Such methods for team training are currently implemented in large scale throughout the health-care system, with a great deal of effort put into assessing their effects (Blum et al., 2005; Dahlström, Laursen & Bergström, 2008; Finn, Learmonth & Reedy, 2010; Pettker et al., 2011; Rabøl, Østergaard & Mogensen, 2010; Siassakos et al., 2011).

Defining medical emergency, crisis and crisis management in binary terms, with the implication of well-coordinated teamwork which is to be achieved by training in non-technical (teamwork) skills, might offer a fruitful incitement for organisational intervention – but the research conducted suggests that it may be that both this definition of what an emergency is, and how management and staff are trained to

respond to it, might underestimate the complexities of health-care work in general and obstetric health care in particular. Through the concept of escalation it is possible to shed light on some of the social and organisational processes preceding the state of emergency which have not previously been coupled to the concepts of emergency and crisis.

The data collected using naturalistic research approaches (as outlined in Chapter Four) are used to interpret health-care escalation situations as inherently complex social processes, which involve relations of power (Feldman, 1997; Foucault & Gordon, 1980; Grint, 2005; Klein, 1998) and narrativised professional identities (Cilliers, 2010; Dinka, Nyce & Timpka, 2005; McDonald et al., 2006), and are often justified by appeals to structures for bureaucratic accountability (Bosk, 2003; Dekker, 2011b; Holmes, Roy & Perron, 2008). The studies conducted are specifically focused on one decision: the intervention decision by which a midwife calls for help from a physician. As it turns out, this very decision is not only suggested by researchers to be an interesting focus for studies of organisational resilience (Cuvelier & Falzon, 2008), but it is also a decision constructed by health-care staff as an important moment in the organisational process of going from *normal operations* towards *non-normal operations.* In Sweden, midwives operate with a high degree of independence and a typical answer from a midwife to the question of when to call for help is:

> As a registered nurse and midwife I am qualified to manage normal pregnancy and normal labour. When it is not normal any longer, that's when I call the physician who takes charge over the situation. Emotionally, however, I still feel responsible for the mother, but practically I go from being autonomous to following instructions. (II, p. 4)

Regarding the social process of escalation this quote is interesting for a number of reasons. First of all, it emphasises an adherence to the medical model of competence/hierarchy (Larsson, 2007) in which the kinds of organisational change that seem to occur during health-care escalations can be characterised as an appeal to structures of bureaucratic accountability, or institutionalised hierarchy/competences (I, p. 6). It seems, for example, that during a crisis a midwife not only hands over the charge of the patient to the physician, but also the control of both the ward and the work carried out there. Once they have decided that the situation is no longer normal and have called for help, midwives no longer see themselves as responsible, especially in any bureaucratic sense of the term, for any future unfolding of events. Furthermore, this way of constructing the problem in terms of an intervention decision makes it look complicated rather than complex (II, p. 4). The midwife's autonomy (over the normal situation) is explicitly specified, and in hospitals with midwife-led labour (the model used in Sweden), the responsibility of judgement on all normal aspects of labour, including foetal heart rate interpretation, rests with the midwife. When the situation is no longer normal, responsibility for the situation

shifts actively from the midwife to the physician (who might be more junior than the midwife making the call), and the physician is then responsible for the non-normal situation.

The problem (interpreted in Paper II in terms of complexity) inherent in this construction of intervention is the question; Who gets to say what is normal and abnormal? The studies conducted suggest that the delineation between normal and pathological is never simple, but just as complexly sensitised as the midwives themselves (II, p. 4), being affected by factors such as time of day, number of patients at the ward, multiple conditions of the specific patients, and which physician is on duty. Furthermore, the data suggest that any interpretation of the complexities of obstetric intervention cannot be constrained to the midwife alone, but must be seen to extend, above all, to the midwife's assessment of the physician who will be called as and when the situation is constructed as non-normal. Midwives make assessments or predictions on the basis of the physician's experience, sensitivity to clinical evidence, interruptibility in the context of estimated ward workload (their historical responses to being interrupted), and also on the basis of how they perceive the physician's sensitivity when it comes to calling the next level in the medical hierarchy, i.e. the level of the attending obstetrician (II, p. 5). It seems that, in their construction of when, how and why to call for help from an attending physician (II, p. 3), junior physicians still appeal to the same kind of narrativised professional identities vis-à-vis attending physicians as Bosk (2003) interpreted from his field-work at an American surgery ward in the 1970s[17] – interpretations which few of our respondents are willing to acknowledge when they are explicitly outlined.

Another aspect of the complexity of escalation is the shift from loose to tight coupling of the actors engaged in the process. The independence of actors in times of loose coupling (with local adaptations of working procedures and the emergence of local language, culture and ways of talking about others) becomes an important part of the nature of the organisation's (or joint cognitive system's) activity once its actors become tightly coupled. As described in Snook's account of the friendly fire accident over northern Iraq in 1994 (2000), the resilience of the entire joint cognitive system becomes an emergent property of the interactions and adaptive strategies used at local level. Understanding local-level interaction therefore becomes an important part of understanding the social processes of escalation, and is a further example of its interpreted complexities.

[17] Bosk suggested that attending physicians constructed the capability of becoming a surgeon ("having what it takes") on the basis of factors such as decision autonomy. Ruling whether a call for help is valid or not is not a decision for the junior doctor to make, but for the senior practitioner who is called. Knowing that calling "too often" will affect others' judgement of whether he/she has "what it takes" seems to be a vital factor in how and when a junior doctor calls for help.

So far, the notion of power has mainly been treated in classic hierarchical terms, as imposed by those higher up in the hierarchy on those lower down. However, in analysing obstetric intervention as a complex problem it is interesting to go even further when interpreting the exercise of power involved in *making* such a decision. As suggested, the simple model of medical hierarchy/competence is only one possible interpretation (and a seemingly *complicated* and standardised one). The conclusion of the studies conducted is in fact that the very construction of a situation as normal or non-normal (i.e., in the obstetric case investigated, the decision to call or not to call) can in itself be interpreted as an act of power: the power of definition (I, p. 9). Midwives can wield considerable power in the delivery room because they can construct and define situations there as normal or not. For a midwife, virtually any kind of ward event can become evidence for one position or another regarding the ward's and patients' status. In Foucault's terms, what the midwife does through her definition of a situation as normal or non-normal would be negotiating "the order of things" (Foucault, 1973; Foucault & Gordon, 1980). Applying a social constructivist lens when interpreting the data, it can now be concluded that the power of definition turns the focus away from the *situation* towards the act of *situating* (Grint, 2005).

The notion of escalation is no longer treated as a process *imposed* on the organisation, a force from outside the organisation which it needs to respond to, but as a social process intertwined with the social relationships of power, narrativised professional identities, and uncertainties concerning normal and non-normal work. Even the distinction between normal and non-normal can now be seen as highly complex and negotiable, rather than as a seemingly complicated process for which there are best-practice guidelines to follow.

Implications of the answers given to question 1a

The studies conducted outline some answers to the question of *what* aspects are important for beginning to build an understanding of the social processes of escalation in health care. These answers in turn give rise to even more questions, which require answers in terms of *why?* For example, why is it that midwives construct it as the most natural and logical thing to do, to call for someone with 30 years less experience in managing non-normal labour situations (the junior physician) to take over responsibility for the situation? As it seems, this reproduction of the hospital structure not only confirms hierarchy, but also increases the junior doctor's chances of climbing up the hierarchy (by gaining experience). An interesting question to ask is if this reproduction of organisational structure at the same time also reduces midwifes' chances of climbing up the hierarchy. While health-care staff accept that this is the way their world works, scientists may ask why it is so. To further investigate questions like this, proposals are presented for a scientific agenda rooted in action research using ethnographic approaches (I, p. 10). This methodology allows the researchers and practitioners to work together to build an understanding of issues that

the group or organisation finds intractable or (as in the case given above) has never regarded as problematic at all.

Within the scope of this thesis these interpretive conclusions also gave rise to more normative questions regarding the use of compliance-based best-practice strategies in complex domains. In that sense, formulating an answer to question 2a (with its research contributions outlined below) can be viewed as an implication of the research contributions made regarding research question 1a.

Addressing research question 1b

Paper V forms the basis for answering the second research question coupled to the theme of the theorisation of escalation: *What is the academic basis on which sensemaking has been so readily embraced by the community of organisational science?*

Since sensemaking was introduced and further outlined as an important focus of analysis by the organisational scientist Karl Weick (Weick, 1993; Weick, 1995; Weick & Sutcliffe, 2007; Weick, Sutcliffe & Obstfeld, 2005), diverse scholars of the organisational sciences have engaged in adapting the concept to their respective fields of interest. To give some examples: Klein (2006; 2003; 2006), Harris (1994), and Elsbach, Barr and Hargadon (2005) use sensemaking as a concept to confirm the data-frame theory of human action, while at the same time linking it to studies of naturalistic work environments. Brehmer (2005; 2006) gives sensemaking a vital role in his model (named the DOODA-loop), as a tool for explaining the functions that need to be accomplished for successful command and control of any military organisation. Scientists studying crisis management and rescue service operations have taken the approach of applying a sensemaking perspective to guide future research into crisis management support and better design of information technology (Landgren, 2005; Schraagen & van de Ven, 2011). As a further example, studies of joint cognitive systems confirm the usefulness of sensemaking as a construct to describe human work in settings such as intensive care units (2007). Others have used the concept of sensemaking to reflect upon the role of the researcher in social enquiry (Aadland, 2010; Allard-Poesi, 2005).

In establishing the theoretical framework for this thesis it became necessary to review the use of sensemaking theory, in order to find out in what way it could help to add to the existing knowledge regarding the processes of escalation. Weick's seminal piece on the loss of sensemaking in the Man Gulch disaster, in which a forest fire escalated and eventually killed thirteen young fire fighters (Maclean, 1993; Weick, 1993), is indeed a story about the social processes of escalation, and reviewing it became the starting point for the broader study of the use of sensemaking in organisational studies. In the analysis of the Mann Gulch disaster, sensemaking is seen as an on-going accomplishment linked to the social role structure of the organisation. If the role structure is lost – which the analysis argues happened in this case because of

failure of leadership – the team disintegrates amid a loss of sensemaking, and this leads to panic (Weick, 1993, p. 636). It is further concluded that among those who manage to stick to the social roles (which might be done through maintaining close face-to-face interaction, through an individual's mental simulation of a role-structure, or through improvisation) sensemaking might be maintained, panic avoided, and a successful outcome (rational actions in order to survive instead of irrational panic) accomplished. Our analysis argues that this appeals to an Anglo-American folk-theory emphasising autonomy and individualism (V, p. 3) in explaining social events and phenomena.

The review of the literature on sensemaking theory has had a broader input into my research than simply being applicable to my investigation of the process of escalation. Through considering the concept, both as outlined by Weick and as applied by researchers in the field of organisational science, in the light of a fundamental conflict of the social sciences, I have together with my co-authors formulated an interpretation of why sensemaking has been so appreciated by a broad scientific community. The two fundamental models of social science used as points of reference are the Durkheimian sociology emphasising *explanation of social facts* (Durkheim, 1972), and the Weberian sociology of *interpreting social phenomena* (Runciman, 1978). The conflict between these two poles causes problems for social scientists because they need to position themselves in the space between the two basic models. While Weber opened up for multiple perspectives and interpretations in the light of historical interpretation, Durkheim, for his part, insisted on defining fixed categories of social facts to explain the essential nature of social life. In fact, Weber argued that Durkheim's position makes social phenomena even harder to understand by seeing them as graspable via causal explanations, because such an explanation will always be overwhelmed by the complexity of meaning.

The research contribution this thesis seeks to make is to outline an interpretation of sensemaking as a *way out* of this conflict between the Durkheimian and Weberian models of social science (V, p. 8). Setting the theoretical stage for sensemaking enquiry has the effect of emphasising both the interpretive nature of sensemaking processes, and the interpretation of the self as a focus of analysis (Weick, 1995, p. 23; Weick et al., 2005, p. 412). Sensemaking is described as an on-going social construction which is highly dependent on the history of the social context under study (Weick, 1995, p. 13). In these descriptions there is no *objective state of the world*. Instead, processes of sensemaking should be analysed as driven by *plausibility* rather than *accuracy* (Weick, 1995, p. 55; Weick et al., 2005, p. 415). However, the notion of sensemaking also leaves room for analyses of a more Durkheimian nature, by offering sensemaking theory as the *social fact* that erases the problems associated with scientific interpretation. This is effected by positing that the complexities so vital to Weber (and not particularly interesting to Durkheim) are in fact all explainable

through the concept of sensemaking. This conclusion is made explicit in the statement that:

> Analysis of sensemaking provides (1) a micro-mechanism that produces macro-change over time [...] (4) description of one means by which agency alters institutions and environments (enactment); (5) opportunities to incorporate meaning and mind into organisational theory; (6) counterpoint to the sharp split between thinking and action that often gets invoked in explanations of organisational life… (Weick et al., 2005, p. 419).

An example of using sensemaking as a causal Durkheimian social fact is, again, the analysis of the Mann Gulch disaster. In this analysis, potential aspects of escalation such as complexities of meaning, structure, relationships between individual and organisation, and relationships between individuals, are all reduced to the explanatory model of sensemaking. When the social structure is lost, sensemaking collapses; and when sensemaking collapses, humans panic (V, p. 5). Bad leadership causes the loss of social structure and a collapse of sensemaking (V, p. 6). However, if each of the individuals can stick together, mentally simulate a social structure in their heads, or improvise, the sensemaking process might be maintained (V, p. 7). The relationship between individual and organisation, between micro and macro, which Durkheim left out of his conception of a social-facts-based science, is pinpointed as the explanatory social (and individualist) fact of sensemaking.

Implications of the answer given to research question 1b

The tendency to use sensemaking as an explanatory social fact is also visible in those of the studies reviewed which apply the concept of sensemaking. The sensemaking process is described as an on-going social construction to the individual under study, but to the researcher it is through social enquiry that the process becomes really real and accessible. Allard-Poesi (2005) shares this concern in her critical analysis of how enquiries into sensemaking run the risk of being subject to the paradox whereby the researcher's position consists both of maintaining that "reality is defined as essentially mental and socially constructed, yet seeking to disengage from that experience and objectify it" (p. 181). Indeed, the main implications of research into sensemaking are linked to the role of the researcher in social scientific enquiry, with a questioning of the level of epistemological self-confidence or modesty in the way social problems are approached (Al-Amoudi & Willmott, 2011; Angell & Straub, 1999; Cilliers, 2005; Dekker et al., 2010).

The problem discussed – that of simplifying the connections between micro and macro structures in an organisation, or a team – also has applications for other areas covered in this thesis. It applies, for instance, to studies of team cognition and performance: when one sees "these two intertwined aspects of team cognition – individual cognition of team members and team process behaviours – as analogous to

cognitive structures and cognitive processes at the individual level" (Cooke et al., 2004, p. 85), the same kind of analytical sacrifice is made. This will indeed be a challenge for students of joint cognitive systems for many years to come.

Addressing research question 2a

Paper II forms the basis for proposing an answer to the first of the research questions dealing with the theme of drawing normative conclusions based on interpretive analysis of escalating situations. The question concerned is: *What theoretical as well as practical implications can be drawn from analysing escalating situations in health care through the theoretical lens of complexity theory, and in what way do such implications differ from prevailing dogmas?*

The concept of *complexity* is often used in describing normal as well as non-normal health-care work (Buckle et al., 2006; Cook et al., 2007; Cook et al., 2000; Plsek & Greenhalgh, 2001; Woods et al., 2009; Xiao et al., 1996). However, the concept of complexity is rarely operationalised, making it hard to draw direct implications from the conclusions (or assumptions). Using complexity theory the interpretive conclusions drawn in answering research question 1a present an example of how a seemingly *complicated* process – that of calling in additional team members (from higher levels in the organisational hierarchy) – might in fact be interpreted as highly *complex*. Analysing the complexities of normal as well as non-normal work makes it possible to draw further conclusions regarding the potential of using compliance-based strategies for managing the system. The focus here lies on the pragmatic implications of interpreting the complexities of work in high-risk domains in general and health care in particular (the complexity argument itself as a model to gain further understanding of escalation is conceived as a contribution to Research Question 1a).

Using the distinction between *complicated* and *complex* (as outlined in Chapter Three), the conclusion drawn is that management through best-practice guidelines and other compliance-based strategies is based on a view of the system as complicated rather than complex (II, p. 5). Compliance-based strategies are typical of management by standardised rules, in line with the reductionist (rather than complex) metaphor of the organisation being describable as a machine (Mintzberg, 1979). Compliance-based approaches aim at imposing order on the system by making sure that each component (or actor – there is no need to distinguish between the two in a complicated system) adheres to the rules. However, the application of complexity theory leads to the conclusion that order cannot be imposed on a complex system. Instead, order *emerges* from the intractable number of constantly changing local interactions that take place in the system (Cilliers, 1998; Cilliers, 2005; Heylighen et al., 2007).

Implications of the complexity argument

The complexity argument might seem pessimistic and no more than a critique of the ontological ways in which we understand the nature of the world with which we engage, a critique which offers no detailed recommendations regarding how to move forward. This argument is typically seen in statements such as: "So what this implies is ultimately that there is no way of controlling the system and that anything goes". Cilliers (2005) deals with this same issue in discussing whether the conclusion that the system needs to be seen through the lens of complexity implies a relativistic, or even nihilistic, position. Cilliers' argument is that the complexity position is not a weak position, but a "modest" position. Cilliers states:

> In the first place, one should realize that the claim that we cannot have complete knowledge does not imply that anything goes. 'Limited' knowledge is not equivalent to 'any' knowledge. If this were so, any modest claim, i.e. any claim with some provisionality or qualification attached to it, would be relativistic. The only alternative then would be an arrogant self-assurance. Such a self-assured position is deeply problematic since its complacency forecloses further investigation. Modest claims are not relativistic and, therefore, weak. They become an invitation to continue the process of generating understanding. (Cilliers, 2005, p. 260).

So, what modest claims can be made regarding compliance-based approaches in complex systems? First of all, that reliance on them is highly problematic, and that relying on them as *ex post facto* evidence in the aftermath of any accident is perhaps even more problematic (Dekker, 2011a; Dekker et al., 2011; Dekker, 2010). Secondly, interpreting the complexities of escalating situations does not lead to the conclusion that there is no way of maintaining resilience. By emphasising the notion of *diversity*, complexity theory can contribute to explaining how systems, interpreted as being complex, maintain resilience in highly dynamic and changing environments (Dekker, 2011a; Dekker, 2011b; Dekker et al., 2011; Feltovich, Spiro & Coulson, 1997; Patterson et al., 2006). Instead of focusing on how to make people comply to a greater extent, the complexity argument implies shifting focus onto how to enhance the positive aspects of diversity.

In a currently on-going attempt to put these findings into practice, I am taking part in a project to develop methods for team training based on the notion of celebrating organisational diversity rather than simply teaching compliance-based best practice guidelines. In a multi-professional setting, representatives from different wards, specialities (such as anaesthesia, obstetrics, paediatrics) and hierarchical levels (nurse assistants, nurses, specialised nurses, residents and attending physicians) come together to work collectively (through discussions and group activities) on the coordination problems that arise when they go from loosely coupled (as in normal operations) to tightly coupled and highly interdependent (as when a situation starts

escalating). This set-up gives the diverse group of health-care staff the possibility to understand how patterns of communication can have one meaning in one setting (to one particular profession or sub-culture) and a complete different meaning when interpreted by representatives from another. In the language proposed by Klein, et al. (2004), such a team-training activity aims at establishing *common ground* on the basis of which the acts of the different actors in the diverse organisation in any given event can become *interpredictable to* and to some extent even *directable by* the others.

Furthermore, there is also a possibility that even in complex systems there may be specific situations that look more or less identical from one occasion to the next (II, p. 5). Such situations – and the moment right before initiating a surgical operation could be one – can well be described as merely *complicated*, with routines developed accordingly (such as working through a time-out checklist) (Gittell et al., 2000; Nyssen, 2007). Identifying such complicated moments in a complex system can also be a fruitful exercise to carry out in a multi-professional discussion environment, and might be a good investment for establishing a team environment which is equipped for successful coordination and good use of its diverse members even before the situation starts becoming increasingly complex (Amalberti et al., 2005; Svenmarckt & Dekker, 2003).

Addressing research question 2b

The second research question related to the theme of drawing normative conclusions from interpretive studies is: *How do different coordination strategies affect the level of team control in escalating situations?* The answer is based on the analysis outlined in Paper III.

The way the question is formulated suggests that there are different coordination strategies that can be applied in escalating situations, and turns the focus towards the *outcome* of these different strategies rather than limiting the answer to the strategies alone. However, an important part of answering the question is also to describe the interpretations of the different coordination strategies, which are triggered by the selection of teams from different backgrounds. These two aspects of analytically describing *process* and *outcome* also give the research contributions both an *interpretive* dimension (through the interpretations of process) and a *normative* dimension (because of the potential to use the analysis to establish which process is the most efficient one).

Based on the experimental study in which teams with different experiences, both of the domain in which the simulation took place (the maritime domain) and of crisis management, managed escalating situations over the two-day simulation programme (described in Chapter Four), the interpretations of four different coordination strategies were defined and discussed in terms of their consequent mode of control (as defined by Hollnagel and Woods (2005) and also described in Chapter Three).

The first coordination strategy interpreted in the study is one of how teams consisting of civil crisis managers seem likely to establish a *common ground* around the strategy of making decisions in consensus. This might be expected. Civil crisis managers in Sweden (where all the civil crisis managers participating live and work) are indeed taught the principle of making decisions based on a *Common Operating Picture* (Hansén, 2009), which is often conceptualised as making decisions based on a collective sharing of all available information. Although it works well in in times of lower-intensity information flow, the data suggest that this strategy seems to cause disruptions to both role structure and team-member interaction in rapidly escalating situations. Being based on the determination to collectively consider all incoming data, this coordination strategy entails the risk of not making the process *directable* in times of escalation. Instead, it seems as though the clutter problem of data overload – with so much data that the participants are unable to extract semantic meaning that can guide choices of action (Woods et al., 2002) – poses problems with regard to establishing strategies for according priority among incoming information in escalating situations. These problems impair the actors' judgement as to which incoming data are significant for the developing situation. As a result, teams applying this strategy are interpreted to be forced into a *scrambled* control mode in which no course of action can be determined to be better than another (III, p. 224). With the simulation program used in the study being designed to give the participants a second chance (it is designed with two scenarios, and plentiful time for debriefing and changing team processes in between the two sessions), it is also interesting to note that a team applying a coordination strategy interpreted as consensus-driven in the first scenario is likely to revert to the same strategy once the situation deteriorates in the second scenario.

The second coordination strategy interpreted in the analysis is a hierarchically driven approach to teamwork. It seems as though teams with members who have maritime experience tend to use a strategy in which the team leader (the Captain) is responsible for making all final decisions in the simulated environment (in this case, their native environment: a ship's bridge). This *common ground* of how to structure the roles and tasks, while it makes the role-structure clear and the process *predictable* in periods of lower tempo, seems however, in rapidly escalating situations, to overload the team leader with data (the clutter problem of data overload (Woods et al., 2002)) as well as with decisions to make (the workload-bottleneck form of data overload, as outlined by Woods et al.). In paper III there is a description of how one team member's own suggestion to take over particular tasks from the Captain functioned as an ice-breaker for stepping out of the hierarchical process and the paper also describes how another team used a process in which the division of labour was effected horizontally in 'normal' operations, but became more hierarchical in escalating situations. Regarding the level of control, the interpretation made in the study is that the coordination process characterised by a hierarchical structure serves as an attempt to apply a *tactical*

control mode relying on procedures and routines. However, the difficulties associated with applying such predefined procedures in escalating situations tend to degrade hierarchical teams to an *opportunistic* control mode with limited planning or anticipation, because of the inability of the team leader to keep up with the workload generated by the rapidly escalating situation (III, p. 225).

The third coordination process interpreted in this research process is the tendency of teams that are unfamiliar with the domain (the maritime context) and the task (managing unknown situations), to apply a coordination process characterised by a rigid adherence to predefined role structures, with no more than limited efforts to share information between team members. This coordination strategy, guided by a principle of individual rather than collective responsibility, tends to result in a response to escalation characterised by late collective acknowledgment of the severity of the situation. The participants applying this strategy *direct* their actions on the basis of how information is distributed to each member of the team. However, the individual actions taken are, right from the outset, hard for other team members to *predict* because little effort is put into sharing information with the other members of the team with regard to the unfolding course of events or the decisions taken. This process is characterised by few discussions or other information-sharing strategies (like writing information on a whiteboard or plotting current course or weather). Often this strategy implies that the main task of the team leader is to mediate information to the various members of the team (i.e. those with more specified and specialised responsibilities than leading the process), and as a result there is not much in the way of process supervision or reflection. In terms of control, the study's interpretation is that this strategy tends to entail that each participant uses a *tactical* control mode, strictly adhering to the pre-defined roles and tasks. However, since this is a strategy guided by individual responsibilities rather than collective coordination, the observed management strategies are labelled as *opportunistic* within each team member's limited knowledge of the unfolding situation (III, p. 226).

Finally, and potentially most interestingly, students of shipping and air traffic control seem likely, when managing the simulated ship's bridge, to establish a teamwork environment which is guided by clearly defined and agreed-upon goals and role-descriptions, but which at the same time incorporates flexibility for changing those goals and role-descriptions in times of rapidly changing (escalating) situations. We call this a *proactive* coordination strategy reflecting the interpreted outcome. It was seen that the members of these teams put a lot of effort into briefing each other not only about their respective roles and tasks, but also about decisions made and future expectations once the process is underway. This is interpreted as a successful means of making the actions chosen by each team member *predictable* to other team members. The team leader in these groups typically seems to be neither responsible for receiving and distributing incoming data, nor for making operative decisions. Rather, the team-leader role is one of overseeing and monitoring the coordination process, and also of

directing it by suggesting updates of the team goals in response to information shared by the other team members. The conclusion we draw is that knowing about the roles and tasks of the other team members, and knowing about the decisions they make, facilitates the information-sharing process as well as the process of reformulating team roles as a strategy for adapting to the dynamics of the situation. The constant and explicit goal updates seem to function as a successful strategy for establishing *common ground* on the basis of which the participants are able to make their respective actions *interpredictable* to their fellow team members, even as the situation escalates. This proactive coordination process was interpreted to be characterised by a distributed and decentralised decision-making process in which the team members make decisions within their respective areas of responsibility. These teams are typically keen on establishing an information-sharing process in which one member is responsible for sorting and distributing ("moderating") incoming information to the different team members. The fact that it is not the team leader who is assigned this role seems to mean that the team leader is able to monitor the process and can consequently step in and re-distribute or re-formulate areas of responsibility. In this way the coordination strategy is interpreted as rigid but also flexible in its potential for adaptation to the dynamics of the situation. The study suggests that the way these proactive teams establish and maintain a *common ground* is through the formulation of shared and explicit goals (III, p. 227). The goal-driven process seems to support them in sorting the significant pieces of data with reference to the context, thereby enabling them to focus on tasks in response to their perceived significance rather than their urgency. In this way the proactive teams may be able to avoid (or at least ease) the problems of data overload as described by Woods, Patterson and Roth (2002). The responses to the escalating situations (which were designed to trigger a change from higher to lower control mode) observed in these teams are interpreted as representing a *tactical* approach in which the strategies applied have been agreed upon beforehand (e.g. sending crew to investigate indications of fire or evacuate passengers to specific locations in emergency situations). However as the situation escalates (and uncertainties increase) even further, the proactive teams' coordination strategies might even be described as *strategic* because of the way they respond proactively, drawing on expectations as to how the situations will develop (e.g. predicting how a fire might spread, what course the ship should take, or where to move the passengers next).

Implications of the answer given to question 2b

The research conducted illuminates a number of demands that escalating situations place on teams' data-processing capacities and processes, with implications for how to support crisis managers in establishing a coordination process that is well adapted to such demands. One implication of the research is the suggestion that tools for information sharing in a crisis management system need to go beyond a presentation of all available data to all the actors involved. Our data analysis indicates that when the cognitive work in a team is focused on continuous sharing of as much data as

possible, this can trap decision-makers in a pattern of reactive behaviour during escalation. This observation contradicts prevailing views, which tend to focus on methods for collecting ever-larger amounts of data, integrating these data into systems, and presenting them using ever-more advanced presentation methods.

The studies also indicate benefits of applying a theoretical language which focuses on team interaction at the level of the joint cognitive system responsible for managing a particular situation, rather than limiting the analysis to the behaviour of individual actors. This analytical focus helps lift questions concerning crisis management to the levels of professional identity and tradition, of organisational culture and history (even though this is an application of interest for the future rather than an answer to the particular research question). The findings also give rise to critical questions concerning measures of team performance, by correlating team performance with the level of consensus in the team (Cooke et al., 2004).

While the study points out the benefits of applying a new language for team performance analysis, it is also concluded that such an approach needs improvements in terms of the methodology for analysing team performance. This issue is what led to the formulation of Research Theme Three.

Addressing research question 3

Paper IV forms the basis for answering the single question that addresses the theme of assessing team performance. The question is: *How can the academic and empirical basis for the assessment of team performance in escalating situations be enhanced towards a focus on macro-cognitive features of work?*

The initial research investigating team performance in escalating situations (Bergström et al., 2009; Bergström et al., 2008; Dekker, Jonsén, Bergström & Dahlström, 2008) suggested that while team performance in complex and escalating situations cannot be addressed using classical approaches such as behavioural assessments (Bergström et al., 2011), there are few satisfying alternatives. Few methods for team performance assessments rooted in the paradigm of joint cognitive systems theory (see Chapter Three) were identified when reviewing the literature. Research question three was formulated with the purpose of designing such a method.

In this thesis, research question three is approached from a design-science perspective (March & Smith, 1995), implying that a number of design criteria were defined to guide the process of method design. Once the assessment protocol was ready it was used in a pilot study involving two teams of participants at a nine-week course for fire officers given at the Civil Contingencies Agency College at Revinge, Sweden. The method was used to analyse a total of four staff exercise scenarios (this process is further outlined in Chapter Four).

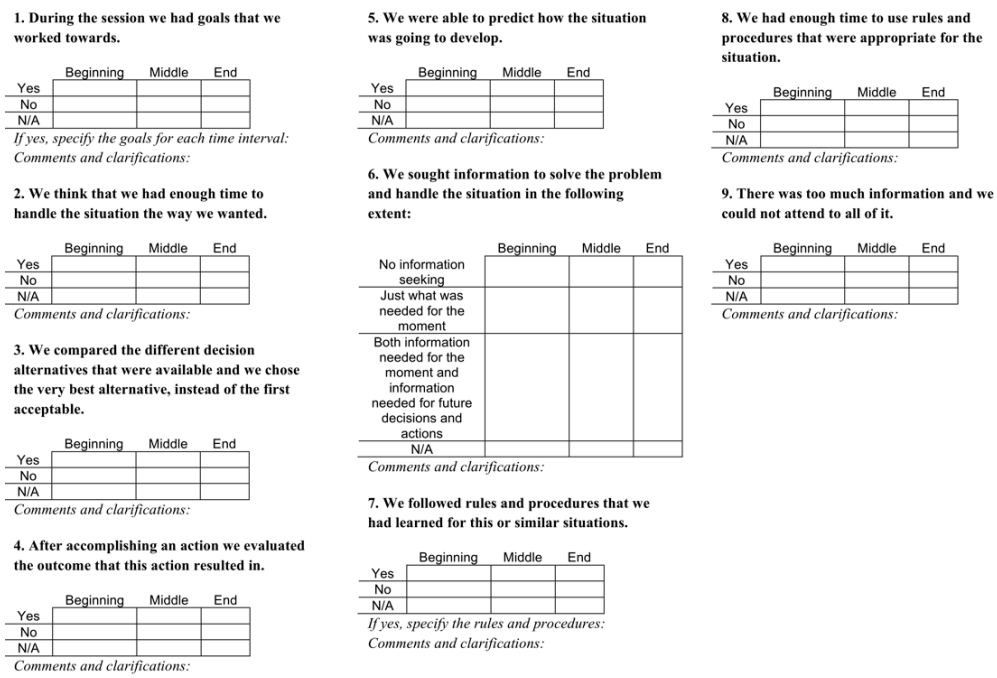
The protocol developed is an instrumentalisation of the joint cognitive system theory view of control in general and the contextual control model in particular. The reason

for choosing the COCOM-model was that Hollnagel and Woods (Hollnagel & Woods, 2005) define a number of indicators for the four different control modes defined in the model. These indicators were incorporated into one observer analysis (embracing the parameters defined as *observable*) and one participant questionnaire (embracing the parameters defined as *non-observable*). The observer analysis is portrayed in table 5-1, below.

Table 5-1. Outlining of the parameters labelled observable. The indicators are divided into four main parameters (left column) and structured according to the four control modes (top row)

	Scrambled	**Opportunistic**	**Tactical**	**Strategic**
Information seeking	No information is being sought	Only information that is absolutely necessarily at the moment	Information sought if needed both for the moment and the future, but only from a limited set of sources	Information is sought for the moment and the future, and from all sources available
Evaluation of decision alternatives	There are no alternatives	The first alternative identified is accepted	The alternatives are evaluated or a decision-rule/procedure used	All alternatives are evaluated
The actions follow a general procedure	No	No	Yes	No
A powerful indicator attracts the attention and on-going plans are interrupted	No	Yes	No	Yes

For each parameter, there is also the option *not observed* indicating that it was not possible to observe the parameter. At a given time-interval (in the pilot study five-minute intervals were used) the evaluator interprets the observed actions and indicates the observation of one control mode for each of the four parameters. The same procedure was performed with the participant questionnaire, shown in figure 5-1, in which the different answers were translated into control modes.



1. During the session we had goals that we worked towards.

	Beginning	Middle	End
Yes			
No			
N/A			

If yes, specify the goals for each time interval:
Comments and clarifications:

2. We think that we had enough time to handle the situation the way we wanted.

	Beginning	Middle	End
Yes			
No			
N/A			

Comments and clarifications:

3. We compared the different decision alternatives that were available and we chose the very best alternative, instead of the first acceptable.

	Beginning	Middle	End
Yes			
No			
N/A			

Comments and clarifications:

4. After accomplishing an action we evaluated the outcome that this action resulted in.

	Beginning	Middle	End
Yes			
No			
N/A			

Comments and clarifications:

5. We were able to predict how the situation was going to develop.

	Beginning	Middle	End
Yes			
No			
N/A			

Comments and clarifications:

6. We sought information to solve the problem and handle the situation in the following extent:

	Beginning	Middle	End
No information seeking			
Just what was needed for the moment			
Both information needed for the moment and information needed for future decisions and actions			
N/A			

Comments and clarifications:

7. We followed rules and procedures that we had learned for this or similar situations.

	Beginning	Middle	End
Yes			
No			
N/A			

If yes, specify the rules and procedures:
Comments and clarifications:

8. We had enough time to use rules and procedures that were appropriate for the situation.

	Beginning	Middle	End
Yes			
No			
N/A			

Comments and clarifications:

9. There was too much information and we could not attend to all of it.

	Beginning	Middle	End
Yes			
No			
N/A			

Comments and clarifications:

Figure 5-1. The nine questions of the participant questionnaire - the non-observable parameters (IV, p. 8).

Control modes are determined at the set time interval, for each of the observable parameters using the observer protocol, and for each of the non-observable parameters using the participant questionnaire. After this, the two are weighted in a semi-quantitative analysis (this procedure is further outlined in IV, pp. 10–11).

Once a control mode has been assigned for each time interval, this information can be plotted in a *team performance assessment diagram*. Below, two team performance assessment diagrams are shown. They represent the same scenario but run with different teams.

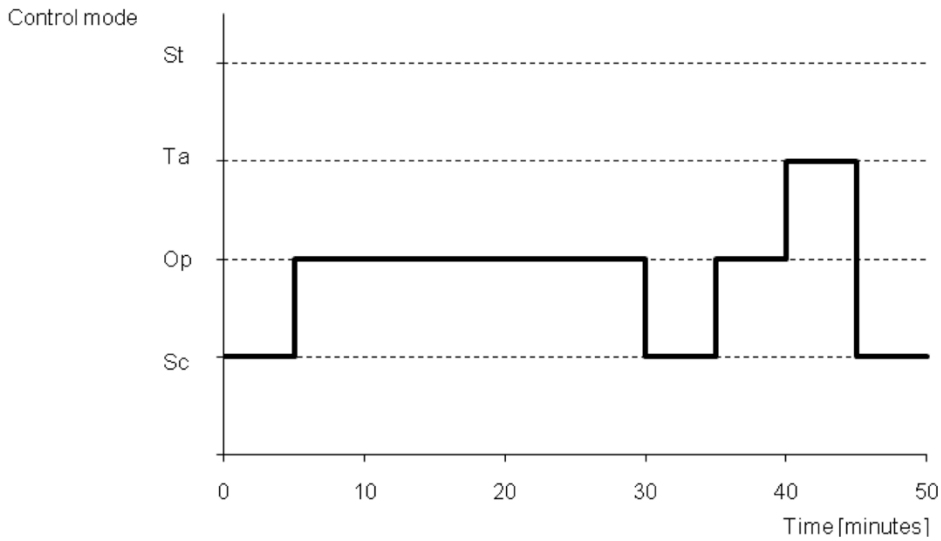


Figure 5-2. Team performance assessment diagram of Team One, Scenario A (IV, p. 9).

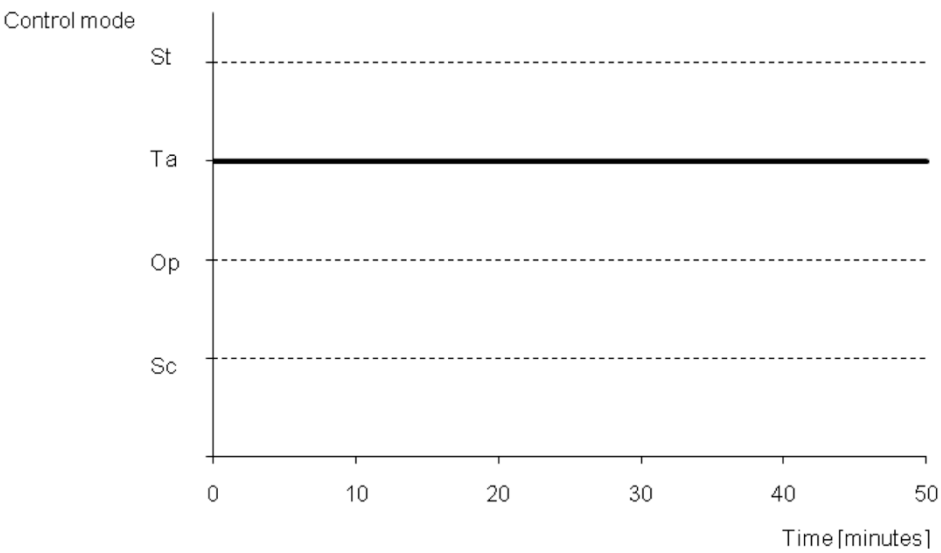


Figure 5-3. Team performance assessment diagram of Team Two, Scenario A (IV, p. 9).

Apart from the overall design constraint that the protocol for performance assessment should be based on the Contextual Control Model, five specific design criteria were defined for the study. The following looks at them one by one to illuminate the research contribution made by developing this method for team performance assessment.

The first specific design criterion states that *the protocol should be usable in a natural context.* Indeed, this is an important aspect of joint cognitive systems theory, where this principle is followed with the purpose of offering the scientific community a set of theories applicable to naturalistic rather than laboratory environments (Cook & Woods, 1996; Hoffman & Woods, 2000; Hollnagel, 1998; Hollnagel & Woods, 1983; Lipshitz et al., 2001; Miller et al., 2006; Woods, 1992). The conclusion that the method does not address the design criterion could be drawn if it were seen that the coordination processes labelled *observable* were in fact not observable, or if the participants found that the questions asked were not applicable to the scenario they were engaged in. In this case, the pilot study conducted indicates that the method does address the design criterion. The commanding-staff training facility used in the pilot study is designed to be as similar to an ordinary commanding-staff facility as possible, and the method was successfully applied in that context. However, there are issues related to user-friendliness when using it in diversely distributed teams, which will be addressed below.

The second specific design criterion states that *the protocol should be generic*. In order to conclude whether the assessment method developed addresses the design criterion, it needs to be used in different settings, with teams representing different industries and in different kinds of scenarios. Consequently, the pilot study cannot confirm the method's ability to live up to this design criterion, as it was only used in one environment (the staff environment used by Swedish rescue services). However, at the time of completing this thesis, further studies are in progress, using (and refining) the method in the health-care domain.

The third specific design criterion defined in the process of developing the team performance assessment method states that *the protocol should be user-friendly.* The conclusion from the pilot study is that the method is not sufficiently user-friendly. In order to interpret control levels in a team with its members distributed over several rooms (as in the case with the staff exercise), different recording devices are needed for all these rooms (with a consequent need to analyse all these recordings separately). However, in a naturalistic environment with fewer and less physically dispersed participants this problem might not arise. For the moment it is suggested that the method be limited to use in situations where only one or two rooms are used during data-collection-activities.

The fourth specific design criterion states that *the protocol should be easy to update.* This criterion would not be addressed if the usability of the method were severely

reduced as a result of small changes being made to its design. It is concluded that the method developed adheres well to this design criterion. The questionnaires can easily be adjusted to suit different situations by changing the time intervals at which the questions are to be answered. It is also easy to add or remove questions from the questionnaire. The observation analysis can also be easily adjusted by changing the time interval at which the recording is to be analysed, and parameters can easily be added or removed. The number of video cameras and sound recorders can also be adjusted to suit the session to be analysed. However the design criterion is broader than the procedural simplicity of updating the protocol. The design criterion also implies that any suggested update should be easily qualified against the designers' original purpose of the protocol. This is ensured through the formulation of joint cognitive systems theory as a "kernel theory" (Gregor & Jones, 2007) both guiding and qualifying the design (and any update of the design). It is concluded that the design-process (and not only the protocol) adheres to the criterion of being easy to update both by the procedural simplicity of doing so but also by clarifying the theoretical constraints.

The final design criterion requires that the method *should give comparable results*. The design criterion would not be met if groups – by their own members or instructors, or by the person performing the data analysis – were thought to perform qualitatively differently without this conclusion being mirrored by the assessment results. Furthermore, one could not conclude that the design criterion had been met if all data analysis gave exactly the same results (and this would apply even if the teams were interpreted to have performed similarly). The pilot study indicates that the method does address the design criterion. Two groups went through the same two scenarios and, in order to appraise how well the design criterion was fulfilled, interviews were conducted with the teams themselves (debriefing sessions) and with the instructors leading the scenarios. The results from the pilot study were compared both within each group (intra-group comparison of the difference in results between the two scenarios) and between the two groups. According to the instructors, who were asked to make an ordinal comparison of the groups, Group Two performed in general "better" than Group One. The participants of both groups also expressed the feeling of having performed better in Scenario Two than in Scenario One. Both these interpretations are replicated in the results of the pilot study, if the interpretation of "better" can be operationalised through a higher and more stable control mode (an interpretation which should not be seen as obvious from how the model of contextual control is defined). However, the sample is too small to call this result more than an indication, which is an argument for the need for further testing of the method.

With reference to the main research question, the conclusion is that the method developed represents a promising step in the process of developing an empirical basis for the assessment of team performance using the theoretical framework of joint cognitive systems theory. It requires further testing, validation and refining in order to

gain contextual relevance and contribute to the body of scientific knowledge in the field (a process described as the "Rigor Cycle" by Hevner, 2007). In short, the method developed generates several implications for further research.

Implications of the answer given to research question 3

The method developed for assessing team performance using an operationalisation of the contextual control model gives rise to implications for further testing and refining, and for use in several different contexts. The study suggests, for instance, that it is possible to shift the focus of enquiry from the language of motivational factors (good and poor behaviour and attitudes) toward the process of joint cognitive activity. This is an argument for conducting further research into the way team performance assessments are carried out in a range of different industries (such as aviation, health care, shipping, and power supply). One of the ultimate aims of such a process would be not only to change the language via which team performance is assessed, but also to spotlight how instructors talk to participants about teamwork (retrospectively as well as prospectively). Moreover, the method is not only applicable to a training environment, but could equally well be used as an element of *cognitive task analysis* (Crandall et al., 2006; Hoffman et al., 1998; Miller et al., 2006; Naikar et al., 2006) in connection with the redesigning of a workplace, or the implementation of new routines for conducting specific tasks.

During the spring of 2012 (while this thesis is being completed) the method is being evaluated for its potential use in the health-care domain. The study being conducted focuses on how to ensure that a method to assess team performance based on joint cognitive systems theory is user-friendly for the domain of health-care training. The ultimate aim is to find a way to make the method usable by instructors seeking to assess team performance as the scenario is run and debriefed, without losing so much of the method's original *resolution* as to drain its theoretical depth. The project is designed in the form of an initial pilot study to test the original method in the health-care domain, with the possibility of going back to adjust the method before using it a second time in the same domain.

Synthesis: Escalation Explored

Applying an epistemologically pluralistic approach to explore organisational resilience in escalating situations, the different research contributions embodied in the studies can be synthesised to form a more coherent theoretical concept, in that the studies can be seen to converge on some central findings regarding the understanding of escalation in organisational contexts.

One such convergent theme of the different research contributions is that organisational resilience in escalating situations can be described as an emergent

property of interaction. The different studies highlight different kinds of interaction. For example, observations of naturalistic health-care work led to the interpretation that escalating situations are vital moments for the confirmation, through interaction, of organisational structure, having the effect of reproducing structures such as those of professional identity and power (I, p. 6; II, p. 4). It may seem contradictory to conclude that the moments in which the organisation is at its most adaptive, unpredictable and potentially even unstable (i.e. moments of escalation), are at the same time vital for confirming organisational structure. Such an interpretation could be seen as suggesting that structures of power and identity are nothing but problematic with reference to the establishment of organisational resilience in moments of escalation. However, another side of the same coin is the conclusion that the power of *situating* escalation, the power of constructing a situation as normal or non-normal, then becomes an interesting focus for studies of organisational adaptability and resilience (I, p. 8).

The power of situating might be interpreted as one strategy for enhancing diversity in complex situations. The studies conducted in experimental settings offer some other suggestions for what might constitute such diverse interactions. Facilitating coordination strategies with characteristics such as explicit goal formulation, flexibility of roles, and distribution of decision-making rather than strict role-rigidity, celebration of hierarchy or rationality by consensus (III, pp. 224-227) – all of these might offer suggestions for how to pragmatically go about enhancing organisational diversity in escalating situations. The findings are currently being implemented in the design of new team-training systems as well as in methods to evaluate and describe team coordination (IV).

Describing organisational resilience in escalating situations as an emergent property of interactions suggests that macro-behaviour (e.g. organisational resilience) is *influenced* by micro-behaviour (interactions rooted in factors such as common ground, power structures and professional identities), but not *controlled*[18] by it. Thereby the theoretical framework for escalation is distinguished from a theory such as sensemaking, because of fundamentally different interpretations regarding the relationship between micro and macro[19]. Sensemaking theory, in explaining the loss of sensemaking in terms of incomplete interaction (I, p. 7), does so by causally connecting sensemaking to role structure and role structure to leadership (V, p. 6).

[18] Note that the notion of control is used here in a different meaning than elsewhere in this thesis. Here, control is used to describe a direct and causal influence between action and reaction. As applied in chapter Five, the notion of control is used to describe the macro-level result of micro-level coordination efforts.

[19] Traditional studies of team cognition run this same risk by analysing, without problematising, team cognition as ”analogous to cognitive structures and cognitive processes at an individual level” (Cooke et al., 2004, p. 85).

The theoretical framework outlined for organisational resilience in escalating situations, on the other hand, emphasises that any such relationship will always be highly arbitrary, full of nuances and contingent upon the perspective taken by the interpreter. For example, from the perspective whereby the power of situating is distributed among a diverse organisational structure, the question arises: who is really the leader anyway?

Chapter Six

Discussion and Suggestions for Future Research

This discussion section is divided into two parts. The first section is a reflection on the research process, while the second section outlines how the findings formulated in this thesis might serve as points of departure for future research initiatives.

Reflecting on the Research Process

From Cognitive Models to Joint Cognitive Systems

This thesis essentially argues for a shift of focus, away from information-processing notions of behaviour and cognitive constructs, towards an attempt to grasp the more complex processes of interactions, relations and emerging coordination strategies that take place amongst a multitude of actors in a joint cognitive system. Indeed, reflecting on the research process leading up to this thesis underlines the arguments in favour of such a shift. After initially having tried to understand and analyse team performance using the behaviouristic approach (e.g. Bergström et al., 2009; 2008) a critical discussion was initiated regarding the limitations inherent in using such models. This discussion ran into two channels that eventually engendered two of the themes outlined in this thesis: the development of new methods for team performance assessments; and the topic of naturalistic studies. I came to the conclusion that while the controlled studies were useful for interpreting different approaches to the management of escalation, they implied an over-simplistic model of the concept of escalation itself. In order to be able to interpret more complex social aspects of escalation, studies in naturalistic environments were planned and conducted. The conclusions from the naturalistic and controlled studies formed the basis for introducing a new theoretical framework describing escalation as an inherent process of organisational life. This methodology is the quintessence not only of the explorative approach but also of the doctoral education process.

Having worked with operationalising joint cognitive systems theory in several studies, I feel that some critical reflections on the theory would not be out of place. First of all, one can identify a potential contradiction between joint cognitive systems theory and complexity theory. The question arises as to whether the notion of commonality, as incorporated in the concept of *common ground*, is in fact incompatible with the notion of diversity as understood in complexity theory. Indeed, commonality might be interpreted not only as incompatible with diversity, but as its direct opposite. Emphasising that a *common operating picture* (Hansén, 2009) is necessary if it is to be possible, using joint cognitive activity, to make the most rational decision, might be argued to be an application of commonality that is not compatible with the notion of diversity (III, p. 224). However, the notion of common ground applied in this thesis does not necessarily need to imply a maximum level of commonality. Common ground as used here is, rather, a way of interpreting (and simplifying) organisational ideas concerning how to engage in coordinative action. The common ground on the basis of which actors engage in a proactive process is interpreted differently to the common ground which forms the foundation for a rigid coordination process. Common ground, in this thesis, is not measured on a scale of commonality, but qualitatively interpreted in terms of organisational ideas about how best to coordinate.

The second critical reflection on the way in which the theory of joint cognitive systems is instrumentalised in this thesis applies to any attempt at categorising qualitative data. By deciding beforehand what categories to use (in this case, categories of joint coordinative activity) there is a great risk of not being open-minded to any data that does not easily fit into those categories. However, when it comes to the categories of joint coordinative activity it may well be the other way around – that observations are too easily labelled in terms of the categories, implying a risk that the categories themselves are too broad, and common-sensical rather than adding meaningful theoretical knowledge. My conclusion regarding this point as it relates to my thesis would be that the categories used are well suited to shifting analytical focus from the micro-level to the macro-level cognition of a team in an experimental setting, or to interpreting macro-cognitive features of a limited activity in a naturalistic setting[20]. In short, the categories help in forming an interpretation of *how*, but other analytical tools are needed in order to interpret questions of *why*. It is also important to emphasise that the theory is used to interpret the data rather than the data being used to confirm the theory.

[20] I am currently, as a supervisor, taking part in a Masters project in which an anaesthesiologist interprets coordination strategies (and coordination failures) in the joint cognitive activity that takes place between an anaesthesiologist and the anaesthesia machine. There, too, the preliminary conclusion is that the categories do offer a language for interpreting macro-cognitive features in a well-defined activity.

The Balance between Interpretive and Normative Research

One question to discuss with regard to the research process is why one would write a critique against the concept of sensemaking, and at the same time (without much criticism) embrace the notions of coordination and control. A second question that needs to be addressed is whether it is at all possible to strike a balance between instrumentalism and complexity, or whether, instead, any such attempt is antithetical.

An answer to both these questions can be outlined from the perspective of epistemological modesty (Cilliers, 2005). Indeed, my study reviewed both joint cognitive systems theory and sensemaking theory by asking this overall question: can either of the theories help researchers move towards an understanding of teamwork in escalating situations that is characterised by holism (complexity) and modesty (interpretivist claims with potentially normative applications)? In other words, it is not a matter of finding out which theory is right and which is wrong. Rather, the process is about finding theories and methods which offer a language which, in Levi-Strauss' words, is "good to think with"[21] (Harding, 1996) in the work of striving towards the pragmatic research aims. This thesis outlines the process of evaluating both these theoretical models with regard to their potential for guiding thinking about issues of teamwork and team performance. There are, and should be, normative as well as ethical implications involved in choosing one of them as offering a more promising language to guide thinking about teamwork processes in escalating situations. The conclusion drawn in this thesis is that the notion of sensemaking holds the risk of leading one into explanations which represent a reversion to cognitive and behaviouristic models of human work – i.e. explanations in terms of self-contained individuals (being poor or good leaders, making sense through individual mental simulation), couched in a rationalist language rather than the language of complexity thinking. If instead we use the language of joint cognitive systems and complexity theory, it provides us with analytical tools enabling us to recount the narratives of human and organisational work in escalating situations in terms of interactions, relationships, and joint cognitive coordination strategies.

Being modest about the research contributions made is to appreciate their contingency in time and space. It should be asked whether the conclusions drawn from the experimental settings are applicable to any settings other than the particular one in question. Relating and comparing findings concerning coordination strategies obtained by studying naturalistic work to those obtained from studying the experimental setting, might represent a fruitful exercise and give one the sense of questioning their generalisability. As discussed above, the experimental settings did

[21] The importance of asking this question is something that one of my co-supervisors has kept emphasising throughout my PhD study process.

indeed offer a first step for building a framework for understanding escalation, and moving away from the general (experimental) towards the particular (naturalistic) was a natural way of forming a richer (and more complex) picture.

The Outsider Researcher

The studies of naturalistic environments were conducted with myself taking the role of the outsider researcher. Since I am not trained as a physician, midwife or nurse (but as a risk management engineer), and was therefore potentially unable to "think in their symbols" (Wax, 1985), there was a great amount of preparatory work for me to do before even entering the domain. Attending lectures and training courses, and holding a significant amount of lectures for a medical audience, much of the first two years of study were spent preparing for the naturalistic data collection activities. The data-collection activities themselves of course then offered great opportunities for learning the patterns, symbols and professional identities of the domain.

However, being an outsider is not only a disadvantage when entering the naturalistic field of health care. There are two main advantages of entering the domain of Swedish health care as an outsider. The first is the opportunity of looking at the patterns and symbols with fresh eyes. As Wax puts it: "For what the social scientist realizes is that while the outsider simply does not know the meanings or the patterns, the insider is so immersed that he may be oblivious to the fact that patterns exist" (p. 3). The culture of professional health-care provision is indeed well rooted. My outsider status meant that this culture was subjected to reflection from without, not only from within, and throughout the research process this has been seen as an advantage, not only by members of the research team but also by several members of the health-care organisations involved. Preliminary conclusions, contributions in debriefing discussions following serious incidents, and the team-training applications developed using the findings from the research, have all been very well received by the *insiders* involved.

The second advantage of being an outsider is that one has the opportunity of establishing a non-prestigious conversation atmosphere. The outsider is not a threat in the same way as an insider, who might have to deal with more suspicion and overcome possible criticism regarding *the way we do things around here.*

The potential disadvantages of conducting the research as an outsider were mainly dealt with by engaging a specialist in obstetrics in the role of assistant supervisor. Her contributions were vital for framing the findings in a way that is useful for health-care practitioners while also being credible in a broader sense. Of particular value were all the long conversations in which she explained the patterns of thinking, culture and identity underlying various statements and working patterns that I had not initially been able to grasp.

Future Research

The research conducted for this thesis has identified some areas as relevant for further studies. Indeed, certain parts of the thesis focus particularly on research processes and the methods and findings of previous research, so some implications for further studies should be expected as a result. There are also a number of interesting aspects that were not fully considered in the studies conducted for this thesis, and these will also be outlined in this section.

The primary conclusion of my thesis is that it shows the importance, and some of the implications, of shifting focus when conducting crisis management studies. Studies of crisis management which, rather than having best-practice routines and procedures as their main focus, aim instead at studying complex relationships of power, narrativised identities and the ways in which situations of crisis are framed, negotiated and situated, offer an interesting focus for future research in the field. However, such studies will not be of interest or value outside the rather narrow research community unless the research findings are translated into applications and inventions for practical use in the industries concerned. It is therefore my suggestion that future research into issues of organisational resilience in escalating situations should be conducted as action research projects in which the researchers engage in developing and implementing new practices (for example with the aim of increasing diversity in the organisation), follow the short-term as well as long-term effects of their work, and formulate theoretical as well as practical findings. An example of such a project has been initiated during the final year of working on this thesis. Using the format known as "Classroom-Based Crew Resource Management Training", I am taking part in a project which aims at developing a system to engage health-care staff (ranging from assistant nurses to attending physicians) from three clinics at a medium-sized Swedish hospital in work to improve the coordination process in escalating situations. The project builds on multi-professional discussions on topics such as: the situations in which the actors in the organisation shift- from loose to tight coupling; hierarchical structures; communication patterns; and organisational subcultures and attitudes as they affect response measures vis-à-vis accidents and incidents. The aim is to establish an organisational climate in which diversity and divergence are not only encouraged but are an integral part of organisational life.

This thesis suggests a way forward in the field of team performance assessments. This is also a field where there is broad scope for future research activities, and some have already been initiated. The method proposed here mainly offers a language and way of thinking, which can be modified to meet several purposes. One primary aim is to make the method flexible enough to be useful for conducting exercises and simulations in a range of different industries. Such a project is being conducted during the spring of 2012 (even as this thesis is being finalised) with the aim of making the method usable in practice for the field of medical team training. Studies

have also been planned in the domain of aviation, a traditional stronghold of behaviouristic approaches to team performance assessment. An additional aspect that needs further consideration is that of expertise. Further research is needed to investigate how expert performance can be discussed in terms of the framework developed here. The questions to ask include how experts affect the level of control in the joint cognitive system, and how to make expert performance observable in terms of performance indicators.

Chapter Seven

Conclusions

The studies conducted for this thesis appear to converge on a central finding: as interpreted in the organisations and teams studied, resilient performance in escalating situations is an emergent property of the interactions, relations and coordinative strategies amongst a multitude of actors, rather than being the result of heroic achievements or "correct decisions" on the part of single actors.

More specific conclusions include the following:

- Rather than treating crisis in binary terms and as a state that is extraneous to the organisational structures, it could be advantageous to understand escalating situations more in terms of social processes reproducing and confirming such organisational structures. A richer understanding of the qualitative organisational change, which arises during the process of escalation, can be gained from social enquiry which seeks to interpret the complex expressions of interactions, relations, narrativised identities, goal-conflicts and local practice that constitutes not only a response to crisis, but a part of escalation itself.
- The social process of escalation in obstetric care can be seen to offer a rich case-study environment for interpreting the complexities of health-care work. Since complexity theory emphasises that complex systems know no superior method, constructs such as *best practice, compliance, workarounds* and *violations* represent normative rhetorical concepts fundamentally belonging to a rational ideal, with epistemological as well as practical limits in terms of their applicability in domains such as health care.
- On the basis of my interpretations of the complexities of health-care provision, strategies for ensuring organisational resilience in escalating situations might benefit from an increased focus on enhancing the diversity of actors and response repertoires in situations when organisational actors shift from loose to tight coupling. This conclusion has implications for the development of new concepts in the fields of team training and organisational governance.

- Joint cognitive systems theory offers a framework on which new approaches to team performance assessment can be based. It helps in directing the focus away from cognitive and behavioural models of individual actors, and towards the joint performance of the cognitive system as a whole. This conclusion has promising implications for evaluations of team performance, team training, task analysis and workplace design.
- Interpreted coordination strategies for coping with escalating situations include strategies characterised by: 1) consensus, 2) hierarchies, 3) rigidity and 4) decentralised distribution of decision-making authority. It is my conclusion that proactive coordination of the management of escalating situations is achieved in those teams which focus on developing an understanding of the different team members' roles and needs, as well as on sharing overall aims.
- In the seminal writings, sensemaking is presented as a model which, in explaining processes of escalating crisis, seems to revert to an individualist (and reductionist) model of organisational failure and success. The community of organisational science has readily embraced this model because, in the way the theory is articulated, it seems to promise a reconciliation of the two grand traditions within the social sciences. Theoretically formulated in Weberian (interpretive) terms, it promises the ability to study sensemaking as a Durkheimian (explanatory) social fact.

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Appendix: Appended Papers

Paper I Bergström, J., Nyce, J. M., Dekker, S. W. A., & Amer-Wåhlin, I. *The Social Process of Escalation: A promising focus for crisis management research*. Submitted as a "debate paper" to a peer-reviewed journal.

Paper II Dekker, S. W. A., Bergström, J., Amer-Wåhlin, I., & Cilliers, P. (2012). Complicated, Complex and Compliant: Best practice in obstetrics. *Cognition, Technology and Work*. doi: 10.1007/s10111-011-0211-6.

Paper III Bergström, J. Dahlström, N. Henriqson, E. & Dekker, S. W. A. (2010). Team Coordination in Escalating Situations: An empirical study using mid-fidelity simulation. *Journal of Contingencies and Crisis Management*, 18(4), 220-230, doi: 10.1111/j.1468-5973.2010.00618.x.

Paper IV Palmqvist, H., Bergström, J. & Henriqson, E. (2011). How to Assess Team Performance in Terms of Control: A Protocol Based on Cognitive Systems Engineering. *Cognition, Technology and Work*. doi: 10.1007/s10111-011-0211-6.

Paper V Bergström, J., Nyce, J. M. & Dekker, S. W. A. *The Emperor's New Clothes: Organisation Science and the Notion of Sensemaking*, Submitted as a "Speaking out paper" to a peer-reviewed journal.