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Trondheim, February 2017

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Thesis for the degree of Philosophiae Doctor

Norwegian University of Science and Technology (NTNU)
Faculty of Economics and Management
Department of Industrial Economics and Technology Management

Supervisor: Associate Professor Endre Sjøvold, NTNU
Administrative organizer of defense: Professor Arild Aspelund, NTNU
Committee of experts: Associate Professor Eva Hammer Chiriac and Dr. Tommy Krabberød.

Kenneth Stålsett, Trondheim, February 2017

Abstract

My original contribution to frontline team knowledge is that efficient adaption stems from a continuous focus upon internal interaction patterns. This means that focusing upon task, procedures, and individual expertise is not enough to enable teams to excel through uncertain contexts and ambiguous tasks. To be able to extract and combine the unique skills and knowledge from each individual teammate, teams must be able to utilize a broad spectrum of behaviors; establish and accept a deep collective understanding of each other's skills, attitudes and knowledge; balance individuals' influence; and ensure efficient leadership perspectives. This means that advanced team interactions build on a collective commitment and the will to develop. As such, the team leader is responsible for enabling the advanced team dynamics, but the teammates also have to contribute to efficient leadership.

The empirical contributions stem from The Royal Norwegian Naval Academy (RNoNA) and the Norwegian oil and gas company Statoil ASA, which both build their operations around efficient teamwork. While the purpose of these two organizations are clearly different, they both have to deal with high-risk environments, as well as teamwork that ensures adoption and innovation in rapidly changing contexts.

Part I of the thesis provides the theoretical foundations and insights into trends in team research, and brings the findings from the four empirical papers into the broader discussion. The first part ends with suggestions for further research, practical implications, and concluding remarks. Part II presents the four empirical articles that investigate various aspects closely related to the team's ability to adapt and excel through uncertainty. These papers originate from gaps in my literature review, as well as the research partners' interests.

Executive Summary

This thesis investigates various aspects that are important for developing teams that are able to excel through uncertainty. It is possible to read the Part I as a short summary of the whole work. The first part begins with a literature review that can be used to understand the various trends in the team literature, and thereby help leaders to understand the implications from the different perspectives. At the same time, the perspective I advocate builds on the premise of enabling teams to adapt to their contextual demands, which means that a focus upon the teams' internal interplay is highly important. The second part of the thesis consists of four separate articles that visit topics such as team building; team insights and perceptions; the distribution of influence, and leadership perspectives and structures. These articles can be read separately, but reading the whole thesis will help to give a broader insight.

For many leaders, some of the suggestions will be inconsistent with long-held leadership- and team theories. The focus on the "soft" sides of teamwork, instead of task and procedures, can be quite different from established practices and knowledge bases. Indeed, the implications of focusing on behaviors, curiosity, and collective mutual understanding can be quite far from focusing on technical and task-oriented discussions. However, these "soft" oriented discussions help teams to foster new insight and knowledge and to facilitate adaptable behaviors.

The idea of abandoning an authoritative controlling leadership style in crisis settings will truly be counterintuitive and surprising, and maybe even provoking, for many leaders. Nevertheless, I hope that reading this thesis helps to broaden leadership perspectives and, by this, spark interesting discussions within organizations that rely on teamwork in uncertain and ambiguous contexts.

Acknowledgments

Writing this doctoral thesis has been like navigating in a blizzard. It has been hard, frustrating, unpredictable and given me learning at many dimensions. Truly, my Ph.D. process has contained several failures and disappointments, but surely also a lot of fun. By nature, a doctoral thesis carries the name of a single author. However, no researcher is an island, and there are several persons that have supported me and my work in various ways.

The quote: “I'm a success today because I had a friend who believed in me and I didn't have the heart to let him down” from Abraham Lincoln describes my gratitude to my good friend and supervisor Endre Sjøvold. This thesis would not have been finished without you. Your support and our research discussions been highly rewarding. At the same time, it is the countless of hours that we have used to discuss *anything else* than this thesis I have really appreciated!

Thereafter, I would like to thank my friend and colleague Trond R. Olsen. Trond, it has been quite a journey and I am glad I have done it together with you. I would also express my gratitude to Professor Alf-Steinar Sætre, the eminent and highly engaged NORSI-PIMS program director. Alf-Steinar, I am thankful for giving me the opportunity to be a part of this program, and thanks for all of the hard work you have put down for all of us! At the same time, Professor Arild Aspelund, celebrating your birthday in Lund was truly a game changer for me. Thank you as well, our discussions has truly been helpful and rewarding.

I would also like to thank the rest of my fellow doctoral students in the NORSI-PIMS program: Joseph S. Schultz, Erik A. Sæther, Rikke Stoud Plataou, Monica Rydland, Lisa S. Schüle Græslie, Nhien Nguyen, Marta Morais-Storz, Kine Norheim, Ingrid Lunde Ohna and Daniel Leunbach. I hope we can keep in touch in the future, and thanks for all of your support and brilliant conversations. Also, I am highly grateful for the talks I have had with you Dr. Øyvind Bjørgum, seeing you finishing your thesis this winter has truly been inspirational. In the end, everyone in the “Faggruppe” deserves my appreciation; I have learned something from each and one of you.

I have been supported by numerous of family members and friends outside of the office as well. Obviously, it is impossible to forget my mother and my brother in this process, I am quite sure they both are rather tired of hearing me talking about this thesis, but thanks for listening to it! Thereafter, I have many friends that have helped me to keep sane and focused. In such, I would like to express a special gratitude to Thomas, Morten H., Martin, Toni, Per-Arne, Joachim, Espen, Christer, Morten S, Kenneth, Ole, Bård, Preben, Henning, and Truls. You have all bothered to listen to me jabbing on about this thesis for four years now, and at

the same time been able to pretend that you have cared. That is actually impressive, and I owe you all. Indeed, the numerous beers released from cans and bottles, as well the world problems solved, have all been crucial in order to keep my mind of this thesis. Thanks! I would also like to thank Louise for the extensive amount of proof writing she has gone through, I can only imagine the patience this has required. There is also another anonymous person out here that deserves a hug for keeping faith in me (especially when I have lost it myself).

Kenneth Stålsett
Trondheim, September 2016

Preface

This thesis is written as a scholar at The Norwegian Research School in Innovation - Program in Innovation Management and Innovation Strategy (NORSI-PIMS). NORSI-PIMS is hosted at the Norwegian University of Science and Technology (NTNU), which has paid for and hosted my work. The doctoral program is built by a cohort of doctoral students belonging to different institutions in Norway. While we, as students, go through same program as a cohort, our work covers a diversified field in - and between - existing organizations. NORSI-PIMS consists of a diverse international faculty, all experts and leading researchers in their field. Attending the NORSI-PIMS program has been both intense and valuable, and it has unquestionable influenced my work. I have gained 72 credits in total through the NORSI-PIMS, whereas 60 of them are formally credited to my certificate. The Ph.D. courses are briefly described by:

Overview of my Coursework

Course	Session name	Facilitator(s)
Perspectives on Innovation		
- Session 1	Research on Innovation Processes	Professor Andrew Van de Ven
- Session 2	The systematic Nature of Innovation and Economic Growth	Professor Jan Fagerberg, Professor David Mowery and Professor Ben Martin
Research Methods and Academic Writing		
- Session 1	Survey of Quantitative Research Methods and Intro to SPSS by the CIRCLE and Ultrecht team	Professor Bjørn T. Asheim (organizer)
- Session 2	Qualitative Research	Professor Yvonna Lincoln and Professor Mats Alvesson
- Session 3	Scientific Writing and The Academic Publishing Process	Professor Keld Laursen and Professor Nicolai Foss
Innovation in Projects and Networks		
- Session 1	Innovation in Networks	Professor Håkan Håkansson and Professor Walter Powell
- Session 2	Innovation in Projects	Professor Jonas Söderlund and Professor Andrew Davies
Organizational Theory and Behavior		
- Session 1	Organizational Theory	Professor Richard Harrison
- Session 2	Organizational and Managerial Cognition and Behavior	Professor George Huber

Strategic Management of Innovation and Service Innovation		
- Session 1	Strategic Management of Innovation	Professor Nicolai Foss and Professor Keld Laursen
- Session 2	Service Innovation	Professor Per E. Pedersen and Professor Per Kristensson
Exploration and Exploitation		
- Session 1	Exploration and Exploitation in Organizations	Professor Dovev Lavie
- Session 2	Innovation and Organizational Ambidexterity and Open Innovation	Professor Michael Tushman and Professor Henry Chesbrough
Innovation, Learning and Change		Professor Daniel A. Levinthal
- Session 1	Absorptive Capacity, Organizational Learning and Adaption	
- Session 2	Innovation from a Learning and Change Perspective	Professor Henrich Greve
Teaming and Disruptive Innovation		
- Session 1	Teaming	Professor Amy C. Edmondson and Associate Professor Endre Sjøvold
- Session 2	Disruptive Innovation	Professor Clayton Christensen Associate Professor Endre Sjøvold
Methods for Research and Consulting of Teams Emphasizing SPGR		

The research project "Operational Leadership"

My thesis is as a part of the research project "Operational Leadership", which aims to develop new knowledge about leadership- and team practices in frontline operations. A focal element in this work is to understand how teams align and excel through highly uncertain and ambiguous contexts. To illustrate, frontline operations can run as routine tasks for long time-spans, but in the blink of the eye the environment alter into an unknown complex chaos. In these situations, the implemented practices and routines will fail to cover the actions that are required to handle the raising ambiguity.

Dr. Endre Sjøvold, my supervisor, leads Operational leadership, while the project founded by Norwegian Agency for Digital Learning in Higher Education (Norgesuniversitetet). Sjøvold has been leading a small research group consisting of my NORSI-PIMS colleague Trond R. Olsen and myself. In addition, we have had 21 master students involved in this project. The project's purpose is to develop a decentralized

interactive education program for leaders, project managers and others that operates in high-risk industries. It is through "Operational Leadership" we have been able to obtain the sociometric badges from MIT Media Laboratory, Human Dynamics Group. The third article in this thesis uses these badges.

Attending this project has obviously influenced and guided my research, but the boundaries has been broad, meaning that I have been able to pursue the topics that I found interesting and relevant. Due to this freedom, I have gained insights in several industries and areas that are tightly connected, but outside of this thesis. As examples, we have studied several topics: how the dynamics in top management teams spread through the organizations; how virtual collaborations affects knowledge transfer; as well as challenges in multinational and multicultural team collaborations.

The contexts in our research projects vary from the power supply industry, pure software companies, and more industrial production institutions. This additional effort has been interesting, time consuming and fun, and resulted in data from various Norwegian companies that operates in countries like Russia, Poland, India, China and South Korea. In hindsight, I should probably have focused my energy more specifically towards my thesis - but participating in several research projects has definitely helped me to broaden my scope and understanding of team dynamics and leadership. In addition, this work has provided me with interesting data sets that I will continue to work with after this thesis is finished.

Operational Leadership had its formal start in 2014, and is supposed to finish in the end of 2016, whereas the education program will be started in the spring of 2017. However, the plan is continue to develop the content of the program with relevant research and publications. None of us has received any salaries from the project, but Operational Leadership has covered traveling costs for data collections and conferences, as well as paid for language cleaning of articles and other operating expenses. The project was central in my application for the SCANCOR program at Stanford, which I attended from March - September 2015.

Conferences and communication

I have attended several conferences and been active with various interviews and publications in newspapers. In general, I have used conferences to test ideas and get feedbacks on research topics, while the non-scientific publications are inputs to various debates and discussions. This work has been reported in CRIstin. CRIStin's work includes several tasks related to research documentation and access to research information. This responsibility was given to

the organization by the Norwegian Ministry of Education and Research and the Norwegian Ministry of Health and Care Services, and covers universities and university colleges as well as institutions and health trust[1].

My registrations in CRIstin are:

Olsen, T. R & Stålsett, K. (2014). The executive team's influence on the organization. NFB Conference; 2014-08-28 - 2014-08-29 NTNU.

Olsen, T. R & Stålsett, K. (2014). The executive team's influence on the organization. NORSI Conference; 2014-09-02 - 2014-09-02 NTNU.

Sjøvold, E., Olsen, T. R & Stålsett, K. (2014). www.innovativeteams.no NTNU.

Stålsett, K. (2014). Operational leadership and knowledge-transfer in high risk operations. GRASP; 2014-05-22 - 2014-05-23 NTNU.

Stålsett, K. (2014). Oppskriften på et vinnerlag. www.forskningsrådet.no [Internet] 2014-01-28 NTNU.

Stålsett, K. (2014). På tide med debatt om personlighetstester. Ukeavisen ledelse NTNU

Stålsett, K. (2014). Team-training and the executive team's organizational influence. GRASP; 2014-05-22 - 2015-05-23 NTNU.

Stålsett, K. & Christiansen, A. (2014). Oppskriften på et vinnerlag. www.forskningsradet.no [Internet] 2014-01-28 NTNU.

Olsen, T. R & Stålsett, K. (2014). Operational leadership and developing team dynamics within high risk operations. NFB Conference; 2014-08-28 - 2014-08-29 NTNU.

Olsen, T. R & Stålsett, K. (2014). Operational leadership and developing team dynamics within high risk operations. NORSI Conference; 2014-09-02 - 2014-09-02 NTNU.

Olsen, T. R & Stålsett, K. (2015). Operational teams: Focusing on shared mental models and team dynamics to increase the level of quality in decision making during crisis. Seminar at SCANCOR Stanford University; 2015-05-22 - 2015-05-22 NTNU.

Sjøvold, E., Stålsett, K. & Olsen, T. R. (2015) Nettavisen.no/ http://innovativeteams.blogg.no/. NTNU.

Stålsett, K. (2015). Er det på tide med et nytt syn på ledelse?. Ukeavisen ledelse 2015 NTNU.

Stålsett, K. (2015). Ikke snakk negativt om Silicon Valley. 3in.no 2015 NTNU.

Stålsett, K. (2015). Open Innovation - hva er det?. Ukeavisen ledelse 2015 NTNU.

Stålsett, K. (2015). Open innovation - hva er det?. Dagens Perspektiv 2015 NTNU.

Olsen, T. R & Stålsett, K. (2015). Team leadership within integrated operations in the oil and gas industry. Seminars at SCANCOR Stanford University; 2015-04-17 - 2015-04-17 NTNU.

Stålsett, K., Sjøvold, E. & Olsen, T. R. (2015). Team leadership within integrated operation in the oil and gas industry. Konferens för grupp- och socialpsykologi; 2015-05-18 - 2015-05-19 NTNU.

Stålsett, K. (2016). Volda kommune benyttet profilanalyser i lederkurs. http://www.nernett.no/ [Newspaper] 2016-03-18 NTNU.

Stålsett, K. & Solheim, M. (2016). Da klokka klang så fort vi sprang.... Ukeavisen ledelse 2016 (9) p. 31-32 NTNU.

[1] http://www.cristin.no/english/about

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Contents Part II: The Articles

1 Introduction

Why do some teams excel through uncertainty and ambiguous goals, while others fail dramatically as soon as novelty becomes a part of their operational context? This thesis aims to contribute to this discussion by studying frontline teams that have to operate in environments that can change from predictable into chaotic in the blink of the eye. In such situations, the ability to adapt is not only a question of organizational performance, but it can also be the difference between life and death.

We, as humans, have organized ourselves into groups since our early days on earth (van Vugt & Ronay, 2014), and today's organizational life is, in large, organized around teamwork (Edmondson, 2012a; Mohrman, Cohen, & Morhman Jr, 1995). While the small group traditions have roots that are more than 100 years old (e.g. Sumner, 1906; Triplett, 1898), many consider Kurt Lewin as the founder of the field (Lewin, 1942, 1945, 1947, 1951). The field of team research is broad and has truly spread through the literature domains (Levine & Moreland, 1990), making group insights valuable and important in other fields than the traditional small group research domain (e.g. organizational management) (Morrison, 2010). Despite the popularity of teams and teamwork, there are numerous of examples of teams that fail spectacularly. Janis (1982) illustrates such failures through examples as the attack on Pearl Harbor, the Bay of Pigs invasion, and the escalation of the Vietnam War. In the effort to understand such historical examples, it is alluring to agree with Nietzche who claimed that madness is the exception in individuals, but the rule in groups.

In an operational frontline setting, an ominous example of teams that fail is described with the terror attack in Norway on 22 July 2011, where a total of 77 people died due to the acts of a single terrorist. The novelty and complexity of in the circumstances required the Delta Force police teams to be innovative; however, due to the pressure and stress stemming from these events only imprinted drills and routines were executable. Hence, the Delta teams ended up as static actors while awaiting new orders that allowed them to initiate counter-movements. As a consequence, external investigators now ask the Police to come up with new practices to ensure that their teams can handle uncertainty and ambiguity (Gjørv et al., 2012; Johannessen, 2013).

Teamwork failures, with fatal consequences, are also found in civilian settings. The oil and gas sector has historically experienced several accidents and near accidents (e.g. Alexander Kielland in 1980, Piper Alpha in 1988, Deep Water Horizon in 2010, and the COSL rig in 2015). In 2010, the Deep Water Horizon platform collapsed in the Mexico Gulf.

The catastrophe killed 11 people and created severe environmental, social, and organizational impacts (Tinmannsvik et al., 2011). While several technical aspects of the platform failed, the established operational practices and procedures were misaligned and insufficient to prevent the minor early events from escalating into a huge catastrophe (Tinmannsvik et al., 2011). Organizations and policy makers focus on learning from near- and real accidents, but there are still many chances for major accidents at the Norwegian shelf today (Petroleumstilsynet, 2013; Tinmannsvik et al., 2011). Even if each accident, or near accident, is unique, the human interplay is always a significant factor in the results of investigations.

Notably, safety and risk management are central parts of oil and gas operations; this focus builds upon deeply anchored evidence-based procedures, routines and centralized management (Tinmannsvik et al., 2011). However, this focus is, in large, founded upon known and solvable problems, leading the organizations to be misaligned when novelty and ambiguity arise. Hence, this industry also requires new perspectives that help teams to proceed from stable and predictable contexts into hazardous and rapidly changing environments.

Teams are complex dynamic entities (McGrath, Arrow, & Berdahl, 2000), but the dominating research perspectives have handled teams through static methodical practices (Kozlowski, 2015; Kozlowski & Chao, 2012). Thus, the complexity surrounding team dynamics is described as hard to study (e.g. Keyton, 2016; Tajfel, 1982), making Mathieu, Maynard, Rapp, and Gilson (2008) argue that many of the implications from the dominant team domains are more often wrong than correct. At the same time, managers argue that efficient teamwork is essential for performance (Martin & Bal, 2006). This is somewhat ironic, as research illustrates that only a minority of teams are really successful, and up to a third of all teams are directly failing (Edmondson, 2012b; Govindaran & Gaupta, 2001). Due to this, several scientists have started to ask for more research that starts to unveil more of the mysteries around team process (e.g. Kozlowski, 2015; Mathieu et al., 2008; McGrath et al., 2000; Salas, Goodwin, & Burke, 2008). This desire encompass an expansion from an intra- to an inter-team focus (McGrath et al., 2000), as multiple teams usually constitute part of a dynamic operational context (Avolio, 2007; Heldal & Antonsen, 2014; R. Hogan, Curphy, & Hogan, 1994; Johns, 2006; Kaiser, Hogan, & Craig, 2008; Keyton, 2016; Likert, 1961; Parsons & Bales, 1953; Parsons & Shils, 1951; Sjøvold, 1995, 2006a, 2006b, 2014b; Sjøvold & Park, 2007; Tannenbaum, Beard, & Salas, 1992). However, such important contextual impacts are, in large, neglected in team research.

While the team domain is vast, the focus upon frontline teams that need to handle high uncertainty and rapidly changing tasks is scare, which increases the demand for such research

(e.g. Danielsen, 2015; Heldal & Antonsen, 2014; Keyton, 2016; Kozlowski, 2015; Nielsen, Sundstrom, & Halfhill, 2005; Sjøvold, 2014a). Truly, these requests for advances raise the complexity of group studies, leaving scholars asking for more theory-driven empirical work (Ilgen, Hollenbeck, Johnson, & Jundt, 2005) and new methods (Ancona, Bresman, & Caldwell, 2009; Burke, Salas, Estep, & Pierce, 2007; Carter, Asencio, Wax, DeChurch, & Contractor, 2015; Keyton, 2016; K. J. Klein, Ziegert, Knight, & Xiao, 2006; Pentland, 2012; Zander & Butler, 2010). I am to contribute to this through the overarching research question:

"How do teams enable their resources to adapt to changing contexts and ambiguous tasks?"

To respond to this question, I have based my work on a complex dynamic theory, and developed a total of four papers, all anchored in the theories and arguments found in the first parts of this thesis. Hence, Part I gives an introduction to the field, a review and a baseline of the literature, including potential research gaps; while it also contains a discussion based on the four empirical papers, before it concludes. The four articles, found in Part II, shed light on different aspects that are vital for efficient team adaptions. Altogether, the thesis creates several empirical and theoretical contributions that advance the understanding of teams operating within highly uncertain contexts.

1.1 The research context

"Operational Leadership" has two main partners, which both have high interest in my work. I give a brief introduction to each.

1.1.1 The Royal Norwegian Naval Academy

The first project partner, The Royal Norwegian Naval Academy (RNoNA) is based in Wallemsviken, Laksevåg, at the outskirts of Bergen. RNoNA is one of three educational institutions owned by the Norwegian armed forces. The school's educational purpose is to develop future leaders and officers for the Norwegian Armed Forces. Through a combined use of theoretical and practical education, cadets acquire the knowledge and capabilities needed perform effectively in military operations. By completing a three year program, the cadets achieve a Bachelor's degree in Military Studies (RNoNA, 2009).

RNoNA is on the forefront of evidence-based team development in Norway (Mjelde, Smith, Lunde, & Espevik, 2016; Sjøvold, 2014a), and operate in complex environments containing innovative technological solutions, different international and national juridical regulations, as well as various natural forces. While ensuring correct and efficient operations, cadet groups need to be able to coordinate, as well as cooperate, with ground-based units, submarines, other fleets, and aircraft - often at the same time. Execution of actions can be triggered by unforeseen events, turning a stable context into dangerous chaos, which puts significant emphasis on the value of unconventional and innovative team responses. This insight guides the RNoNA's educational programs, making strenuous exercises highly valuable (RNoNA, 2009).

1.1.2 Statoil ASA

Statoil, a Norwegian oil and gas company, is the second project partner. They are the largest actor on the Norwegian Shelf, have operations in more than 20 countries, and employ approximately 20,000 employees worldwide. In February 2013, Statoil established a new center for operational leadership. This center builds on leading research, and focuses on enabling the leaders to conduct safe and effective production and to handle uncertainty and crisis settings (Statoil, 2013b).

Statoil builds their operations around the concept of "integrated operations" (IO), which includes extensive usage of innovative technology as the core of their operations (Albrechtsen, 2013). The IO structure has led to a significant relocation of expert knowledge from offshore installations to onshore locations, and has thereby significantly raised the demands for efficient leadership and team behaviors. IO is supposed to help support and ensure that this is possible, and also ensure that standardized operations are, as far as possible, handled by computers. Thus, the IO-structure has clearly changed the way Statoil operates within normal business activities, however, the organizational operations and structures implemented within crisis settings have not changed (Grøtan & Albrechtsen, 2008; Tveiten, Lunde-Hansen, Grøtan, & Pehrsen, 2008). In this industry, the potential for major accidents (e.g. Deep Water Horizon) is overwhelming, and major catastrophes can develop rapidly out of minor errors. An example exists in Petroleumstilsynet, (2016b), which documents how only a series of coincidences prevented a major accident at one of the platforms in the North Sea in February 2015, and that human errors were central in this case. This report has naturally opened up a major debate in relevant journals in Norway. At the same time, Statoil faces threats from various directions such as terrorist attack and unpredictable natural forces. For

example, in 2013, five Statoil employees were killed in a hostage situation in Amenas, Algeria (Statoil, 2013a) and in 2015, a 15.5 meter high wave unexpectedly struck the COSL rig outside of Norway. The monster wave killed one person and injured four (Petroleumstilsynet, 2016a). It follows that enabling a full understanding of all possible risks on a platform is close to impossible. The continuous globalization, as well as the significant drop in oil prices the since 2014 (Baumeister & Kilian, 2016; Yoshino & Taghizadeh-Hesary, 2016), forces Statoil to continuously innovate and develop their organizational structures.

1.2 The Articles

Table 1 gives a short introduction to the four articles found in Part II. The combination of these papers contributes to answering my overall research question.

Table 1

A Brief Overview of the Articles in This Thesis

Paper	Title	Authors	Status	Method/ context	Findings
1	Facing uncertainty: Developing adaptable teams	K. Stålsett E. Sjøvold R. Espevik	Submitted to the journal "Work"	Mixed methods/ RNoNA	Focusing and discussing the unique social interaction patterns in each team help to advance the complexity of team dynamics
2	Team adaption: Uncovering differences in shared mental models	K. Stålsett E. Sjøvold	Submitted to the journal "Military Psychology"	Quantitative methods/ RNoNA	Team-related shared mental models are sticky and hard to change
3	Unfolding influence: Sociometric data and group dynamics	K. Stålsett E. Sjøvold	Submitted /transferred to the journal "Cogent Social Sciences"	Quantitative big data/ RNoNA	Sociometric badges can be used to capture influence by combining verbal and non-verbal communication in groups
4	Dynamic team leadership within integrated operations in the oil and gas industry	K. Stålsett E. Sjøvold T. Olsen	Accepted with minor reviews in the journal "Scandinavian Psychologist"	Mixed methods/ Statoil	The implemented structures and perspectives in this industry hampers leaders' ability to establish efficient interteam collaboration and handle chaotic situations

1.3 Structure of thesis

Part I is structured as seven chapters, consisting of the introduction, a literature review, my theoretical foundation, the research strategy, the main findings in the papers, a discussion of the findings against the overall research question, and some concluding remarks. Part II contains the four empirical papers.

2 Literature Review

In this chapter, I introduce my literature review that goes through broad trends within the team domain before it presents topics that are important in my work and deserves more attention in future research. These topics stem from concepts that are highlighted in theory, or have been brought up in various discussions with my stakeholders. An abstract is included as this chapter can be used as a framework for practitioners and new scholars in the field.

Abstract

This review chapter goes through the general research trends that have appeared in the team literature since its early days. By doing this, I provide a framework that can be used to categorize and position previous and forthcoming work. The framework should be valuable, as the group literature is enormous, making it easy to get lost and end up with illogical assumptions and theories. Hence, researchers and practitioners can use the framework to find relevant literature and understand where they should search for gaps and inspirations. The general trends I present are categorized as a) the 1950-70s, focusing on team dynamics; b) 1960s- (and forward), investigating various input-process-output (IPO) factors; c) 1980s, emphasizing roles, d) 1990s, finding the ideal team; e) 2000s, centering on personalities; f) 2010s, understanding dynamics related to the context. This review originates from a research project that focuses on teams that operate in highly uncertain and ambiguous contexts. Due to the stakeholders' interests, as well as the potential for theoretical development, the paper ends by pinpointing research gaps within the topics: *team leadership*, *group dynamics,* and *cognitive mechanisms*. This chapter should be especially useful for new scholars in the field, but also for other researchers and practitioners who want to anchor their work in a framework.

Keywords: team research, research trends, group dynamics, research gaps.

2.1 Team research trends: Review and possible advancements

The team literature is enormous, and just too diversified to capture in a single review. To illustrate, the book "Theories of Small Groups: Interdisciplinary Perspectives" (Poole & Hollingshead, 2005) 42 authors use more than 400 pages to review the then-current state of small group research. At the same time, Kozlowski and Bell (2013) conducted a review of 42 articles going back to 1987, including several review articles, that covered the broad literature on team effectiveness. This review builds on the work of Kozlowski and Bell (2003). In fact, using tools such as Google Scholar gives millions of findings when searching with keywords containing "teams" and "groups", or different keywords

related to this topic. This means that a useful review must be anchored somewhere and have a clear strategy.

As the complexity of the interaction patterns increase significantly as dyad expands to triad (Simmel, 1955), I start by defining a group or a team: as "three or more people who share a common goal and interact to achieve this goal" (Sjøvold, 2006b, p. 17). This means that I aim to include work that satisfy this definition. Inspired by Kettner-Polley (2016), I focus upon *issues*, meaning that I do not lock this review into a single theoretical perspective, but instead approach the field with an open mind. Kettner-Polley (2016) presents an historical, and relatively detailed, snapshot of the small group traditions. This snapshot also presents issues around interdisciplinary collaborations, and Kettner-Polley argues that there is still a lot to accomplish within this topic. My review takes another angle, as it provides an overall timeline of the different team-research trends and the implications of these. Such a timeline helps to gain an overall understanding of the broad team research topic, solving an issue by making team research easier to access and position for new scholars and practitioners. In addition, my review ends by highlighting several gaps in the literature, some of which are addressed in this thesis.

The current review builds partly on the work of Kozlowski and Bell (2013) as they reveal several possible future research areas that overlap with my work. Notably, I take the difference between a dyad and a triad into considerations, while Kozlowski and Bell (2013) did not. Interestingly, Kozlowski and Bell (2013) mention teams that operate in extreme conditions, while their review does not really bring such contexts into focus. In fact, this is not particular surprising. Nielsen et al. (2005) write that only two of 53 articles published between 1999 and 2004 deal with the topic of "action teams," suggesting that this is an area deserving of more attention. The call for papers for the special issue "Teamwork in Extreme Environments" in Journal of Organizational Behavior (Maynard, Kennedy, & Resick, 2016) illustrates the same; teams operating within uncertain and complex environments is a field that demands more development and attention. In addition, Kozlowski (2015) writes that team dynamics are the next frontier for research, and I argue that understanding team dynamics is essential in order to create adaptable teams.

This review stems from a research project that investigated teams operating in uncertain and changing environments. The idea is that teams often work under longer periods of routine and process tasks, which suddenly fall into uncertainty and chaos due to unexpected events. Such traits are typical for the oil and gas industry as well as for the naval military warfare sector; these are the core stakeholders in the project. To follow up on this, I anchor my work in the domain "small group research," which focus on interpersonal interactions and social psychology. As Kozlowski and Bell

(2013) write, this literature tends to minimize group tasks and technology, which is emphasized more in the organizational domain. Since the research project focuses on real teams, with real tasks and massive technology, I combine these streams of research to create something that has practical relevance.

2.2 Review strategy

Hart (1998, p. 13) defines a literature review as: "(...) the selection of available documents (both published and unpublished) on the topic, which contain information, ideas, data and evidence written from a particular standpoint to fulfill certain aims or express certain views in the nature of the topic and how it is to be investigated, and the effective evaluation of these documents in relation to the researching being proposed". This work is not straightforward. More than 60 years ago, Glass (1955) wrote that "no problem facing the individual scientist is more defeating than the effort to cope with the flood of published scientific research, even within one's own narrow specialty" (p. 583). The team and group literature is not different in that way. While some researchers tend to follow the idea of focusing on top level journals (e.g. Netland & Aspelund, 2014), this will not lead to fruitful progress for this review as the team literature is dominated by perspectives that are outside of my scope. Due to this, I have tried to use an opponent strategy to challenge the "echo chamber" (see Pentland, 2013). This does not mean neglecting high standing journals. Instead, these journals have been handled carefully to ensure that their contributions fit into my work.

My line of inquiry is to follow the purpose of the research project, and make sure that each cited theory has practical significance for the collaboration partners (Van de Ven, 2007, 2011). Truly, not everyone will agree with such a strategy, however I really fancy what Westbrook (2009, p. 15) states: "In sober moments, however, academics ought to notice that what professors say carries relatively little weight in society writ large". Inspired by "issues," we, as academics, should focus upon work that helps the society instead of fighting between disciplines, especially when we study the same field or context. However, combining ideal theories is not straightforward, and must be done without creating illogical assumptions (Van de Ven, 1992).

The process started with electronic searches in suitable computerized databases for academic literature. My choice of databases followed the assertion that many disciplines (e.g. social and cognitive psychology, business, innovation and management studies) cover the relevant subjects, and that several sources are needed to ensure high quality (Yin, 2014). Furthermore, my work has been influenced by the contents of the NORSI-PIMS program, and

my thesis should contribute to broadening the understanding within innovation topics. Notably, innovation studies has a long tradition, and is a cross disciplinary field that is rapidly expanding (see Fagerberg, Fosaas, & Sapprasert, 2012).

Specifically, four separate databases were used: ISI Web of Knowledge, NTNU BIBSYS, Google Scholar and Scopus. I have used multiple combinations of keywords to address the topic at hand. As such, it has been useful to use Boolean operators in order to narrow the scope, and increase the relevance of the searches. As an example, the search string: TITLE-ABS-KEY ("team building" OR "team training" OR "team development") AND "shared mental models"), resulted in 25 hits in Scopus, compared to 385 hits when "shared mental models" was used as a single search word. In addition, I have done extensive nesting, both by investigating which papers the article at hand cites; and to see which papers that have continued to cite the original article.

The research gaps have been chosen by the fact that they bear on the topics that have been discussed with the stakeholders at the beginning of the review process (see Van de Ven, 2007, 2011). Hence, the purpose is to help the stakeholders to expand their understanding, and not just to review the field for theoretical gaps.

2.2 Research trends

2.2.1 A brief timeline

Figure 1 illustrates the timeline of trends in group research. I have not seen any research containing a similar figure, but this one should be useful for researchers and managers who try to position themselves in the massive team literature. Figure 1 provides a summary of the work in the following subsections.

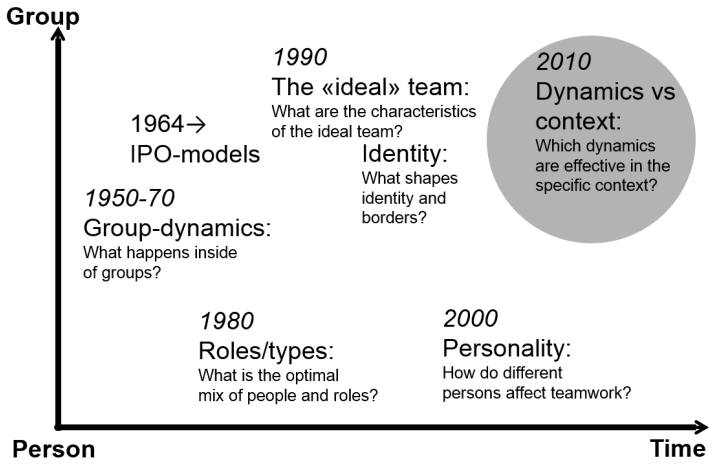

Figure 1. A snapshot of team research trends (Adjusted from the NORSI-PIMS seminar Teaming and Disruptive Innovation by Dr. Endre Sjøvold).

2.2.1.1 1950-70s, dynamics

The history of team research has strong roots within the field of social psychology. Sumner (1906) was ahead of his time when introducing the terms in-group and out-group, which describe how we, as humans, differentiate ourselves based on the social groupings to which we belong – or do not belong. While the field of intergroup relations research slowly evolved, Kurt Lewin's work is seen as providing the central building blocks for the understanding of group dynamics (Lewin, 1942, 1945, 1947, 1951). The small group research tradition had its heydays in the 50s and the 60s. This period produced important contributions to team research that are vital fundaments for the work done today. The main focus included various aspects of team dynamics, touching directly upon behavioral and psychological themes (e.g. Allport, 1954; Asch, 1955; Bales, 1950a; Bales, 1950b, 1953, 1985; Bales, Cohen, & Williamson, 1979; Bion, 1961; McGrath, 1991; Mills, 1967; Parson, 1953; Parsons, Bales, & Shils, 1953; Parsons et al., 1951; Schutz, 1958; Simmel, 1955; Triplett, 1898; Tuckman, 1965; Zajonc, 1965).

However, it seems that many researchers ignore some of this early work. As an example, a number of influential team studies do not distinguish between dyads and teams (e.g. Eckes, 2002; Salas, Sims, & Burke, 2005). As an example, the work from Salas, Fowlkes, Stout, Milanovich, and Prince (1999) includes dyads of helicopter pilots. According to Simmel (1955), in a work originally published in German in 1922, the interaction between

two persons should be considered as a “personal conversation”, while the complexity found in groups are found when expanding from a dyad to a triad. Meanwhile, the founders of my project seldom have the benefit of operating as dyads. Ergo, to support the famous statement "nothing is as practical as a good theory" (Lewin, 1945, p. 129) the complexity of triads and larger groups must be encompassed to ensure a validated theoretical foundation for my stakeholders.

Levine and Moreland (1990) reviewed the small group research domain and concluded that “Groups are alive and well, but living elsewhere” (p.620), suggesting that other research fields, particularly organizational psychology, have picked up the thread. Morrison (2010) reported 20 years later that the terms *team* and *group* were the most common keywords in submissions to the Academy of Management Journal from 2007-2009. What happened? The next subchapters will help to shed light on this topic.

2.2.1.2 1960s- , IPO.

McGrath (1964) introduced the input-process-output (IPO) model, which dominated team studies in the organizational domain for the next 50 years (e.g. Hackman, 1986, 2002, 2009; Hackman & Morris, 1975; Wageman & Hackman, 2010). Several researchers have started to criticize this perspective (e.g. Braun & Kuljanin, 2015; Cronin, Weingart, & Todorova, 2011; Kozlowski, 2015; Kozlowski & Bell, 2003). The main concern in this critique is that the IPO-perspective handles the “process” as a black box (see Kozlowski & Bell, 2003), while the dominant research practices have, in general, frozen the model into static constructs (Braun & Kuljanin, 2015; Cronin et al., 2011; Kozlowski & Bell, 2003; Kozlowski, Chao, Chang, & Fernandez, 2015). This situation is explained by the methodological choices that dominate the IPO-perspective; retrospective self-reports tapping into different constructs, and cross-sectional research designs (Kozlowski, 2015; Kozlowski & Chao, 2012). The IPO-perspective tries to force the *complexit*y within group dynamics into something *complicated*, meaning that investigators imagine that they can control and predict outcomes as long as they know the inputs (see Glouberman & Zimmerman, 2002). McGrath (1964) never intended the IPO-framework to end up as a unidirectional cause-effect perspective, and he argues that teams are complex, adaptive systems (McGrath et al., 2000). This situation implies that team dynamics are essentially understudied since the heydays of group observation in the 50s and 60s (Keyton, 2016; Kozlowski, 2015; McGrath et al., 2000).

Interestingly enough, while still being a part of the IPO domain, Mathieu et al. (2008) actually write that the IPO-framework is more often wrong than it is predictive – clearly asking for new

methods, theories and perspectives in order to make practical contributions to society. Nonetheless, this perspective has a strong foothold, and quick searches in databases provide hundreds of various input-suggestions. I agree with Mathieu et al. (2008), this provides few helpful implications for leaders trying to understand team dynamics and thereby enable teams to adapt. In fact, I would argue that all the various inputs, mediators, and moderators found in this tradition have the potential to confuse and facilitate illogical actions if implemented without a critical eye.

2.2.1.3 1980s, roles

At the same time, there were also other trends outside of the IPO-domain. During the 1980s, a stronger focus toward individual roles in teamwork dominated the literature (e.g. Frohman, 1978; Quinn, 1988). These roles fall into various categories such as: gatekeeper, idea generator, champion, administrator, devil's advocate, market keeper and so on. The assumption is that each team needs to fill certain roles to function. Following these recommendations, teammates were supposed to take roles depending upon the progress of the work, or by given situations. As an example Van de Ven, Polley, Garud, and Venkataraman (1999) argue that the critique role, extracted from Quinn (1988), is most important in the early phase of an innovation development project. I, however, claim that being able to raise a critical voice and challenge established patterns and perceptions is important at all stages of an innovation project. Several things could go wrong also, after the implementation of the product, which means that teams should be able to discuss and question every aspect of their work.

Assigning roles, however, has a tendency to lead to stereotypical expectations, and self-fulfilling expectations (Brophy, 1983; Carpenter, 1995; Word, Zanna, & Cooper, 1974). If these expectations lead to frozen polarizations (Bales, 1950a, 1950b, 1999; Polley, 1987), the team can encounter severe problems such as open conflicts and failure to adjust to their tasks (Bales & Hare, 1965; Sjøvold, 2006b, 2014b). Thus, being the one who started out as the devil's advocate, intending to raise critical concerns in teamwork, can result in becoming the sourpuss at work. In another example, Janis (1982) illustrates how a group of smokers, including the team leaders, acted against a non-smoker – who was originally a part of the group – because of their stereotypical anticipations. The non-smoker's crucial action was claiming that everyone could stop smoking without going through a program, and as a result he was frowned upon and thrown into what Sumner (1906) would call the out-group. All of this trouble escalated because the non-smoker criticized the stereotypical perspectives that were held by the group. The principle of assigning roles in groups is alive today, especially because of consultancy companies. In addition, I argue that the stronghold of this tradition

is quite natural, as many of the researchers from this period hold important positions in business schools and universities today.

3.3.1.4 1990s, ideal.

As shown in Figure 1, the 1990s brought a trend in which researchers tried to describe the ideal team (e.g. Katzenbach & Smith, 1993). This period used identity-establishing and categorizations to try to explain performance outcomes (e.g. Cohen & Bailey, 1997; Sundstrom, De Meuse, & Futrell, 1990). The categories and identities are exemplified with ideas such as: teams that recommend, teams that make or do, and teams that run things (Katzenbach & Smith, 1993). This stream of literature is indeed alive today. As an example Lee, Koopman, Hollenbeck, Wang, and Lanaj (2015) state that one of the most basic task in team research is to describe exactly what kind of team is being studied. While this might be of interest, it is certainly true that many teams deal with different kinds of tasks. It can therefore be questioned whether or not such classification actually helps teams. First off, creating in "ideal" team that can handle any situation will be practically impossible, as each team has unique members. Furthermore, I claim that most teams have a sense of what they are doing and the boundaries of their work, which means that labeling them does not really help to solve their problems. Also, many of these teams, depending on where and what they do, will work within several different classifications. As an example, think of a military special forces team, operating in remote areas of Afghanistan. These groups rely upon themselves to "recommend, make, and run things". The same principles follow a range of groups; just think of startups with a limited available resources and team members.

3.3.1.5 2000s, personalities

In the 2000s, the concept of personalities in teams became more salient (e.g. Greenwood & Suddaby, 2006; Neuman, Wagner, & Christiansen, 1999; Salas, Sims, et al., 2005; Sheldon, Ryan, Rawsthorne, & Ilardi, 1997). Instead of creating teams based upon roles as in the 80s, this trend emphasizes the teammates' personalities. Indeed, strong personalities can alter the behaviors of the group (Nissestad, 2008; Sjøvold, 2007), as well as create a group climate in which their actions dominate and guide the group's actions (Bion, 1987; Sjøvold, 2006b). In teams in which members do not experience any pressure to cooperate towards a common purpose, or do not care about adjusting to eventual changing circumstances, people can, to a certain degree, let their personalities shine.

At the same time, Sumner (1906) argues that in-groups have their own identity, which helps them to separate from out-groups. This identity builds on the internal group norms and controls the social interactions inside the team (Sherif, 1936). Hence, the norms elucidate what is seen as normal or abnormal behavior (Sorrels & Kelley, 1984). In addition, individuals use the norms to make sense of the actions of people both inside and outside the team (Heider, 1944, 1958). Finally, Hackman and Morris (1975) argue that teams often have a meta-norm saying that members should not directly discuss their "regular" first-level norms. The norms are sticky. In fact, the originally established norms can affect the dynamics and decisions for up to eight "generations" after the departure of the original group (Jacobs & Campbell, 1961; MacNeil & Sherif, 1976). Ergo, people have a tendency to adjust their behaviors to conform to the group norms, as most of us enjoy being a part of a group.

Validated surveys that measure personality profiles do exactly this, and these reveal frequently displayed traits. Due to this, it is natural that the respondents recognize themselves in the results. Building teams in this way, however, easily leads to the problem of self-fulfilling expectations; whereby people cling to their roles instead of adapting to the group. Thus, trying to create a high functioning team by leaning on personality types can quickly lead into the same pitfalls with polarizations, stereotyping, and self-fulfilling expectations as mentioned earlier

As with the example of the smoker, persons that lean on personality profiles instead of adjusting to the group's tasks and contexts risk ending up in serious conflicts. Instead of focusing on potential stereotypical traps, Danielsen (2015) argues that military special operational forces (SOF) teams rely upon respect, deep understanding and advanced behavioral interplay in order to proceed. Hence, the principle of personalities become less important as the dynamics in these teams advance, a phenomena which is similar to that proposed by other small group researchers (Bales, 1985; Bales et al., 1979; Hare, 2003; Mills, 1967; Parson, 1953; Sjøvold, 2002, 2006a, 2006b, 2007, 2014b). Notably, there are strong commercial forces that rely heavily upon different kinds of personality measurement, and they make serious money on them. Due to people recognizing themselves in the result and the strong commercialization, such tools are widely accepted in many industries. It is speculative, but one of the reasons could be that many of those tools are easy to learn, and use standardized prescriptions in order to try to help the attendants. In such, they also attempt to force the complexity of teams into something complicated, trying to transform the consultancy job into something straightforward. At the same time, there are researchers who clearly advocate against accepting ideas simply as "since it is heavily commercialized, it must

be true" (Pfeffer, 2015; Wheen, 2005). The "personality and teams" debate, however, is arguably a tough fight.

3.2.1.6 2010s, dynamics and context

Lastly, the grey circle in Figure 1 illustrates the research trend that has become more salient since 2010. Within this trend, performance depends on how well team dynamics align to the operational context. While contexts are seldom static, this means that there exists no such thing as a unique and perfect dynamic that will handle all situations. Instead, effective team dynamics depend on the situation at hand (Heldal & Antonsen, 2014; R. Hogan et al., 1994; Johns, 2006; Kozlowski, Watola, Jensen, Kim, & Botero, 2009; Sjøvold, 1995, 2002, 2006b, 2007, 2014b). Figure 2 illustrates how the individual's performance relies on the interplay within the team, which again should be aligned to the contextual demands.

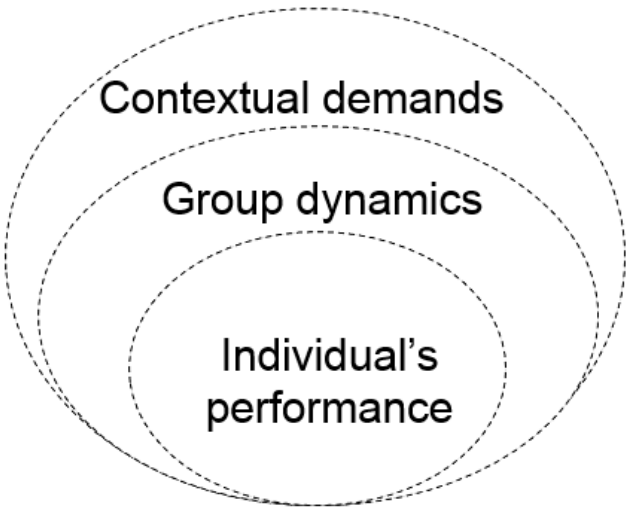

Figure 2. How the individual's performance relies upon group dynamics and the contextual demands (From the NORSI-PIMS seminar Teaming and Disruptive Innovation by Dr. Endre Sjøvold - reprinted for scholarly usage).

There is huge literature, spanning several fields, which talks about different organizational structures based upon teams. Groups are pervasive in the management and strategy literature, but they are also important in trending topics such as innovation (e.g.

O'Reilly & Tushman, 2008), entrepreneurship (e.g. Mol, Khapova, & Elfring, 2015), agile development (e.g. Crowder & Friess, 2015), design thinking (e.g. Johansson-Sköldberg, Woodilla, & Çetinkaya, 2013), and holocracy (e.g. Bernstein, Bunch, Canner, & Lee, 2016). In addition, the "resilience" (e.g. Bergström, van Winsen, & Henriqson, 2015; Hosseini, Barker, & Ramirez-Marquez, 2016; Mjelde et al., 2016) and the "crisis" literature both focus on aspects of team work (e.g. James & Wooten, 2005; Sommer, Howell, & Hadley, 2015). However, these research streams do this, as far as I can find, without properly grasping how interaction processes relate to contexts. Instead, they look at general structures and perspectives as described previously; exemplified by the effect of individual leadership, personalities, time pressure, roles, and so on. As an example, Sommer et al. (2015) studied a one year long capacity crisis in a Canadian hospital. This setting is definitely different from what frontline teams experience when they have adapt, in the blink of an eye, as the context and task priority change. Even so, it is noteworthy that the also these scholars ask for research containing rapid contextual shifts and extreme demands.

Now and then researchers tend to use sports teams to gain insights (e.g. Aime, Johnson, Ridge, & Hill, 2010). While this can be useful for some purposes, comparing SWAT teams to basketball teams (see Dyer, Dyer, & Dyer, 2013), or SWAT teams to film crews (see Bechky & Okhuysen, 2011) is a risky approach. Sports teams know when, where, and who they will meet – and the course will be nearly identical each time they train and play. Film crews, on their hand, might have to adapt, but they do not face the potential of a catastrophe or life threatening circumstances. Even though it may be expensive, film crews can stop and adjust their plans without seeing criminals or terrorists succeed. Therefore, when researchers try to blend football teams into the domain of frontline teams (see Ishak & Ballard, 2011) in order to investigate how teams adapt to ambiguity and complexity, they are on a dangerous path.

There are also scientists who label teams operating in extreme contexts with their own tags. This is exemplified by: 1) Ancona et al. (2009) who presents "X-teams", teams that are externally oriented; 2) Dahle (1999) with his "Xtream teams," teams that excel through extreme demands; 3) K. J. Klein et al. (2006) with their "extreme action teams," exemplified by medical teams in trauma centers; and 4) Lipman-Blumen and Leavitt (2009) with their "hot groups," teams that are addicted to performance. None of this work, however, really emphasizes the unique dynamic context (see Heldal & Antonsen, 2014; Johns, 2006; Parsons & Bales, 1953; Parsons & Shils, 1951; Tannenbaum et al., 1992). They fail to describe the

shifts in interaction patterns, and do not properly describe how the teams succeed during changing conditions.

Naturally, teams will benefit from being externally oriented in order to grasp and analyze a changing context. This, however, is not enough. Being able to fully understand your teammates, being internally oriented when needed, are vital to adapting and proceeding under uncertainty. Danielsen (2015) exemplifies this with special operation forces (SOF) groups. SOF-operators claim they know their teammates better than their wives, and thus know how the teammates will move before they actually move. Being able to balance SOF-operators' focus is seen as the difference between life and death.

Extreme demands are not necessarily the same as changing context and complexity. An underdog sports team trying to beat the obvious champion will most likely feel the pressure of extreme demands. As such, the idea of raising performance through clear goals (or stretch goals), creating commitment, and giving feedback are some of the strongest psychological guidelines in the business world (Hackman & Oldham, 1976; Locke, 1968, 2004; Sherman, 1995; Sitkin, See, Miller, Lawless, & Carton, 2011), and exert mental pressure. However, this is not the same pressure as that felt when operating in the frontline of warfare. The operational context is vital when aiming to understand team dynamics.

The importance of medical work cannot be underestimated. Nevertheless, medical teams usually conduct their work within rather stable circumstances inside of hospitals. Naturally, the consequences of failure can be fatal, and medical teams experience high performance pressure. At the same time, most of their operations rely upon drills and deeply anchored routines, which requires different dynamics than uncertain and ambiguous tasks. Being in a group that is addicted to performance should be beneficial for most team members. Labeling based on such a perspective is not straight forward, and is similar to the idea of creating the "ideal team" that can solve anything. It is possible to find teams in all domains that are addicted to performance. This, however, is not the same as having groups that are able to adapt and challenge the status quo. By illustration, a team working in a routine-based assembling line can be addicted to high performance, which is clearly something different from being able to handle extreme complexity and ambiguous goals.

Understanding the interactions inside of teams that operates in extreme situations is not easy for a variety of reasons. One side of the struggle is the different theories and methods; another side is the access to data. With respect to theories, the framework and trends presented in this chapter should help researchers to position their work. I advocate following the most recent trend, in which dynamics must be aligned with the operational context. This

also suggests that the origins of group research should be incorporated, without focusing too much on the intervening. On the methodological side, snapshots and surveys have limited ability to explain processes, making the combination of several methods important in order to open up the secrets of adaptive frontline groups. Thus, as have other team researchers (e.g. Burke et al., 2007), I claim that in-depth case studies are important to start to uncover the secrets found in real frontline operational teams. At the same time, gaining access to interesting cases and milieus is not straightforward, something that I have experienced through this research project. This, however, can be solved by focusing up on mutual benefits (see Van de Ven, 2007), network, patience and adaptability.

2.3 Groups that excel through ambiguity and uncertainty

To be efficient in the complex situation of war, it is essential to be able to mobilize men and resources, to be flexible, and to reduce friction (von Clausewitz, 1989). It is therefore necessary to understand the leadership perspectives that have been implemented (Hannah, Uhl-Bien, Avolio, & Cavarretta, 2009). The lack of such understanding, a common situation, can lead to erroneous actions (Argyris & Schon, 1974; Chen, Liu, & Tjosvold, 2005; Christensen & Raynor, 2003). As an example, General McChyrstal's interesting book describes how he tried to use complicated leadership perspectives in order to adapt to a complex situation (McChrystal, Silverman, Collins, & Fussell, 2015). After several failures, the General realized that a complex leadership perspective was crucial in the restructuring strategy he called a "team of teams." Accordingly, this structure was fundamental in order actually make some progress in the war against Al Qaida in Iraq.

In the same way, Danielsen (2015) conducted an 18 month anthropological study of the Norwegian Naval Special Operations Command. She is the first researcher worldwide to be able to deeply penetrate the mythical environment that surrounds SOF-units. Danielsen (2015) gives rich and useful descriptions, and clearly illustrates teams that operate as tightly interrelated units, without room for individual heroes. Instead, the concepts of cooperation, respect, diversity, participation, knowledge sharing, innovation, engagement, situational understanding, shared leadership, and adaption are central in her work. SOF-teams have only one certainty: operations are highly uncertain and the goals and purpose will usually change as they endure. Weapons and technology, in an SOF-setting, are secondary. Instead, the key for successful operations is that leaders efficiently align their teams to operational context, and by this turn "the impossible into possible." Managers and researchers, however, might find it hard to generalize and interpret the rich empirical leadership contributions from

Danielsen's military work. For example, believing that oil engineers are able to go through the same amount of training as the SOF-teams is unrealistic.

Nevertheless, focusing on core elements of frontline military operations should be beneficial for most teams that experience uncertainty and ambiguity, a suggestion that other researchers also embrace (e.g. Clemons & Santamaria, 2002; Senor & Singer, 2009). I therefore claim that it should be fruitful to center the rest of this paper on a short review of the following topics; *team leadership*, *group dynamics* and *cognitive mechanisms*. These are concepts that are frequently described as important in conversations with my stakeholders (see Van de Ven, 2007, 2011), and they are seen as vital for military teams to adapt and succeed and to handle uncertainty (Danielsen, 2015; Espevik, 2011; Espevik, Johnsen, & Eid, 2011; Mjelde et al., 2016; Sjøvold, 2014a). Importantly, these concepts also have potential for further theoretical development.

2.3.1 Team leadership

Team performance is tightly linked to leadership behaviors and the team's context (Heldal & Antonsen, 2014; R. Hogan et al., 1994; Kaiser et al., 2008; Likert, 1961). Interestingly, some researchers claim that more than 50% of leaders struggle with major weaknesses in their leadership skills (J. Hogan, Hogan, & Kaiser, 2010; R. Hogan et al., 1994), and up to one third of groups are either under-performing or actually failing (Edmondson, 2012a; Govindaran & Gaupta, 2001). These revelations are noteworthy, as most of the leadership research is concerned with how leaders are perceived, not with how to effectively lead groups (R. Hogan, 2007; Kaiser et al., 2008; Morgeson, DeRue, & Karam, 2010). Avolio (2007, p. 30) states: "Leadership development theory and research has focused on changing the leader, with much less attention given to the interaction of leaders, followers and context." This suggests considerable opportunities for scholars wishing to focus on team leadership.

The leadership literature is a jungle and, as early as 35 years ago, Stogdill and Bass (1981, p. 259) wrote that "there are almost as many definitions of leadership as there are persons who have attempted to define the concept". As I focus on the team perspective, I define leadership as "the process of facilitating individual and collective efforts to accomplish shared objectives" (Yukl, 2013, p. 23). This definition requires that the leader determine which behaviors are appropriate in specific situations, in addition to understanding which team members are the most appropriate for carrying out the actions (Sjøvold, 2006a). Thus, team leaders facilitate team performance not through handing down solutions, but by

organizing collaborative problem solving that utilizes cognitive and coordination processes, as well as the team's motivation and behaviors (Salas, Stagl, & Burke, 2005).

Heldal and Antonsen (2014) show that the team leader's response to interacting contextual factors is highly connected to the interpretation of the situation, and whether or not the team members find the leadership practices meaningful. The latter notion is crucial, as actions that do not make sense for the team can force the leader to the "outgroup," and therefore influence the group to refuse to follow the leader. The Mann Gulch disaster provides an example of teammates rejecting the leader's unexpected orders, resulting in 13 dead firefighters (Weick, 1993). Furthermore, Zander and Butler (2010) point out that the majority of leaders believe the formal leader is the only one who is allowed to lead. Krabberød (2014) found that teams prefer an authoritative leader during uncertain and changing uncertain conditions, as this facilitate trust and help teammates to follow directions. In addition, James and Wooten (2005) write that, in environments with high risks, leaders tend to become extra conservative and authoritarian in their response to uncertainty and ambiguity, making the single authoritative leader extremely hard to avoid. Indeed, how the group perceives leadership behaviors is vital.

On the other side, Bachman (1988) shows, unsurprisingly, that superior Naval commanders are rated as more task oriented and clear than average commanders. Surprisingly, superior officers also displayed significantly higher levels of friendly behaviors – traits often described as soft and feminine. The commanders' behaviors were mirrored down through their chains of command, and helped the frontline teams to adapt and handle uncertainty. This is quite different from being the dominant leader who gives commands and directions without interacting properly with the teammates.

Being authoritative and task-oriented and caring for employees at the exact same time is impossible (Sjøvold, 1995, 2006a); creating a tension referred to as the "leadership dilemma" (Stogdill & Bass, 1981). This situation creates an important direction for future research. A key advance in the leadership literature will be to understand which behaviors are most effective in order to push the team forward in life-threatening situations. As an example, being able to reproduce Bachman (1988) study with SOF-team leaders would be highly valuable for both practitioners and researchers. In addition, Bachman points to another interesting element that deserves investigation: the mirroring effect of top leaders' behaviors. Since the understanding of team interactions and group leadership are scare, an essential research area is the understanding of how the dynamics within top leader teams affects the organization.

2.3.1.1 Collective leadership

Gibb (1954) coined the term *distributed leadership*. He recommended that leadership should be viewed as shared functions among all teammates, including the leader, and not as a function solely connected to the formal leader. This view, which was held by most group sociologists at the time (e.g. Bales, 1950a, 1950b; Mills, 1967; Parsons et al., 1953), illuminates that there are no absolute answers or standard approaches, but the team itself must be able to adapt their leadership actions to align with the complexity of the task and context in which they operate.

Contrary to the authoritative "command and control" strategy, modern maneuver warfare has abandoned the idea of a supreme leader who commands and creates the rules of the game (Clemons & Santamaria, 2002; McChrystal et al., 2015; Senor & Singer, 2009; Shamir, 2011; Sjøvold, 2014a). Leadership in maneuver warfare is seen as the ability to facilitate efficient team dynamics according to the operational context, thus enabling the teams to work toward a common goal, helping team members embrace uncertainty and solve problems. Consequently, Alberts (2007) suggests changing the traditional "command and control" to "focus and converge," as it opens up the stereotypical mental heritage that often follows the old-style chain of command. Thus, if the team leader research is scarce, a focus on shared leadership is even rarer (see Hoch, 2013), making a clear gap for future work.

Weick and Sutcliffe (2011) posit that many organizations operate for significant periods of time in a mindset that may be described as mindless. In addition, some scholars argue that most of the scientifically leadership research done today does more harm than good for organizational science and practice (Pfeffer, 2015), and that researchers need new methods and theories in order to develop the field in a fruitful and positive direction (Kozlowski, 2015; McGrath et al., 2000; Pfeffer, 2015). Work done at RNoNA is the first case I have found that argues that team leaders have the responsibility to align the teammates to the context while, at the same time, arguing that teammates have a profound responsibility to help the team leaders to ensure efficient leadership (RNoNA, 2009). However, Shamir (2011) tells that shared leadership approaches are not consistent with people's common leadership theories, and the idea of being proactive in situations in the absence of preplanned responses can therefore seem counterintuitive for many teammates. The argument of understanding the implemented leadership perspectives stands out as significant, as trying to facilitate collective leadership actions will most likely conflict with the imprinted perceptions in the team.

For the stakeholders of my work, this means that leadership efficiency depends on the characteristics of the context in which the teams operate, and how well the teams align to changing environments. In a stable and well-undestood situation, efficient leadership practices are different from the distributed leadership behaviors that will help the same team to propel itself through chaotic circumstances (Sjøvold, 1995, 2002, 2006a, 2006b, 2014a, 2014b). While some would argue that shared leadership and full team-membership inclusion would lead the team to fail to focus efficiently upon the task, such practices lead the groups to enable their "productivity potential" (Steiner, 1972). Hence, the quality of the implemented practices will be significant better through collective actions, increasing the operational efficiency.

Shared leadership actions are fundamental to adapt and solve extreme requirements (Danielsen, 2015; Shamir, 2011). This means that groups must continuously develop and train themselves and modify their perspectives to be able to reap the full benefit of such collective leadership. Notably, Danielsen (2015) highlights that even if the SOF-teams handle ambiguity through shared leadership and team interactions, the teammates also know when to follow orders and obey the formal leader.

James and Wooten (2005) argue that developing competences that can handle crisis and uncertainty are mandatory for leaders. Therefore, I posit that studying the effect of the shift in leadership actions as teams go from stable to unstable environments should be highly fruitful. Such studies should also help to understand more of why teams fail, or excel, when they attempt to change their interaction patterns, and thereby contribute to filling a hole in the literature.

2.3.2 Group dynamics

I define group dynamics as the continuous shift between polarization and unification among sub-groups or individuals in the team (Bales, 1950a, 1950b, 1999; Polley, 1987). Which group dynamics are efficient depends on the context and the task. Hence, less complicated dynamics are required when the context is stable and the tasks are familiar. However, when uncertainty and ambiguity arise, successful teamwork relies upon advanced interaction patterns whereby all members must contribute in order to adapt.

2.3.2.1 Group functions

The shifts between polarization and unification center around different *group functions*, a concept several researchers have documented (e.g. Bales, 1950a, 1950b, 1953; Bales et al.,

1979; Mills, 1967; Parson, 1953; Schutz, 1958; Sjøvold, 1995, 2002, 2006a, 2014b; Tuckman, 1965). How well a team member is able to display behaviors that support various group functions originates from behavioral comfort zones (Hare, 2003). If teammates have strong expectations of each other's behaviors, they often unconsciously adjust their activities to reinforce the expected behavior. Therefore, the individual's behavioral preference can result in a self-fulfilling prophecy, and thus lead to stereotypical expectations from the rest of the group (Likert, 1961; Merton, 1948; Word et al., 1974).

Teams that display less advanced dynamics tend to limit their behaviors to social roles supporting specific group functions, establishing dysfunctional and slow interactions that are hard to change (Gersick & Hackman, 1990; MacNeil & Sherif, 1976; Rohrer, Baron, Hoffman, & Swander, 1954; Sherif, 1936). Therefore, as the group's norms determine which actions are seen as acceptable and not, it can become problematic when someone suddenly tries to use other group functions than those the group expects. As an example, if a person who displays mostly authoritative behaviors suddenly displays caring behaviors, the rest of the group might become suspicious and fear that something unpleasant is coming.

Understanding how to advance team dynamics and help individuals to display a wider specter of behaviors should therefore be of great interest for both practitioners and researchers. The teambuilding literature, however, has not been able to fully demonstrate a positive link between teambuilding and team performance (Ammeter & Dukerich, 2002; C. Klein et al., 2009; Salas, Rozell, Mullen, & Driskell, 1999). At the same time, this literature tends to use a wide spectrum of perspectives and directions, and thereby apply inconsistent definitions of the teambuilding concept (e.g. Aguinis & Kraiger, 2009; Ammeter & Dukerich, 2002; Buller & Bell, 1986; Dyer et al., 2013; Salas, Rozell, et al., 1999; Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012; Smith-Jentsch, Zeisig, Acton, & McPherson, 1998). While Tuckman's classical model of group development with chronological stages (Tuckman, 1965), and many others based upon it, are heavily used in commercialized settings, this model is criticized for not giving theoretical insights or being relevant for real life teams (e.g. Hare, 2003; Kozlowski & Bell, 2013; McGrath, 1991; Sjøvold, 2006a). This opens up an opportunity for expanding our knowledge of how real teams develop in order to improve their interaction patterns.

The individuals in our stakeholder organizations need to develop, and they can only do this through their groups (Mills, 1967). Sjøvold (2014b) proposes therefore that teambuilding is a "long-term, systematic, and goal-oriented task, focusing upon normal work tasks in a relevant context, in which the purpose is to improve a team's performance so that it can meet

the demands of its surroundings" (p.71). By focusing on interaction patterns, this definition is useful as it divides teambuilding into *team training* and *team development.* This separation is important as *training* aims to maintain familiar patterns in the group, and thus focuses on repeating and drilling familiar tasks for the sake of increased efficiency. *Development*, however, seeks to expand teammates' behavioral range and thereby enable the team to become adaptable, innovative and able to handle uncertain and ambiguous contexts. This perspective is close to what the military perspective uses when they describe teambuilding sessions (see Danielsen, 2015; Mjelde et al., 2016; RNoNA, 2009). As far as I can find, there has been little empirical work anchored in such a perspective, which means that this should be a fruitful path for future research.

2.3.2.1 Influence

van Vugt and Ronay (2014) illustrate that we as humans have lived and cooperated in groups since our early ancestors, and so developed psychological mechanisms designed to influence each other. A team's dispersion of influence affects its dynamics, and influential teammates have the capacity to alter the behavior of the whole group (Nissestad, 2008; Sjøvold, 2007). Heavily influential teammates can therefore create a group climate in which their prominent group functions dominate and guide the group's behaviors (Bion, 1987), thus creating behavioral norms and potentially locked polarizations and conflicts. Influence in groups does not have to spring from formal roles. Instead, influence is an embedded and important part of the group interactions, and can drive, or hinder, teammates' behavior patterns, and affect the team's performance. The potentially destructive effects of over-influencing individuals in teamwork are highlighted by several researchers (e.g. Bales, 1954; Blenkinsop & Maddison, 2007; Conger, 1990; Danielsen, 2015; R. Hogan et al., 1994; Launonen & Kess, 2002). A full understanding of how influence floats within group dynamics, however, is still not established.

Scientists argue that speaking time correlates strongly with individuals' influence in teams (e.g. Mast, 2002; Stein & Heller, 1979), while body language is usually left out in studies of groups (Pentland, 2008). When humans can interact by facial expressions that are as brief as 170 ms (Yan, Wu, Liang, Chen, & Fu, 2013), leaving body activity out of group research is a clear weakness. As an example, if a highly influencing teammate just gives a minor facial expression to illustrate his or hers perception of a suggestion, this can be enough to terminate the whole discussion. Hence, a promising way of studying influence and group

dynamics can be found by implementing novel technology into team research. Several researchers are now looking into innovative wearables that are able to capture the real time big data of human interaction (see Kim, McFee, Olguin, Waber, & Pentland, 2012; Kozlowski et al., 2015; Olguín et al., 2009; Onnela, Waber, Pentland, Schnorf, & Lazer, 2014; Pentland, 2012; Wen, Olguin-Olguin, Waber, Taemie, & Pentland, 2012). Applying such technological advances into the teams that operate the oil and gas industry or military should be fruitful. By this, it is possible to achieve data that is close to impossible to collect otherwise without disturbing their operations. In addition, these teams often operate in extremely noisy environments, or in total silence, during military-missions (see Danielsen, 2015; Mjelde et al., 2016; Tucker & Lamb, 2007). This means that these groups also have to rely upon embodied interaction patterns. Advancing our understanding of influence in groups will unquestionably be beneficial for both theory and practice.

2.3.2.2 Cognitive mechanisms – shared mental models

The team literature contains various concepts that deal with cognitive processes and mechanisms (see Kozlowski & Bell, 2013). I choose to focus upon the notion of shared mental models (SMMs), as they are mentioned directly or indirectly when I discuss the topic with my stakeholders and have the potential for further theoretical development. SMMs describe teammates' collective, organized understanding and mental depiction of knowledge regarding the teams' operations and contexts (Klimoski & Mohammed, 1994). It is a well-established construct in the group literature (e.g. Badke-Schaub, Neumann, Lauche, & Mohammed, 2007; Bolstad & Endsley, 1999; Cannon-Bowers, Salas, & Converse, 1993; Espevik, 2011; Espevik et al., 2011; Johnson-Laird, 1983; Klimoski & Mohammed, 1994; Lim & Klein, 2006; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000), but the phenomena is still open for more development (Mjelde et al., 2016; Uitdewilligen, Waller, & Pitariu, 2013). Cannon-Bowers et al. (1993) divide SMM into four categories, 1) equipment model – technical understanding of the tools used by the team; 2) task model – understanding the work process, goals and requirements the group faces, 3) member model – the perception of characteristics, knowledge, assumptions, skills, and habits of teammates; and 4) teamwork model – the knowledge and assumption by teammates about appropriate and effective behavior processes. These four categories can be configured into *task* and *team* related SMMs (see Mathieu et al., 2000). As such, it is the team oriented SMMs are seen as fundamental when tasks and contexts become novel and filled with ambiguity (Cannon-Bowers et al.,

1993; Espevik, Johnsen, Eid, & Thayer, 2006; Mathieu et al., 2000; Sjøvold, 2014b), an argument which is in line with SOF-teams perceptions of group work (Danielsen, 2015).

Healey, Vuori, and Hodgkinson (2015) argue that task-related and team-related SMMs must be shared in the group to enable efficient performance. This is a reasonable argument. Nonetheless, in ambiguous contexts in which the goal might change as the team proceeds, I argue that teammates possess unique knowledge that must be made explicit in order to succeed. At the same time, if a group argues that it has full task-agreement in such changing environments, there is reason to expect difficulties with stereotyping and self-fulfilling expectations (Brophy, 1983; Carpenter, 1995; Word et al., 1974), groupthink (Janis, 1972, 1982) or the Not-Invented-Here syndrome (Katz & Allen, 1982). In addition, I argue that the stakeholders of my project enhance high task and technical understanding as a result of their formal training. The oil industry teams consist, in large, of highly technically skilled engineers, while the military groups go through extensive weapon and technical training before they are deployed in operational settings. Thus, continuing to develop team-related SMMs into something practically understandable should be of great interest to our stakeholders.

Uitdewilligen et al. (2013) claim that research on SMMs are limited to a static perceptions, with limited understanding of the dynamic nature of SMMs and performance, and thus demand further research progress. At the same time, scholars have found that SMMs are a key predictor for adaption, learning, communication, innovation and risk understanding (Eid, Johnsen, Bartone, & Nissestad, 2008; Espevik et al., 2011; Espevik et al., 2006; Healey et al., 2015; Kolbe et al., 2014; Marks, Zaccaro, & Mathieu, 2000), making SMMs a vital part of team processes. The notion of "predictor" is noteworthy, as dominant methods measure SMMs through respondents' perceptions of various outcome variables, such as learning, efficiency, situational awareness, and notice of changes. As such, they do not really tap into the core of how teammates perceive each other's behavior, but how they describe the results of their behaviors.

There is also limited research on how multiple team memberships affect SMMs. Belonging to several teams is a typical trait that is often left out in studies, but it has gradually been taken into account in recent research (see Tannenbaum, Mathieu, Salas, & Cohen, 2012). For my stakeholders, this is a part of everyday operations; teammates might belong to a certain focal team, but they do also spend large amounts of time within "other groups." This opening in the literature creates room for important and stimulating work that can expand both practice and science.

Interestingly, Uitdewilligen et al. (2013) argues that there are no empirical studies of how SMMs change over time as teams experience changes in the task and context. This clearly opens up opportunities for future studies. While Uitdewilligen et al. (2013) argue that they studied teams that experienced a moderate degree of change, I argue that conducting such research within military frontline teams should be valuable (see Burke et al., 2007). Indeed, these teams' context can change in a split second, and a stable context with familiar tasks then turns into total chaos, making a dynamic perspective of SMMs central.

In general, SMMs are handled as a theoretical construct, making it hard to grasp for practitioners – especially when moving from the often more tangible or visible task oriented aspects and into the team-related sides of the construct. Sjøvold (2014b) presents some interesting work with graphical interfaces of how teammates perceive each other. This work, however, still has potential for further examinations, in which the investigation of the effect of specific differences in group members' SMMs should be of great importance.

2.4 Conclusion

This review has given a brief overview of the various research trends that has followed team research since its days of origin. These trends should help both practitioners and scholars to sort out and position different work, and thus help them to guide their literature searches. The framework should be especially useful for new scholars to position themselves in the field, as the vast group literature can become overwhelming. In addition, this chapter introduces and describes concepts and ideas for practitioners who want to develop their teams.

To make practical contributions to society, I argue that researchers should be aware of the trends that I have described, and focus on issues that have practical relevance for their stakeholders. By this, I advocate for continuing the trends that emphasize the unique context, making various case studies important. Such focus is especially important to understand the unique settings various operational frontline teams experience. These contexts can vary from industry to industry, making it hard to generalize empirical findings.

The concepts that I argue deserve more attention, *team leadership*, *group dynamics* and *cognitive mechanisms*, are vital aspects of teams' everyday life, and truly affect their performance in various contexts. These theoretical concepts should be handled as dynamic and tightly embedded in the groups' operational context, making them challenging, but not impossible, to both study and implement. In the heydays of teamwork, researchers relied a lot on observations. As Kettner-Polley (2016) also argues, maybe it is time for scholars to revisit some of the classical literature and methods, and thereafter help to bring this work into the

modern times. While it can be discussed how fruitful some periods of research actually have been in order to understand team dynamics, the future looks brighter than ever.

3 My Theoretical Foundation

In this chapter, I present a brief introduction to the theoretical foundation used in my work. Some theoretical aspects are already covered in the literature review, but in this chapter, these topics are brought into an overarching theoretical framework. I also reintroduce some definitions and acronyms in order to make the chapter easier to read.

3.1 The Spin theory of small groups

The theoretical foundation of this thesis is anchored in the *Spin Theory of Small Groups* (Sjøvold, 1995, 2002, 2006b, 2007, 2014b), which is a complex theory that attempts to integrate well-documented aspects of group-dynamics as well as the group's intense relation to its immediate context. I do not aim to give a full description of the theory, but I highlight important elements in order to understand where this thesis is positioned. Interested readers should visit Sjøvold's work for both deeper and broader understanding.

The Spin Theory expands and integrates the work from several influential group and social psychology researchers (e.g. Allport, 1954; Bales, 1950a; Bales, 1950b, 1953, 1985; Bales et al., 1979; Bion, 1961; Lewin, 1947; McGrath, 1991; Mills, 1967; Parson, 1953; Parsons et al., 1953; Parsons et al., 1951; Schutz, 1958; Sumner, 1906; Tuckman, 1965). Notably, the SYMLOG theory (see Bales, 1985, 1999; Bales et al., 1979) comprehends several elements of this work, however, the Spin Theory is richer and advances this theory, both methodologically and theoretically. As such, the Spin Theory is as one of the most advanced group theories in the field, and covers a broad spectrum of a team's inner life and how teams align to their context. Table 2 provides a short comparison of elements built into the Spin Theory of Small Groups. A broader elaboration of Table 2 is found in Sjøvold (2006b, p. 58). The first row introduces the scholar behind the ideas; while the second row presents the contribution of the theory; and the rest of the rows introduce the overlapping relationships between the works.

Table 2

Fundamental Aspects and Relationships of Various Theories that Founds the Spin Theory of Small Groups (Sjøvold, 2006b, p. 58).

Tuckman	**McGrath**	**Bales**	**Schutz**	**Bion**	**Parsons**	**Mills**	**Sjøvold**
Phases	*Choice*	*Dynamics*	*Needs*	*Emotions*	*Context*	*Learning*	***Balance***
		Equilibrium		Work group		Growth	***Synergy***
Performing	Project Execution	Structure	Authoritarian		Goal	Goal	***Control***
Forming	Inception	Affect	Overly social and personal	Pairing	Integrative	Instant satisfaction	***Nurture***
Storming	Conflict solving		Unsocial and impersonal	Fight/flight	Latency	Autonomy	***Opposition***
Norming	Problem solving		Dependent	Dependence	Adaptive	Conservation	***Dependence***
		Resolution		Fight/flight			***Withdrawal***

Sjøvold's Spin Theory combines elements from the Tavistock tradition and the Small Group Research tradition, and focus on group interactions related to the operational context. Thus, the theory treats groups as dynamic units must mobilize their resources for optimal performance in the operational context. Efficient group dynamics, according to the Spin Theory, differ according to the situation and task at hand, making it impossible to predefine a standardized and optimal solution. Sjøvold (2006b, p. 17) includes the importance of task and technology by defining a group or team as "three or more people who share a common goal and interact to achieve this goal." Hence, the Spin Theory builds on the previously discussed work from Simmel (1955). The Spin Theory uses three central constructs: 1) four basic *group-functions;* 2) *balance;* and the 3) *level of purpose;* to explain how the group's dynamics can be aligned with the situation it confronts.

3.1.1 Group functions

The four *group-functions* are labeled: *nurture*, *dependence*, *control*, and *opposition* (Sjøvold, 1995, 2006, 2007, 2014). Albeit under different labels, the existences of four quite similar functions is well documented in the Spin Theory's theoretical foundations. The *nurture* function is supported by active, caring, empathic, or even spontaneous behaviors; whereas the *dependence* function by passive, conforming, and obedient behaviors. Further, the *control*

function is supported by active, analytical, task-oriented, or even autocratic behaviors; while the *opposition* function is supported by active, critical, assertive, or even self-sufficient behavior. Also, the order of the functions describes their openness and accessibility to change. Which group functions that prevail will vary according to the situation and task at hand, along with the overt behavior of the team leader.

The group functions create the two first basic *dimensions* in the Spin Theory: control versus nurture (C-N), and opposition versus dependence (O-D). As such, the C-N dimension describes whether or not behaviors are *goal* oriented; while O-D describes the level of *autonomy* a person displays. The poles in the dimensions illustrate that the opposing behaviors are two ends of a continuum. As an example it is impossible to be both controlling and nurturing at the same time, however it is possible to switch rapidly between the behaviors.

It is possible to subdivide these four group functions into two similar, but marginally correspondent categories. Such separation is done by dividing the functions into 1 and 2, as illustrated in Table 3. For instance, the group function control (C) can be divided into C1 (Ruling), and C2 (Task-orientation). Thus, C1 describes behaviors related to controlling, authoritative, and attention to rules and procedures; while C2 describes actions that are analytical, task-oriented and conforming.

Table 3

The Subdivided Group Functions and Related Behavior.

Group function	Typical behavior
Nurture (N)	
N1 Caring	Taking care of others, attentive to relations
N2 Creativity	Creative, spontaneous, emotional
Dependence (D)	
D1 Loyalty	Loyal, obedient, conforming, dutiful
D2 Acceptance	Passive, acceptance of the group
Control (C)	
C1 Ruling	Controlling, authoritarian, attentive to rules and procedures
C2 Task-orientation	Analytical, task-oriented, conforming
Opposition (O)	
O1 Criticism	Critical, opposing
O2 Assertiveness	Assertive, self-sufficient, blunt

In the Spin Theory, group dynamics are defined as the constant shift in polarization among sub-groups or individuals in the team (Bales, 1950a, 1950b, 1999; Polley, 1987). As poles in a

polarization, sub-groups and social roles are found to center around different group-functions (Sjøvold, 1995). How successfully an individual displays actions that assist each of the four group functions originate from the group's behavioral comfort zones (Hare, 2003). If group members display strong expectations of each others' behaviors, members often unconsciously modify their actions to reinforce the expected behavior. This means that the individual's behavioral preferences can lead to a self-fulfilling prophecy, and thereby result in stereotypical expectations from the rest of the group (Likert, 1961; Merton, 1948; Word et al., 1974). Thus, groups that reveal less advanced dynamics tend to limit their actions to specific group functions, thus establishing social roles in team. This situation can lead to dysfunctional and slow interactions that are hard to change (Gersick & Hackman, 1990; MacNeil & Sherif, 1976; Rohrer et al., 1954; Sherif, 1936), making it hard for groups to adapt to novel circumstances.

3.1.1.1 Complexity of group dynamics

The complexity of the group dynamics are found through two indicators that display the robustness and flexibility of the group: 1) *Synergy*; which describes functional behaviors through engagement, empathy and collaboration; and 2) *Withdrawal*, which describe dysfunctional behavior through resignation, self-sacrificing, sad and non-contributive behaviors. These are opposing behaviors, and establish the third *dimension*: withdrawal versus synergy (W-S), which describes the degrees of *learning* in groups. As with the group functions, the W-S indicators can be separated into two slightly different categories in order to specify behaviors, as shown in Table 4:

Table 4

Subdivided Indicators for Flexibility And Robustness.

Indicator	Typical behavior
Synergy (S)	
S1 Engagement	Energy, determined, committed, constructive and cooperatively behaviors
S2 Empathy	Empathic, caring, supportive, encouraging, interest in fellow teammates
Withdrawal (W)	
W1 Resignation	Disheartened, discouraged, lethargic, low confidence
W2 Self-sacrificing	Self-pitying, complaining, noncontributing

In sum, these behaviors influence how the group learns. A team that displays high energy and supporting behaviors will have a completely different approach to problem-solving than a group that shows discouraged and self-pitying behaviors. Again, how these behaviors are distributed among members affects the internal dynamics. For instance, I will expect that anyone with some experience from teamwork has experienced both the super-engaged person, as well as the disheartened and resigned person, and understands how these affect the team interactions.

3.1.2 Balance

Next, the construct *balance*, describes how behaviors are distributed in the team, and a well balanced team implies that all group functions are supported in order to make the team successful. In particular, it should be highlighted that balance in the Spin Theory should not be confused with the idea of equilibrium. Whereas equilibrium indicates that all functions are present in equal strength at all times, balance suggests that the group functions exist in a dynamic interplay; where balance can be distorted if the situation requires it. As such, balance can be achieved by individuals supporting different roles; or by rapid interactions where all members are able to enhance behaviors that support all of the four group functions. A group with distinct one-person-one-role has, in the terms of Spin Theory, a fixed role structure, whereas a team in which members are able to support several group functions is described as having flexible role structures.

In Spin Theory, a member's *influence* is described by the fourth and last *dimension*: passivity versus influence (P-I) (Sjøvold, 2007). The P-I dimension is an embedded function in the group's interplay. This means that passivity is shown through the *combination* of all behaviors that support the dependence group function *and* the withdrawal actions. In contrast, influence is displayed through the *combination* of actions that supports the synergy behaviors and the opposition group functions. Thus, passive behaviors are described as withdrawn, distant, apathetic, and reserved behaviors; while influencing behaviors are described as extroverted, cooperative, open and accommodating behaviors. Sjøvold (2007) explains that a preponderance of influencing members can be beneficial for groups during certain situations, however the P-I dimension should be balanced over time. Influence does not have to be connected to formal roles in the group; instead, influence can just as well be embedded in the social roles of each team member. As an example, a critical question from a person who is perceived as an expert, or better knowing, can stop formal leaders' attempts to decide or try something innovative.

Therefore, balance is a state where the team is both balanced and unbalanced simultaneously; a paradoxical condition which ,in natural sciences, is often referred to as "the edge of chaos" (Langton, 1989). As such, the core idea is that the team leader is responsible for enabling and facilitating the group functions that are suited to the context at hand (Marks, Mathieu, & Zaccaro, 2001). As a consequence, balancing the C-N dimension is seen as an particularly important leadership skill (McGrath, 1991; Parsons et al., 1953; Sjøvold, 1995, 2006b; Stogdill & Bass, 1981). How well a group leader enables the teammates to behave through a rapid exchange of group functions will directly describe how advanced the group dynamics are - and thus also predict the team's ability to handle uncertainty and change.

3.1.2.1 Shared mental models.

As discussed earlier, shared mental models (SMMs) describe the level of collective knowledge held by the team, and help teammates to interpret and elucidate the team's contexts, purposes and behavior patterns (Cannon-Bowers et al., 1993; Healey et al., 2015; Klimoski & Mohammed, 1994; Mathieu et al., 2000; Salas & Cannon-Bowers, 2001; Stout, Cannon-Bowers, Salas, & Milanovich, 1999). It is popular to divide SMMs into task-related and group-related perspectives (see Mathieu et al., 2000). The first perspective enhances technical and purpose-oriented perspectives; whereas the second aspect covers teammates' knowledge and assumptions about individuals' behaviors, assumptions, skills, attitudes, and habits.

The task-related SMMs cannot be ignored, but it is the team-oriented SMMs that are seen as vital for team performance when groups have to adapt to and handle novel situations (Cannon-Bowers et al., 1993; Espevik et al., 2006; Mathieu et al., 2000; Sjøvold, 2014b). The group should not aim at establishing identical SMMs, however it is the respect and understanding of the individual teammate's unique knowledge and perceptions that are vital. Therefore, teammates should establish deep insight in each other's team-related SMMs, and through a balanced interplay be able to - and expect that others will - challenge, question and learn from these perspectives. The degree of SMMs is therefore tightly connected with the improvement of group interactions.

3.1.3 Level of purpose

The level of purpose (LoP) helps to describe the complexity of the interactions found in teams. In the Spin Theory, this is done by studying the presence and balance of the team's group functions, and how teammates perceive each other. In this way, the LoP can be classified from

less advanced to highly advanced by the descriptions: *Reservation, Team Spirit, Production and Innovation* (Sjøvold, 1995, 2002, 2004, 2006a, 2006b, 2007, 2014b). Importantly, teams do *not* necessarily move from Reservation to Innovation in a fixed order, nor is this always the best case. This depends on the context, task at hand, and the team itself. This means that Reservation and Innovation are poles at the ends of a continuum. The four descriptions are not static categories. Instead, the categories describe how the level of dynamics displayed by the team, which relates directly to the team's ability to learn and adapt. To illustrate, a team able to display innovation dynamics does not operate on this level at all times, but they are able to display such dynamics when needed (Sjøvold, 2006a, 2006b, 2014b). The various group functions that are activated in the different LoPs are described in Table 5.

Table 5

The Activated Group Functions that Teams Display at Each Level of Purpose.

LoP	Group functions	Included behavior
Innovation	Nurture, Dependence, Control, Opposition	Challenges and criticize
Production	Nurture, Dependence, Control	Takes responsibility
Team	Spirit Nurture, Dependence	Loyal and committed
Reservation	Nurture	Considerate

Teams with highly advanced dynamics will have internalized the notion of continuous learning by chasing new ideas, criticizing the status quo, and monitoring the external environment. So, when the complexity and uncertainty of tasks and contexts evolve, teams will benefit from being able to operate at high LoP. Danielsen (2015) exemplifies teams that operates on the Innovation level through research on special operation forces (SOF) teams. These teams maneuver as one living entity, where the group is more important than the individual. Their dynamics evolve through efficient interaction patterns, with a mixture of speech and nonverbal communication. Danielsen (2015) also shows that the SOF-teams are able to adapt, and follow orders and commands to execute more straight forward and routine tasks when demanded. Nonetheless, operating within such routine settings is not how they prefer to work - and they will usually seek tasks and challenges as soon as possible, in which they can operate with advanced dynamics.

The Spin Theory explains that a group that normally operates on a low LoP will struggle to adapt if the complexity of the task and environment increases. In contrast, teams that can enable high LoP dynamics are also able to align their internal interactions to simpler tasks and stable contexts. However, a team operating on a high LoP will be outperformed by an efficiently led low LoP-team during standardized tasks and conditions. An axis that displays the various LoPs, based upon the W-S dimension, are displayed in Figure 3 (see Sjøvold, 2014b, p. 64).

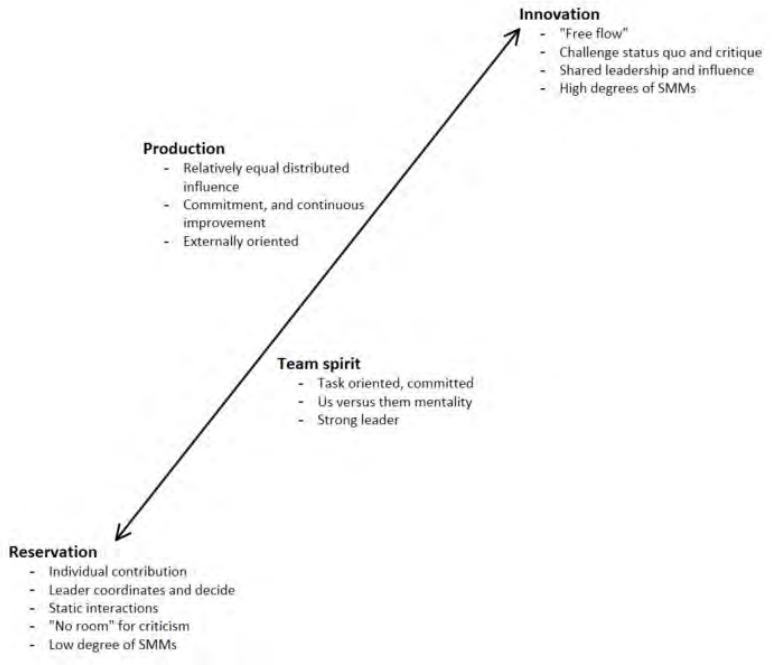

Figure 3. An illustration of the different LoPs. As a team leader facilitates different dynamics from a lower to a higher LoP, the team's external focus and the quality of team members' interactions increase (Adjusted from Sjøvold, 2014b, p. 64 - reprinted for scholarly usage).

3.1.3.1 Reservation dynamics

Reservation dynamics are typical in newly formed teams, where the members are unfamiliar with each other. Importantly, if the behavioral norms are allowed to settle, meaning that the leader fails to develop the team towards more advanced dynamics, these internal interaction patterns will become quite imprinted. Reservation teams activate the nurture function; and are therefore characterized by harmonious interactions - with little room for criticism - and the

demand for a strong leader is considerable. Tasks are divided into smaller activities that are conducted by individuals; while the leader coordinates actions and keeps in touch with the external environment. In addition, the individual focus that persists within the group hinders team members from learning and cooperating with the other team members; suggesting that reservation dynamics are unbalanced and teammates have low levels of SMMs. The communication patterns are quite simple and the teammates expects the leader to solve problems, resolve conflicts, and set the direction. Reservation dynamics can be highly efficient when the leadership and the members are aligned to the task and context.

3.1.3.2 Team Spirit dynamics

A group operating at the Team Spirit level sees themselves as having a shared identity. These groups activate both the nurture and the dependence function; and have established a strong "We"-feeling, which distances the teammates from their outsiders. Such teams operate efficiently within stable and clear boundaries; the leader fulfill the opposition and control group functions. Communication patterns can be quite effective around known topics, which suggests that the team learning is limited to exploiting existing knowledge within the group. Effective Team Spirit groups are highly devoted to drill and training of specific tasks and their performance will often drop significantly when the successful leader retreats. This means that the dynamics are still unbalanced, and teammates struggle with low levels of SMMs. Importantly, the dependence on an authoritative leader is significant. As such, an efficient leader can be turned into a legend or hero and the leader's reputation becomes more important than the actual actions.

3.1.3.3 Production dynamics

When teams are able to activate the nurture, dependence, and control functions they operate with the dynamics found at the Production level. Groups with such dynamics contain members willing to contribute to achieve overall goals by showing initiative, and partaking in collaborative problem solving. Thus, as influence is somewhat distributed among members, there is a lesser need for a prominent leader in the team. This means that the leadership functions are, to a certain extent, shared among the members. Teams displaying such dynamics are curious and aware of their external environment, and they utilize more advanced communication patterns. Due to this, they are able to take advantage of more external inputs,

as well cooperate efficiently with other teams, as long as the context is stable and predicative. These traits stem from a more balanced interplay, whereby the teammates also start to establish a higher degree of SMM. Production dynamics enable teams to learn and execute incremental innovations, which may have a considerable impact over time (see Van de Ven et al., 1999).

3.1.3.4 Innovation dynamics

The most advanced dynamics, Innovation, are found in teams that are able to exhibit, and balance, all of the group functions: nurture, dependence, control and opposition. Members in such teams display a high degree of mutual trust, and they both accept and expect criticism of the "way things are done." These teams benefit from their creative force, and will use this in attempts to proactively manage their external environments. The way the members challenge and spread knowledge, ideas, and impressions will often lead to new and unique knowledge. During intense discussions and operations, the team dynamics can be compared with the idea of "free flow" (see Csikszentmihalyi, 1975). Moreover, team members' common understanding of the close connection between personal and team growth indicate that the classical conflict between loss of individual freedom and team identity are non-existent. These teams utilize body signals, voice, and information from their surroundings to implement fast and complex coordination.

It follows that teams that are able to display Innovation dynamics balance their interactions through a complex interplay, whereby a high degree of SMMs is vital for fruitful discussions. Their abilities to efficiently adapt and learn during changing circumstances are invigorated by collective leadership actions that enable rapid collective decision-making. Another typical trait within these teams is that they have a tolerance for learning from failure, and they emphasize debriefings and after-action reviews to ensure that their knowledge is spread within their organizations. The advanced Innovation dynamics help teams to excel and adapt in highly uncertain and changing situations.

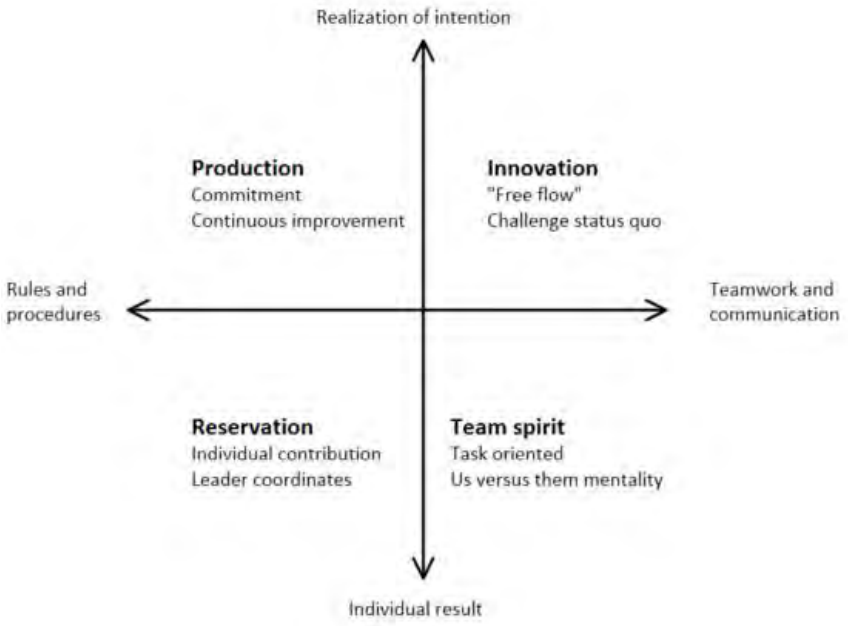

Figure 4. The characteristics and focuses within the four different LoP, Reservation, Team Spirit, Innovation, Production (Sjøvold, 2014b, p. 21 - reprinted for scholarly usage).

The different characteristics and focuses within each level of LoP are described in Figure 4. As emphasized, efficient LoP depends upon the group's operational context. While highly advanced groups will be able to adapt and display less advanced dynamics, teams with less advanced dynamics will struggle to excel and adapt when complexity and ambiguity arise. Importantly, groups can only advance as a social system through their members (Mills, 1967). This indicates that teams that wish to develop must do this as a collective exercise. At the same time individual teammates must understand that they cannot change other members, but they certainly can change how themselves behave and deal with the rest of the group.

Notably, some highly cited classical work claim that team performance follows an inverted u-shape (e.g. Katz, 1978, 1982; Pelz & Andrews, 1966; Shepard, 1956). This work suggests that performance should be maintained by changing teammates at strategically picked time slots. Such solutions are quite different from the idea of focusing upon internal development and behavioral actions. In addition, knowing that implemented norms and behaviors are sticky and tend to stay even if teammates are exchanged (Jacobs & Campbell, 1961; MacNeil & Sherif, 1976), changing personnel seems an inefficient solution. Frequently

forcing teammates out of the group is also a quite expensive and inefficient way of ensuring performance; the risk of losing accumulated unique knowledge is high.

At the same time, there is an unquestionable trend toward firing team leaders if their teams fail to perform. Indeed, the team leader is responsible for facilitating efficient dynamics and has the formal power to initiate such actions. However, it could be that, instead of giving the leader the sack, a more fruitful solution is found in the introduction of this chapter: start the work by uncovering the leader's theoretical perspectives, and take actions to broaden them in order to enable team dynamics that are aligned with the operational context.

4 Research Strategy/Methods

This chapter introduces a brief overview of the overall research design, as well as it expands the understanding of methods used in the papers.

4.1 The overall approach

Being a part of the NORSI-PIMS program has been a highly valuable experience. Going through extensive coursework with professors who have established, challenged, and dominated several paradigms has helped to create a broad theoretical platform. These professors have also been helpful when asked for tips and directions to bring the progress forward. Indeed, attending NORSI-PIMS has clearly influenced the way I have approached my work. This means that the literature collection has not been a straightforward task. Instead, it has been a process that has gone through a series of inductive and deductive cycles (Miles & Huberman, 1994), driven by data collection and the topic of focus.

As the nature of the project has been to challenge the dominant perspectives by building on small group traditions, following an opponent strategy (see Pentland, 2013) has been vital in the search for literature. The literature search process has evolved along with the progress of the project Operational Leadership, and includes countless of hours with fruitful discussions within the project group. These discussions have been crucial to understand the interpretations from established work, as well as carve the way for further progress and literature search. This way of working has built the foundation for the articles found in Part 2, while also contributing to the rest of the progress within Operational Leadership.

4.1.1 Validity and reliability of the studies.

The validity of a body of research is determined by whether or not it measures or studies what it was intended to, while the level of reliability determines the reproducibility of the research. Thus, a study can have low validity and high reliability, while the opposite is impossible (Miles & Huberman, 1994; Yin, 2014).

Papers 1 and 4 in this thesis are conducted as embedded single-case designs (Yin, 2014). This means that each of the articles is built upon a specific context, containing one case and several units of analysis. Arguably, this is done in order to emphasize the relevance of the context (Johns, 2006; Miles & Huberman, 1994; Parsons & Bales, 1953; Parsons & Shils, 1951), which again indicates that the focus has been upon establishing internal validity (Dyer & Wilkins, 1991; Yin, 2014) in each of the cases. As a consequence, the external validity, thus the possibility generalizability of the findings is lower (Yin, 2014). This validity debate, however, contains nuances. As the papers argue strongly for emphasizing the context, which in these studies is dynamic and uncertain, I argue that the studies are relevant beyond an understanding of the specific case. First, naval military institutions are found in several nations; meaning that this is an area with a vast population and teams. In addition, I claim the findings from the four articles should be relevant for all frontline military combat teams - leading this to be generalizable inside of this context and therefore valuable for a larger population.

The oil and gas industry employs numerous people around the globe. The context in article 4 (From routine to uncertainty) including the technological structures and implemented operational strategies, are standards in this industry. The potential for accidents and stakeholder pressure force the industry to continuously innovate and search for efficiency in order to uphold financial performance. As a part of this, downsizing and moving offshore personnel to onshore locations seems central, forcing the remaining personnel to be able to adapt and ensure high performance. Again, if the case study holds high internal validity, the findings have implications for a global industry. The implemented crisis strategies studied in this paper are also seen in several other industries that rely on "traditional" command and control crisis-management. Such practices rely upon a hierarchical top-down leadership, where the main focus is on executing operations founded on rigid routines, rules, procedures and resources available in normal operations (Alberts, 2007; Albrechtsen, 2013; Hannah et al., 2009; Krabberød, 2014; Rimstad, Njå, Rake, & Braut, 2014; Tinmannsvik et al., 2011). While it might be hard to directly transfer the results from the present context, our findings should inspire other industries to innovate their traditional command and control structures.

Article 2, Team Adaption, uses quantitative measurements to show how the cadet groups' team-related SMMs develop through a year at RNoNA. The survey used to measure SMMs stems from the Spin Theory, while internal subject matter experts rate the groups' performance through a final live exercise. Notably, this way of measuring SMMs challenges dominant research practices by focusing on teammates' perceived behaviors and not various outcome variables. I argue that this paper holds high validity and reliability and the findings and implications should be possible to transfer to any team that has to excel through uncertainty.

Article 3, Unfolding influence, uses a different approach than the other papers. This study uses big data in order to understand the level of influence shown by team members within groups. This way of collecting data is possible for any team. The data hold strong internal and external validity, as they are collected through objective electronic sensors, meaning that the actual findings are not case sensitive. However, I argue that the *implications* from these findings are case sensitive and relate to military teams trying to improve their adaptability. Nevertheless, understanding and objectively measuring the level of influence of team members can be valuable as a source of feedback for teams in many different contexts.

While I argue that each of the papers hold strong internal validity and reliability, they also have broad implications. Seen in combination, the papers can be used as a foundation for leaders aiming to understand and improve their teams' to ability to adapt and handle uncertainty.

4.1.2 The researchers' influence in the work

The included papers have been written in collaboration with others, while I am the main author in all of them. However, an explicit focus upon our roles researchers has not been properly addressed (Lyons & Coyle, 2007). First and foremost we, as scholars, should operate as tools in the research (McCracken, 1988), whereby our decisions, way of working, and understanding create the foundation of the process. While most of the overall strategic questions have been discussed within the project group, the operational actions relevant for my thesis have been mine to implement. Thus, the strengths of working as a group has been profound when discussing topics, finding respondents, planning and making strategies, sharing information, and reviewing papers. The final contents, however, are undoubtedly more influenced by me as the storyteller. Researchers should, in general, strive towards objectivity in their work, but our work is naturally affected by our actions. For me, it has been important to ensure validity and reliability and to handle the research objects ethically and

with respect. This means that I have used the research questions and theory to lead the work, and made eventual speculations and allusions from me and my colleagues explicit in the texts.

4.2 Methodical choices

4.2.1 Methods in paper 1,2 and 4

Articles 1, and 4 are built as embedded single-cases utilizing mixed methods (Yin, 2014). The main body of *qualitative data* stems from semi-structured interviews, while more open-ended conversations and quite specific questions are used when appropriate. Open-ended interviews, mostly done as thematic conversations, have been used to get an overview of and insight into the topic and context (Daft, 1983), whereas the specific questions have been useful to validate data and findings. While several qualitative researchers have been relevant through this work (e.g. Miles & Huberman, 1994; Westbrook, 2009; Yin, 2014), most of the data collection has been anchored in the framework from McCracken's book *The Long Interview*. In general this is a circular approach in which you start with a solid theoretical understanding and end up with expanded understanding, usually with the ability to ask more precise and intelligent questions than in the beginning (McCracken, 1988). The interview guides were fundamental in this process; with a focus on letting the respondents tell their story without leading them to the answers.

Most of the interviews were transcribed as a part of the initial analysis process, helping me to better understand the data (Langdridge, 2004). However, a few interviews were hard to record as they were done through video-calls or phone. In such settings, I took extensive notes and wrote summaries immediately after the interview sessions. The qualitative data has been highly important to uncovering processes and gaining solid understanding of the context. This has been vital to understanding how the involved teams are influenced by their operational settings. Johns (2006) argues that "intelligent speculations about contextual impacts seems little different from intelligent application of theory" (p. 403). As such, each of the papers has clear boundaries, while still being relevant for a significant population.

Paper 2 includes overall performance ratings from RNoNA subject matter experts. These experts use RNoNAs' internal framework to rate performance according to various dimensions of task work, teamwork, and the overall mission.

4.2.1.1 The SPGR-framework

Articles 1,2 and 3's *quantitative data* has been collected electronically by using the 24-item SPGR behavior-scale survey (Sjøvold, 1995, 2002), which operationalizes the Spin Theory. This survey asks the respondents to rate their fellow team members, including themselves, on which behaviors they typically *perceive* in the team. These perceptions are described through a frequency weighted as never or seldom (0), sometimes (1), and often or always (2). The SPGR-scale has well-documented construct- and predictive validity, as well as high reliability scores (Sjøvold, 2002, 2007, 2014b).

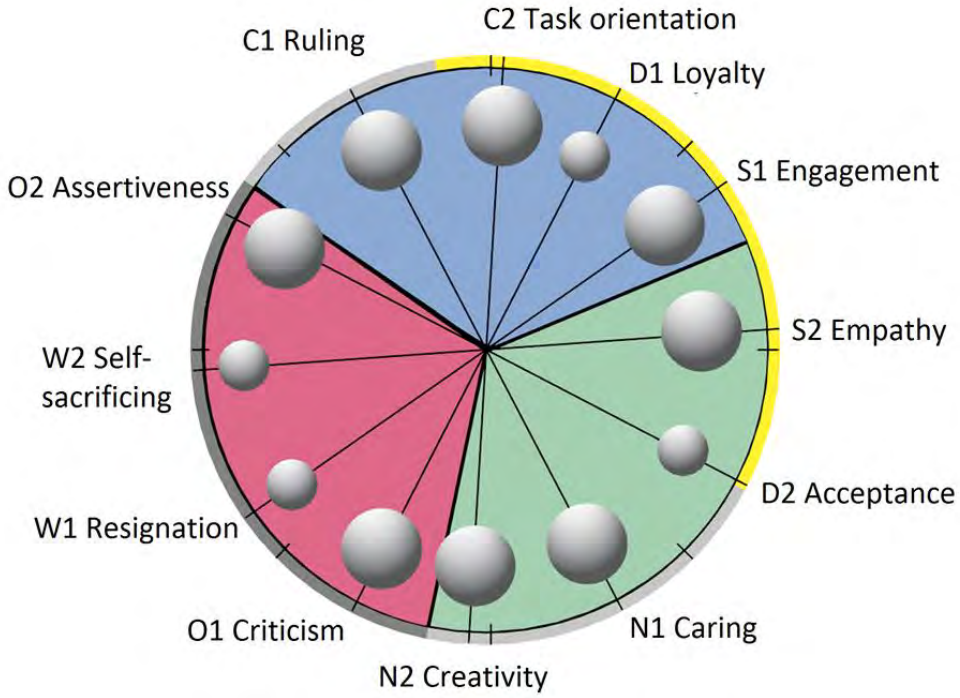

Figure 5: The twelve SPGR-vectors illustrated in a field diagram (Sjøvold, 2014b, p. 137 - reprinted for scholarly usage).

The SPGR-survey operationalizes the three basic dimensions of the Spin Theory (control-nurture (C-N), opposition-dependence (O-D), and withdrawal-synergy (W-S), see Figure 5) and the embedded passivity-influence dimension (P-I). In Table 6 are the collocation of behaviors related to each vector. To produce outcome Indexes, the SPGR-framework uses unique algorithms as described in Sjøvold (2002).

As seen in Figure 5, four vectors, D1 Loyalty, D2 Acceptance, W2 Self-sacrificing and W1 Resignation, are illustrated through smaller circle sizes. The behaviors associated with these vectors are considered as more passive. Therefore, high scores on these vectors reduce the circle size, indicating that the individual has less influence in the group. This is what constitutes the embedded P-I dimension. The vectors opposite from each other are considered mutually exclusive behavior (Sjøvold, 2014b). For instance, it is impossible to be completely autocratic (C1 Ruling), at the same time as being attentive to relations (N1 Caring). The scale of the vectors balance from -9 to 9, while the absolute values are used in the quantitative measurements.

Table 6

The Behavioral Vectors, Code and Typical Behavior

Behavioral vector	Code	Typical behavior
Ruling	C1	Controlling, authoritarian, attentive to rules and procedures
Task-orientation	C2	Task-oriented, analytical, conforming
Caring	N1	Taking care of others, attentive to relations
Creativity	N2	Creative, spontaneous, emotional
Criticism	O1	Critical, opposing
Assertiveness	O2	Assertive, self-sufficient, blunt
Loyalty	D1	Loyal, obedient, conforming, dutiful
Acceptance	D2	Passive, acceptance of the group
Energy	S1	Energy, determined, constructive and cooperatively
Empathy	S2	Empathic, caring, supportive, encouraging
Resignation	W1	Disheartened, discouraged, lethargic, low confidence
Self-sacrificing	W2	Self-pitying, complaining, noncontributing

SPGR-data can be extracted for various purposes, as illustrated in the different papers in this thesis. In addition, the SPGR-software creates a visualization of the results in the Average Field analysis, shown in Figure 6, which is an efficient tool for investigating group dynamics (Sjøvold, 2002, 2006b, 2014b). This visualization compress the factor analytical space into a 2D print, making it possible to qualitatively analyze group dynamics. Article 2, Team adaption, includes this graphical tool, combined with quantitative results. As displayed in Figure 5 and Figure 6, the Average Field analysis is presented on a template consisting of three sectors, each supporting different behaviors. The upper sector, displayed in blue, supports the group function “control”; while the green sector, in the bottom right, supports behaviors connected to the group function “nurture”; and finally, the red sector in the bottom left covers behaviors that support the group function “opposition”. In addition, the colors shown in the periphery of the diagram delimits important information regarding the teams

interplay. In such, the yellow boarder illustrates an area that supports constructive and goal-oriented teamwork; the dark gray boarder describes behaviors that restrict constructive teamwork; and finally, the light gray boarders display behaviors that sometimes are needed in the group, but can be damaging for the team if this behavior becomes to conspicuous.

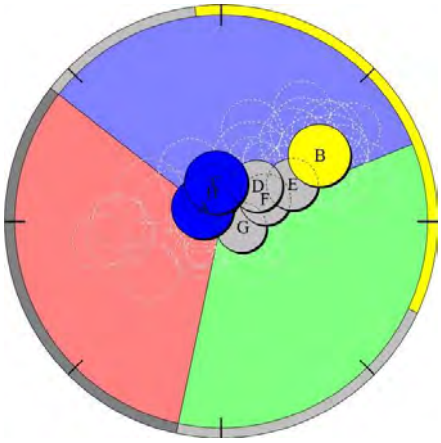

Figure 6. Example of one graphical output from the SPGR survey (see Sjøvold, 2002; SPGR).

By calculating the average of the vectors pulling in different directions, the Average Field analysis visualizes teammates' perceived behavioral position and influence. Each position indicates how the overall team perceive the person's behavior, while the size of the circle describe the persons influence in the group. Persons marked by yellow circles in the Average Field analysis display a relatively balanced spectrum of behavior, implying that they do not freeze into specific social roles. On the other hand, if a person limits the behaviors to a certain function, this person assumes a "role" in the team. As an example, the blue circles in Figure 6 imply that these individuals have taken a controlling role in the group, while the yellow circle display a teammate with balanced behaviors. The Euclidian distance between the circles exhibits the relational closeness between teammates, and eventual distances help to visualize eventual subgroups or individuals operating as satellites to the team. Individual ratings are shown as dotted white circles, and visualize the alignment of SMMs in the team. When the dotted circles fill a large area in the SPGR field diagram, as in Figure 6, this shows that there are large misalignments in teams SMMs (Sjøvold, 2006b, 2014b). Altogether, the Average Field analysis provides broad information about the groups' inner life. As such, the SPGR-framework comprehends an advanced toolbox; I have used the research question to guide which data to extract for each article.

The findings in each article have been discussed with the executives from the relevant organization. This was done to validate findings, ensure practical significance, and give feedback (see Van de Ven, 2007, 2011). These discussions have contributed in a positive way, mostly by making arguments clearer and more specific through uncovering misunderstandings.

4.2.2 Methods in paper 4: Big data from sociometric wearables

Inspired by the work of Pentland (2012), which makes strong claims regarding team research, the fourth paper (Unfolding influence) uses innovative wearables and big data to investigate team dynamics. Specifically, the paper use real time data, combined with qualitative methods, to uncover team members' level of influence within group interactions.

Figure 7 shows a sociometric badge. The badge is small, has long battery time, and is easy to wear (Solutions, 2014). According to Olguín et al. (2009) the sociometric badges have several relevant capabilities. First, they use a three-axis accelerometer. This accelerometer is able to cover 99% of the acceleration power from human movements, as well as being at least 80% accurate in giving real time measurements of daily activities such as sitting, standing, walking and running. Second, the badges extract real time nonlinguistic speech patterns. This means that they are able to display vocal interactions, while ignoring the content of the words in order to ensure privacy concerns. Third, by using Bluetooth and IR sensors the badges can measure proximity between people and face-to-face interactions with a high level of accuracy. Naturally, this accuracy level will differ with the context, but in a day-to-day and person-to-person interactions, the badges can reach more than 95% accuracy. In addition, it is possible to use the sociometric badges to measure locations, networks, traffic, meeting points and so forth. It is also possible to combine the badges with other technical solutions, such as mobile phones and stationary stations. Hence, the devices provide a broad range of possible combinations to collect various interaction data (Kim et al., 2012; Olguín et al., 2009; Solutions, 2014).

Figure 7. Photo of the sociometric badge, from the preliminary user guide revision 1.21 (Solutions, 2014 - reprinted for scholarly usage).

In Figure 8, created by Olguín et al. (2009, p. 46), it is possible to get an impression of the hardware used in the sociometric badges. The idea is to give an overall understanding of the technology, not to dive into in details, as these can be found in Olguín et al. (2009). In short, the badge contains a microphone, an amplifier with filers, a three-axis accelerometer, an IR-transceiver for detecting when people face each other, an audio power amplifier, a speaker, a micro controller, a Bluetooth module for proximity data, a memory card, a battery, and two USB ports (one for battery charging an one for extraction of data). Including the plastic container, shown in Figure 8, the dimensions are 4.5 × 10 × 2 cm, with a total weight of 110g.

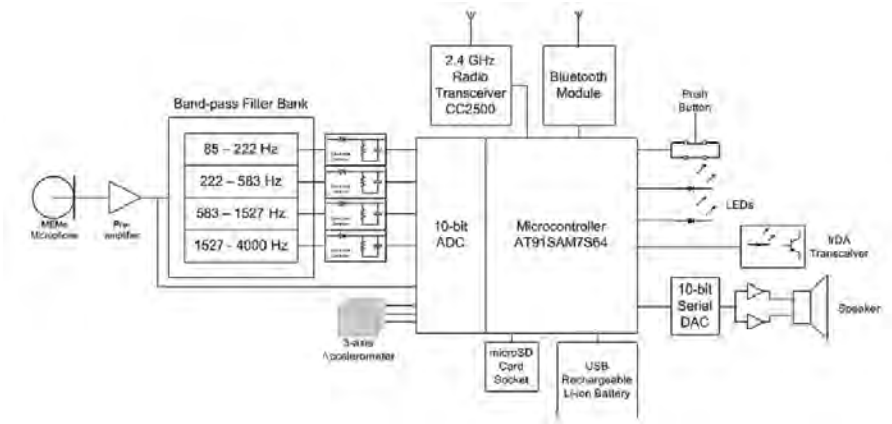

Figure 8. The block diagram from the sociometric badge (Olguín et al., 2009, p. 46 - reprinted for scholarly usage).

The software SSI, created by Sociometric Solutions, follows the sociometric badges and is used to extract data from the sensors. This software allows me to categorize and decide which data that is relevant before SSI analyzes and exports the findings to an Excel workbook (Solutions, 2014). Depending upon the choices made in SSI, the workbook can contain 36 different spread sheets with various interaction data. In the third paper (Unfolding influence), we chose "body activity" and "body movement consistency" to measure how people use their body for non-vocal communication or support vocal communication. To understand speech volume and audio, we use "volume activity" and "audio consistency", while "turn-taking" and "the number of successful and unsuccessful interruptions" are used to analyze speech patterns. These data were chosen due to the descriptions found in the user manual that accompanied the badges (see Solutions, 2014), and how these aligned to theory. As the article illustrates, we argue that the combination of these data help to reveal some of the interaction processes within teams, and help understand how influence is distributed within groups.

While the sociometric badges clearly are an innovative and promising input to group research, we also see some constraints. First, this technology must be connected to validated theories. This includes pinpointing the relevant data before approaching the field; instead falling into the trap of *first* sampling enormous amounts of big data and *then* attempting to mine some conclusions. Focusing upon hardware is also important. While the sociometric badges help to collect data from teams that are physically active, they are less reliable when collecting data from groups that are less active.

As an example, in the project "Operational Leadership," we have observed several top leader teams that interact quite energetically while sitting down, but the sociometric badges fail to pick up their body movement as they tend to sit quite still. Instead, these members facilitate their interactions by facial expressions, turning their heads, and maybe through gestures, while leaving the body more or less in the same position. This means that an individual can talk to the person next to him, while the badge is facing the person up front. Such data sampling creates two obvious errors. First, it seems as if the person is barely physically engaged, and second, the dataset will display interactions between the wrong individuals. In addition, knowing that facial micro-expressions can be quite subtle (Yan et al., 2013), the sociometric badges obviously fail to sample this. In teams that physically move a lot, such micro-expressions may be less important. However, it would have been interesting to have some measures of this in this article, as we indicated that one of the members potentially was more influential than we were able to see and sample. In teams that mostly sit still and work around tables, such as project teams or top management teams, I argue that facial expressions contain a crucial part of the group interactions. Future development should have these limitations in mind, and attempt to develop wearables that able to capture such subtle group interactions as well the broader interactions that are now captured.

4.3 Methodological limitations

The limitations of the work is given in each of the articles. Nevertheless, I find it especially important to highlight that the limitations of the sociometric badges used in article 4, Unfolding influence, creates considerable possibilities for future developments. I further address this topic in the second part of the discussion.

5 Main Findings

In this chapter I present the main findings from the four papers which all address gaps in the literature review, as well as contributing to the overall research question for the thesis. The order of presentation builds on my desire to understand how groups excel and adapt to uncertain and changing environments. The four papers are briefly presented in the following sections, while the full articles can be found in Part II.

5.1 Facing uncertainty: Developing adaptable teams

The first paper follows four RNoNA teams through an 11-week teambuilding exercise designed to enable the teams to handle high stress and uncertain contexts. The article focuses on uncovering "essential factors in order to create teams that are able to uphold high performance in their operational context."

The data illustrate how three of the teams were able to improve their interaction patterns as a result of the intervention. In particular, these three teams invested time and effort in developing their interaction patterns through understanding the teammates' behaviors and attitudes. Understanding how each one influences each of the others, and encouraging each other to try out new group functions instead of relying on behavioral comfort-zones was vital to success. The three teams also spent significant time together between their shifts, while continuously seeking deeper insights in each other's perspectives. In contrast, the fourth group, which failed to develop, did not invest time and energy in the same way, and focused mainly on their given tasks, which resulted in less advanced usage of group functions after the intervention.

Altogether, this paper illustrate that teambuilding should be tailored to the unique problems found in each group, and the main purpose of the intervention must be reflected in the group's operational context. While three of the teams did develop, the data also illustrated that these teams still had challenges to overcome. This indicates that teambuilding should be a continuous exercise, in which teams must continue to train to be able to maintain their advanced patterns.

5.2 Team adaption: Uncovering differences in shared mental models

In the second paper in my thesis, I study team-related SMMs in RNoNA cadet teams, by asking "how do team-related SMMs develop over time? The results indicate that team-related SMMs are sticky and hard to change. While the groups acknowledge changes in polarizations and influence, the mid-level SMMs scores are quite stable through the study. While not being able to establish validated findings, we also notice that the studied teams received mid-level scores in their final demanding live exercise. By this, mid-level SMMs seems to enable mid-level scores, meaning that the teams have potential for advancements by increasing their team-related SMMs.

SMMs are generally treated as a theoretical and quite static construct. We, however, introduce the Spin Theory's Average Field analysis (Figure 6), which is a graphical tool that displayed the *perceived* internal behaviors in groups. By this, it is possible to study the change

of SMMs as groups proceed, as well as provide teams with an efficient tool for discussions and feedback - making the theoretical construct SMMs more explicit.

5.3 Unfolding influence: Sociometric data and group dynamics

This third paper is the most technical one in my thesis. By using sociometric badges, the article is an attempt to answer the question: "Is it possible to utilize sensor technology to unfold the distribution of influence within group processes?" As far as we know, we are the first to use sociometric badges to study groups in this way.

To study the distribution of influence in RNoNA teams, we use various measurements of vocal and non-vocal interactions, and display the findings through average scores as well as graphical illustrations. By combining the measurements, we created a quite solid understanding of how the members' levels of influence affect group dynamics. Thus, we found that influence was in large possessed by a single team member, and we use process data to document how this individual affected the group dynamics in various ways. Indeed, the badges provide us as researchers with new insights and they are an efficient feedback tool for groups.

5.4 From routine to uncertainty: Adaptable teams within integrated operations

The fourth and last paper in my thesis is anchored in the offshore oil and gas industry, and answer the research question: "*How do the shift from routine to crisis operations affect interteam collaboration?"*

The organization claims that they use their normal operations to ensure efficient teamwork, and that they follow a military approach within crisis settings. However, the findings illustrate that the leadership practices facilitate in-group bias, as well as hamper teams' ability to become adaptable. Their leadership practices are in stark contrast to the perspectives used in modern military maneuver warfare. In fact, the implemented leadership actions actually hinder, instead of help, teams to innovate and excel through uncertainty.

An offshore catastrophe has severe implications on various levels, forcing this industry to be in the forefront of crisis management. Therefore, we claim that looking into the advanced leadership practices found in military special operations should be highly valuable, and help leaders in this complex industry to create adaptable teams.

6 Discussion

This section is two-fold. First, it discusses the four empirical papers up against the overall research question; thereafter it addresses the development of sociometric badges.

6.1 Team interactions

Understanding the internal processes within teams and thereby enabling groups to handle changing and ambiguous contexts are important, especially in environments that can promptly change without warning. The dominant leadership practices today, however, build upon a single formal team leader (Zander & Butler, 2010), who often becomes more authoritarian and conservative in their response to ambiguity and uncertainty (James & Wooten, 2005). Instead of enabling collective and innovative actions, such behaviors actually hamper the team's ability to innovate and adapt (Bachman, 1988). In the minds of the teammates, the idea of a single authoritative leader will normally be perceived as the correct way of handling threats. Teammates expect such "strong" leaders to set direction, identify solutions and, by this, establish trust and efficacy (Krabberød, 2014; Shamir, 2011). This means that leaders who try to change established internal patterns, without a collective agreement, risk being ignored or rejected (see Gersick & Hackman, 1990; Krabberød, 2014; Sherif, 1936; Weick, 1993). Changing and facilitating new group dynamics is not straightforward.

The principle of a single leader has strong deeply anchored roots, and we can find it through historical traits of emperors, as well as in more religious paradigms. In more modern times, though, such authoritarian single leadership actions has been widespread and deeply anchored due to Frederick Taylor's "Scientific Management" perspective after the Industrial Revolution (Taylor, 1911). Taylor's ideas for standardization, routines and predictable processes are highly efficient for solving problems in known repeatable milieus, while they become less effective as stability evolves into more chaotic circumstances. Instead, enabling all the resources available for the teams, and often combining these resources in new ways, becomes central in order to succeed. This obviously exceeds the capabilities of a single persons.

Our modern brain has slowly developed since our early ancestors, but it still has strong similarities to the brains in the people that wandered the savannah more than 100 000 years ago (Klingberg, 2009). At this time, people lived in groups containing about 100-150 members and probably saw as many people in a year as modern humans do in a day (Klingberg, 2009; van Vugt & Ronay, 2014). To survive and advance, our ancestors developed various response mechanisms, which Kahneman labels as System 1 and System 2.

System 1 constitutes the automatic behaviors, e.g. fight and flight, and the System 2 enhances the cognitive mechanisms that enable us to think critically (see Kahneman, 2011). As an example, instead of running every time we see something we believe is dangerous, we activate our cognitive mechanisms and notice that we actually observed an optical illusion, allowing us to proceed with our actions.

Based upon biological understandings, the institutions that survive and succeed through efficient adaption base their operations on teamwork anchored in System 2 perspectives (e.g. RNoNA and different SOF-units around in the world). At the same time, just establishing a team and expect it to excel through uncertainty and ambiguity will most likely lead to failure. This thesis contributes to understanding the efforts required to succeed.

Sjøvold (2014b) uses the conceptual ideas from Kahneman to illustrate the difference between teams operating at low and high LoPs. The more static dynamics found at low LoPs are similar to System 1, with reaction- and routine- based work. Hence, the advanced dynamics at higher LoPs are equal to the cognitive mechanisms found in System 2. Such analogies are suitable to quickly understand the difference between high and low LoP teams, as well as to help explain that the teams at high LoP (or System 2) are enabled to learn from the outside world, as well as create new knowledge in order to solve the problem at hand (Edmondson, 2012a, 2012b; Simon, 1991). The quest for team leaders is then aimed towards understanding how to align teams to their context, and thus also how to eventually develop the necessary dynamics if the teams are misaligned. This thesis addresses this topic through the four empirical papers, which all examine teams that operate in highly dynamic and complex environments. While the topics in these papers are investigated separately, they are interdependent in practice and help to develop the overall theoretical understanding, or in Chesbrough's terminology, they help "to assemble the elephant" (Chesbrough, 2001).

6.1.1 Developing group functions

The first paper, Stålsett and Sjøvold (2016a) (Facing uncertainty), focuses on the concept of *group functions*, and how to develop these in order to improve group dynamics. The article responds to some of the gaps in the literature review. Specifically, I argued that there is demand for research that focuses on group functions and how to improve these in order to create adaptable teams. The military cadet teams that we studies must be able to adjust to rapid changes in their environment, and they have to handle several complex elements. When they start their operative careers, they have to work in highly complex settings. This complexity is exemplified through off- and onshore frontline military warfare; international and national

laws; morals and ethics; and various technology systems. Focusing on an individual hero to save the day in such settings would be dangerous. RNoNA understands this, and utilizes a long-term continuous perspective in order to enable the teams to utilize all their resources to adapt and solve the task at hand. A core element in this work is to improve the social interaction patterns, or the group functions, in the teams.

The findings illustrate that teams that improve their group dynamics do so through mutual respect, interest, and collective fruitful discussions tailored towards expanding individuals' behavioral comfort zones. In this way, the cadets are able to tear down eventual stereotypical anticipations and make it possible to expand each member's behavioral range. In terms of the Spin Theory, they have started to *develop* their LoP, while some of the shortcomings in their operations illustrate that they still need to *train* to maintain their advanced interaction patterns (Sjøvold, 2006a, 2007, 2014b). The team that did not focus on such internal processes, failed to improve their interaction patterns, even if they went through the same journey as the other three teams. This means that focusing on the task and structural elements, such as the technology, is not enough to develop the internal interactions.

A central element in the improvement of group functioning is that the cadets have to adjust their behaviors according to their teammates' and supervisors' feedback. This means that the most influential individual, behaving as "a bull in china shop," is told to hold back and create room for other teammates to advance their actions. In contrast, team members that are too obedient and silent are told to demand more space, and communicate more within the group. Balancing behaviors is a central element in groups, and a requisite to enable shared leadership actions.

It also follows that to be able to understand each other's perspectives, knowledge and attitudes, the discussions should foster a higher level of SMMs. Taken together, these arguments indicate that I have tightly interrelated papers, tailored toward understanding how teams enable their resources in order to adapt and handle uncertainty. The first paper's findings advance the theoretical understanding of team building, and also help practitioners to implement cost effective, but possibly mentally demanding, team building sessions.

6.1.2 Advancing collective understanding in teams

The second paper, Stålsett and Sjøvold (2016b) (Team adaption), shows how hard it is to actually develop team-related SMMs. While the teammates describe that their internal polarization and influence values changes through the year, the SMMs seem to be quite stable.

Without being able to validate the findings, we also notice that average internal performance scores in the highly demanding final live exercise follow average levels of SMMs in the groups. This paper also fills a gap identified in my review by focusing on the cognitive mechanisms in teams.

It is a natural and central part of these teams' education to work with internal team-related SMMs. At the same time, the cadet groups consist of 8-9 members, which means that it is demanding to establish high levels of SMMs. However, demanding does not mean impossible, and the teams can therefore advance further by investing time and effort in developing deeper internal insights and understanding. The findings extend the argument from paper 1; teams should be kept intact and they need to maintain a continuous longitudinal focus in order to develop. Further, this implies that SMMs are dynamic by nature, and should not be treated as a static construct.

As far as I know, this is the first article that actually addresses SMMs by asking the teams about their perceptions of their fellow teammates' *behaviors*, instead of alternatives such as the perceptions of the allocation of resources, prioritizing events, notice of changes, learning or performance (e.g Lim & Klein, 2006; Mjelde et al., 2016; Mohammed, Hamilton, Tesler, Mancuso, & McNeese, 2015). This difference of measurement is important. I argue that surveys that do not focus on perceived group behaviors do not capture the *core* of groups' team-related SMMs. In many cases, these surveys measure perceived outcome variables and use the variance in the answers to try to predict the quality of the inputs, without actually tapping into them.

The concept of attribution bias, where teammates attribute positive outcomes to internal processes and negative outcomes to external forces is well-documented (see Heider, 1958; Kelley, 1967; Staw, 1981). As argued, such attribution biases are often found in teams operating at low LoPs. This means that self-rating surveys on outcome variables can lead to false positives, as teams believe they have done better than they actually have. As an example, imagine two teams. The first team is lucky and can perform their tasks as a straightforward standardized operation; while latter team experiences external threats that turn the operational context into chaos. Both teams succeed. However if the first team struggles with attribution bias, this team will rate their outcome performance indicators higher than the team that that actually had to struggle and innovate to perform. If the last team is exhausted and in negative mental state when asked to review their performance, they might rate their outcome variables way lower than they actually are. In such, they might risk attributing their poor performance to the external threats instead of internal shortcomings.

Using external experts is therefore important in order to try to create objective answers. But at the same time, external experts cannot say how the teammates perceived each-others' behaviors as some suggest (see Mjelde et al., 2016). If teammates do not express personal opinions, experts are not able to read their minds. I therefore argue that the only way to really study team-related SMMs is to actually ask the each respondent to answer how they perceive their fellow teammates' behaviors. The data in the third article is collected by using the SPGR-framework, which focuses on perceived *behaviors*. This means that it is able to provide an understanding of how teammates look upon each other. This framework also has a huge data base with normal distributions of scores, making it possible to create a scale to evaluate the teams SMMs from low to high.

In addition, the article provides a practical visual tool, the Average Field analysis. This is an advanced tool and contains several layers of information. However, with some training, the framework is rather easy for teams and leaders to implement in their feedback- and discussion sessions. In this way, the theoretical construct team-related SMMs becomes more understandable and more tangible through visualization, thereby helping teammates to understand how others understand their behaviors. Such a tool can help to foster fruitful discussions and enable teammates to adjust their behavior, as well as measure how such adjustments proceed.

As illustrated in the chapter about the Spin Theory, high degrees of SMMs are traits displayed by teams operating on a high LoP. This does not mean that establishing SMMs alone is enough to improve team dynamics, but it is a central element. The cognitive process behind SMMs can foster collective learning. Establishing such learning, however, can be mentally demanding, and builds on teammates' desire to increase their shared knowledge.

Using constructive confrontation (CC) is mentioned as a successful strategy for such discussions (see Burgess & Burgess, 1996; Sjøvold, 2014b). CC is described as the constant thirst for new information, and thereof the will to question each others' statements. Yet, although it could be intriguing to challenge one's teammates' perceptions of the task and the work environment, it must be emphasized that the method is founded on the expression of mutual respect and genuine interest in the inclinations of others. CC can therefore help to uncover latent disagreements, implicit perceptions, and barriers that hinder team development. Due to this, CC should help to make deeply anchored attitudes more explicit (see Healey et al., 2015), as well as to enable teammates to efficiently interpret nonverbal behaviors (see Hurley, Clark, & Kiverstein, 2008; Pentland, 2008). CC is not limited to action debriefs but can be effectively implemented throughout the entire process of planning, executing, and reviewing

tasks (see Danielsen, 2015; Godé & Lebraty, 2015). Through such collective discussions, it would be natural to assume that teams become externally oriented in order to fill knowledge-gaps and ensure that potentially misunderstood concepts become clarified. In this way, the teams can become more than the sum of individuals; the collective interplay helps them to learn and innovate in order to explore the unknown. Military teams must be able to give, interpret, and work with critical feedback, meaning that critical remarks are viewed as showing genuine interest in helping and developing the team. As such, these dynamics prevent the groups from ending up in locked polarizations and conflicts.

Teams operating with low degrees of SMMs and less flexible social roles should engage external instructors to facilitate CC, and by this help themselves to alter internal perceptions and dynamics. In contrast, teams that have advanced their interaction patterns into a high LoP, have incorporated the principles behind CC into their social interactions. The cadet teams from RNoNA use officers as instructors, which is an important part of their educational program.

6.1.3 The distribution of influence

A prequalification to enable a wider spectrum of group functions in teams, as well as facilitating the collective leadership actions found at a high LoP, is to balance teammates' influence in groups. The third paper, Stålsett and Sjøvold (2016c) (Unfolding influence), also fills a gap identified in the literature review by using novel wearable sensor technology to examine how influence floats within teams. By using such sociometric sensors, the paper provides a visual understanding of how influencing teammates' verbal and non-verbal communication affects the behaviors within the groups. This way of studying influence gives unique insight into how the most influential team members still affect the group dynamics after they are told by RNoNA instructors to step back. It is natural to assume that less influential colleagues in such settings would try to demand more space, but instead the whole group limits their behavioral range.

By using big data to investigate influence in this way, instructors can get objective data and quickly intervene with their teams in order to give feedback and facilitate discussions. Instead of letting the whole session run before giving feedback, it is possible to stop the exercise and facilitate fruitful discussions around the group's intentions and results. This way of displaying team data gives direct insight into group processes. While it is argued that influencing single leaders often relies upon authoritative actions, our process data actually shows that the influencing members balance their behaviors. Notably, the sociometric badges

measure the behavioral patterns, not the explicit group function, meaning that they do not measure the intentions and implications of the actions.

The formal leader and the most influential member do not have to be the same person, meaning that an influential member can alter the whole group dynamic to his or her advantage (Nissestad, 2008). Hence, by using sociometric data, we illustrate that the influential members balance their verbal and non-verbal behaviors rapidly in order to efficiently communicate with each colleague. Indeed, such abilities should be sought by all the teammates, as this helps to enable teams to rapidly adapt to novelty.

This sensor technology should be celebrated for being straightforward to implement. Interpreting the data, however, is not that straight forward and demands further research, a topic I address in the next subsection. Nonetheless, at the current stage I argue that illustrating how influence shifts within the group should be helpful in order to spark CC discussions in teams. Additionally, combining this tool with the Average Field analysis in team-related discussions should be very beneficial. Instructors can use the sociometric data as a graphical time-line and a foundation to discuss eventual misalignments in SMMs, thereby helping the team to create a more holistic understanding of their own actions.

6.1.4 Adapting to crisis

The impact from an oil and gas (O&G) disaster in the North Sea will have severe implications at several levels, economically, environmentally, and directly on human lives. The Deep Water Horizon catastrophe, which cost eleven human lives, happened in the Gulf of Mexico, off the coast of Louisiana back in 2010. However, the possibility of similar disasters on the Norwegian shelf is great today (Petroleumstilsynet, 2013; Tinmannsvik et al., 2011). The fourth paper, Stålsett, Sjøvold, and Olsen (2016) (From routine to uncertainty), studies how the shift from routine to crisis operations affects the inter-team collaboration in this context. In addition, this paper addresses gaps identified in the literature review, and it illustrates that the most common leadership behaviors fail to handle efficient inter-team collaboration and novel situations under crisis settings. The findings in this paper show that leadership practices in normal setting facilitate team dynamics that are found on lower LoPs; whereas the crisis leadership actions actually force the teams into even more static and underdeveloped dynamics, leading teams to activate System 1 actions to respond to problems and threats.

In normal settings, the typical team dynamics and ways of operating seem efficient, as their daily tasks in large follow standardized routines and procedures. At the same time, operating with such dynamics also means that the teammates rely upon their leader to

coordinate and solve problems, while maintaining a largely intra-team focus. When teams operate like this, they risk ending up with problems such as groupthink (Janis, 1972, 1982) and the Not-Invented-Here syndrome (Katz & Allen, 1982), symptoms found in the data.

Siegal (2010) finds that errors more often arise from missing information caused by poor communication rather than misjudgment, making inter-team collaboration especially vulnerable. The intra-team bias found in the teams is therefore problematic, especially after the organization has relocated significant parts of their expert knowledge from offshore to onshore locations. This situation requires teams to be able to cooperate efficiently both within and between physical locations. Due to this, it can be argued that, in normal settings, the teams are aligned to a shortsighted understanding of operational demands, in which relying on technology and procedures prevail. Such myopic focus, however, does not satisfy the organizational demands for collaboration, knowledge transfer, and innovation, meaning that the teams should raise their LoP. Teams should be able to adjust their dynamics to the situation at hand, and thereby enable System 2 traits when they need to. In this way, they can align their operations to standardized processes, but also enable more advanced dynamics when they have to cope with interdependencies, new knowledge, and information.

The high level of expert knowledge, and the respect for this can indicate that the teammates have quite high task-related SMMs. These aspects of SMMs were not measured. However, it is natural to assume that the staff hold high technical expertise (engineers), and such traits are described in the data. By operating at low LoPs, the behavioral norms and common leadership actions fail to help teammates to gain deep knowledge and expand their team-related SMMs. The SMMs scores, one of the measures used to establishing the LoP, are also quite low. As the findings in Stålsett and Sjøvold (2016b) (Team adaption) illustrate, this means that the teams will struggle when they have to utilize all available resources in order to adapt and solve problems. This state hampers the teammates' ability to learn from each other, meaning that individual expertise becomes harder to spread within and among the teams.

Using the "command and control" structure within crisis settings is effective when the situation is stable and the problem is known; the problems arise when things start to escalate and become novel and chaotic. The findings in which leaders become more authoritative in this crisis structure are in line with previous research, while documenting that such leadership behaviors actually hinder teams' ability to adapt conflicts with the expectations most people have. It is noteworthy that the organization compares their crisis management to traditional military strategies. However, such conventional strategies are outdated, and not aligned with the unconventional strategies of modern military organziations (see Alberts, 2007; Clemons &

Santamaria, 2002; Danielsen, 2015; McChrystal et al., 2015; RNoNA, 2009; Shamir, 2011) - exactly because they fail to handle complexity and unpredictable situations. Figure 9 is based on McChrystal et al. (2015, p. 97) illustration of how modern military have abandoned the "command and control" structure and now cooperate as a "team of teams."

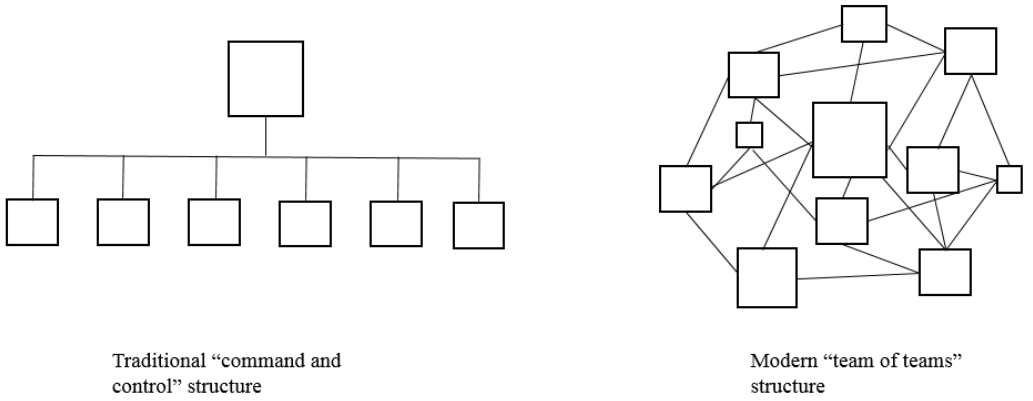

Figure 9. The traditional "command and control structure" and the modern maneuver warfare "team of teams" structure (Adjusted from McChrystal et al., 2015, p. 129 - reprinted for scholarly usage).

Just establishing new structures, without developing the established leadership practices and team dynamics, will most likely not in itself lead to success. This means that attempts to change the established strategies must be followed by intensive team building interventions in order to succeed. Such organizational innovation will most likely be considerable and demand both time and resources. This does not imply that they should implement new structures in the whole organization at the same time. Quite the opposite, I suggest that they should use a step-by-step procedure in which they create some successful cases, and use these cases to learn and ignite a continuous implementation and development program. Given the impact that O&G organizations have on society, they cannot be satisfied with the standards they use today in order to solve the unknown problems of tomorrow.

6.2 Sociometric badges and future development

The third article, Unfolding Influence (Stålsett & Sjøvold, 2016c), introduces novel technology able to capture several kinds of human interaction. These innovative wearables are

developed by a team lead by Professor Alex "Sandy" Pentland at MIT Connection Science and Human Dynamics. Pentland set high standards and expectations for these wearables, known as Sociometric Badges. In his article "The New science of building great teams" (Pentland, 2012), he argues how the badges uncover the core of team dynamics through an advanced set of measurement and analysis.

The idea is that the badges help to measure different kinds of social cues with high predictability (Olguín et al., 2009). Such social cues propagate through ancient reflexes used for unconscious social coordination of human interplay. Pentland (2008) defines social cues as *honest signals*, and proposes that they form an additional and unexplored layer of the communication process. The basic assumption is that these signals are so expensive and hard to fake that they become integrated into our behavioral repertoire; they have even been found to be efficient in dark and noisy environments (Pentland, 2008). It follows that honest signals are reliable predictors of human actions. In a team perspective, this essentially indicates how advanced teams coordinate their actions verbally and non-verbally.

Curhan and Pentland (2007) explain that honest signals can be derived from fine-grained analysis of body movement patterns, timing, energy, and variability of speech. They emphasize four types of signals: first, *engagement*[2] refers to the amount of control one person has over the other's behavior; second, *mimicry* relates to the reflexive copying of one person by another during a conversation; third, *activity* is represented by the energy and time spent in a conversation; and finally, *consistency* is measured by the extent of variability in speech prosody and activity levels. It is important to emphasize that in real-life situations people employ a combination of these signals, and that they may have different meanings across different contexts. Researchers looking at honest signals must therefore be able to evaluate them in light of their social environment.

Pentland (2008) emphasizes that honest signals come with some generalizations. For example, he asserts that the level of team activity correlates with a team's level of productivity, and highly active groups are more productive than their counterparts. In most of their studies, Pentland and his colleagues have used speaking time as a measure of activity, a factor that has also been found to correlate with the dimension of individual influence (Mast, 2002; Stein & Heller, 1979). Similarly, the honest signals framework perceives low team activity as related to highly consistent behaviors. Pentland (2008) illustrates this with a group of highly task-oriented individuals who do not produce more than what their individual

[2] Pentland (2008) later changed *engagement* to *influence*, but for the purpose of this discussion I use the former in order to avoid confusion with the term "influence" used in the Spin Theory of Groups.

contributions would entail; in the Spin Theory this is equivalent to teams operating at a low LoP. Another generalization is that empathetic people are more likely to mimic their conversational partners, which, in turn, could lead to *emotional contagion* (see Hatfield, Cacioppo, & Rapson, 1994) and higher trust levels in a team (Pentland, 2008). The significance of mimicry should therefore not be neglected, as empathy is a prerequisite for the development of advanced group dynamics (Bachman, 1988; Danielsen, 2015; Sjøvold, 1995, 2002, 2006a, 2006b, 2014b).

Another important predictor of team performance is the level of consistency. In fact, the higher consistency in a team member's speech activity, the more mentally focused and task-oriented the person is (Pentland, 2008). In contrast, high variability indicates openness to influence and input from others. Naturally, variability in consistency could also ensue from the conflicting external and internal cues that emanate during turbulent and uncertain situations.

Notably, the sociometric badges lack construct validity (Curhan & Pentland, 2007), and are therefore also missing an explicit connection to Pentland (2008) honest signals. Therefore, we in "Operational Leadership" have analyzed the sociometrics' user manual (Solutions, 2014) against work that enhances various aspects of the honest signal framework (e.g. Curhan & Pentland, 2007; Onnela et al., 2014; Pentland, 2008). We have used several batches of data from various contexts and analyzed how this relates to the theoretical framework. Table 7 shows how to interpret the sociometric badge measures for each of the four social signals, and how the results are presented in spreadsheets produced by the software SSI.

Table 7

Measurement of the Four Honest Signals with Sociometric Badges.

Signal **-Interaction type**	**Measured with (user manual)**	**Spreadsheet output**	**Comment**
Engagement **-Vocal**			
	Number of turns, including self-turns	n_tt_turntaking	
	Successful interruptions	r_tt_turntaking1	
	Speech_profile_overlap	t_speach_profile1	
	Average speaking segment length	r_tt_turntaking1	Because of "air time" in the group
	Audio volume	t_audio_front_volume1	
Mimicry **-Vocal and non-vocal**			
	Body movement mirroring	t_BM_mirroring1	
	Mirroring (posture)	t_posture_mirroring	Left/right and front/back mirroring
	Audio Mirroring	t_audio_front_vol_mirroring1	
	Audio amplitude mirroring	t_audio_front_amp0_mirroring1	Can be used in some cases, not always relevant
Activity **-Vocal and non-vocal**			
	Body movement activity	t_BM_activity1	Best measure for body energy
	Total speaking	t_speach_profile1	Combination of total speaking and speaking overlap
Consistency **-Vocal and non-vocal**			
	Consistency speech volume	t_audio_front_vol_consistency1	
	Consistency body movement	t_BM_consistency1	

As Table7 shows, we suggest that each of the honest signals is created through several measurements (Bollen, 1989; McGrath, 1981). Whether or not it is possible to collapse these measurements into a single construct is another question. One possibility, which would require several large data sets, is to try to find some sort of weight for each of the measurements. As an example, the consistency level could be illustrated through a combination of X% amount of the "consistency speech volume" and Y% of the "consistency body movement", creating 100% of that signal together.

As it is today, a qualitative decision of how to use the measurements is the most promising way of operating. In this way, scholars can pick out the relevant measurements and use them for deeper understanding, but a clear understanding of what to extract is vital (Braun & Kuljanin, 2015; Guzzo, Fink, King, Tonidandel, & Landis, 2015; Kozlowski et al., 2015). Table 7 consists of 13 measurements, and I have focused on not building the same measure into several honest signals, as this is how we understand Pentland builds his framework.

Combining measurements, however, seems logic for me. By example, it would be easy to argue that "body movement activity" could also be a part of the honest signal "engagement". Furthermore, the Microsoft Excel workbook, extracted from the software SSI, contains a total of 36 different sheets with different types of data. This means that I have ignored 23 measurements in table 7. This was done because I found them irrelevant, and hard to connect to the theoretical framework of honest signals.

Naturally, as these signals are social interactions, they are also tightly interconnected (Bollen, 1989; Bollen & Lennox, 1991). This means that future progress can benefit from covariate analysis and, in this way, also validate the measurements. However, this would require large data sets very similar contexts, which the research project does not have today.

6.2.1 Understanding signals

Driskell, Salas, and Johnston (1999) argue that during chaotic conditions, the arousal and information overload lead to a narrowing of team perspective as attention becomes restricted to the most central or salient task cues, thus leading team members to disregard their teammates' social cues (or honest signals). This illustrates the importance of drilling to the point where task work becomes automatic, thereby freeing the mental resources needed by team members to take notice of their teammates' honest signals. The latter is a distinct characteristic of military SOF-teams, which has led Tucker and Lamb (2007) to name them "quiet professionals". When these teams encounter situations in which they are unable to use verbal communication, they have to rely on body language to move quietly, quickly, and determinedly to achieve their missions. In their education, SOF soldiers therefore have to learn a professional non-verbal language, which becomes integrated in both their individual and team practice. It is neither their size nor physical strength that make SOF soldiers frightening, but rather their mental focus and awareness (Simons, 1997). Thus, modern first-line warfare is not only a matter of who has the most sophisticated technology, but also about who is mentally superior and able to fully enable the teams' resources. Generally, the rationale is that the propagation of honest signals builds the foundation for how team members perceive and

understand each other, which in turn, creates the foundation of SMMs in the group. Thus, it would be natural to assume that there should be significant correlations between the measurements of honest signals and the SPGR-framework.

I, however, have not been able to find such positive results. While the honest signals framework seems promising, and builds on biological and psychological elements that exists in groups, this is not the same as a straight forward alignment between the two theories "Spin Theory of Small Groups" and "Honest Signals." In fact, as the honest signals lack construct validation (Curhan & Pentland, 2007), and Olguín et al. (2009) argue that the sociometric data need more theoretical development, I claim that expanding an established and validated theory, such as Spin Theory, is a fruitful means of theoretical evolution. I used this strategy in paper three, Unfolding influence, and it gave promising results. In the end, successful development relates to having a solid and clear strategy of how to use the big data, instead of trying to fish for results in huge data sets (Braun & Kuljanin, 2015; Guzzo et al., 2015; Kozlowski et al., 2015).

Hence, I suggest that the sociometric badges can be used to measure the four group functions (nurture, dependence, opposition, control) in the Spin Theory as shown in Table 8. Naturally, such development requires huge data sets and several analyses from similar contexts and homogeneous groups, in which balancing the impact of each measurement is central. In table 8, some measurements are used in several group functions. As an example, I suggest that "audio mirroring" helps to measure both the group functions nurture and control. Notably, depending on the score, this measurement illustrates different results; high audio mirroring equates with nurture, while low audio mirroring equals with control. The logic is that nurturing and emphatic behaviors are seen when individuals mirrors each other, while a controlling individual mirrors less and focus upon tasks and rules.

Table 8

Using Sociometrics to Measure the Group Functions in the Spin Theory.

SPGR-dimension	Measured with (user manual)	Spreadsheet output	Comment
Nurture			
	Body movement activity	t_BM_activity1	High levels
	Mirroring (posture)	t_posture_mirroring	High levels
	Audio mirroring	t_audio_front_vol_mirroring1	High levels
	Audio amplitude mirroring	t_audio_front_amp0_mirroring1	High levels
	Unsuccessful interruptions	r_tt_turntaking1	High levels
	Consistency speech volume	t_audio_front_vol_consistency1	Low levels, relatively to others
	Consistency body movement	t_BM_consistency1	Low levels
Opposition			
	Successful interruptions	r_tt_turntaking1	High levels
	Speech_profile_overlap	t_speach_profile1	High levels. Willing to talk while other talks. Not that eager to continue the conversation, but interrupt others frequently
These opposition measurements should be combined with some sort of pitch, amplitude or frequencies measurements to try to separate opposition and critique from engagement. Without observing the group, the actual output can be hard to interpret, as the data can relate to both opposition and engagement. I have not succeeded on this topic, but future work will continue upon it.			
Control			
	Consistency speech volume	t_audio_front_vol_consistency1	High levels
	Consistency body movement	t_BM_consistency1	High levels
	Mirroring (posture)	t_posture_mirroring	Low levels
	Audio mirroring	t_audio_front_vol_mirroring1	
	Audio amplitude mirroring	t_audio_front_amp0_mirroring1	Low levels
	Successful interruptions	r_tt_turntaking1	High levels
Influence			
	Body movement activity	t_BM_activity1	High levels
	Consistency body movement	t_BM_consistency1	Low levels
	Audio volume	t_audio_front_volume1	Expected high, but could also be low levels – as shown in Unfolding Influence: Sociometric

		Data and Group Dynamics.
Consistency speech volume	t_audio_front_vol_consistency1	Low levels
Unsuccessful interruptions	r_tt_turntaking1	Contextual: high levels if it is confirmative (mhm, yes, no), low levels if there is less vocal interaction.
Successful interruptions	r_tt_turntaking1	High levels
Number of turns, including self-turns	n_tt_turntaking	High levels
Speech analysis	Total_speeking	Contextual: high in groups with less talks, lower in groups with more talks (highly influential members can listen and confirm)

I claim that developing the Spin Theory with sociometric badges, as illustrated in Table 8, should be promising. The SPGR-surveys are validated (see Sjøvold, 2002; Sjøvold, 2014b), and can therefore be used as a benchmark for validating and balancing the electronic measurement tools. In practice, this means that the first step of future work should be to use sociometric badges (or other wearables) and SPGR to investigate a huge number of homogeneous teams within the same context. Thereafter, one should try to find relevant measurements from the hardware and analyze how to weight these in order to find results that significantly correlate with the SPGR results. The development should therefore include both a focus upon hardware and software, and it would be valuable to create software that can give teams instant visual interaction feedbacks. The project "Operational Leadership" plans to look into this.

6.2.2 Limitations of the sociometric badges

There are also other limitations connected to the sociometric badges. As an example, certain behaviors might have different meanings across various contexts, which makes the interpretation of sociometric data more difficult. In studies such as the one in paper 3 (Unfolding influence), one must therefore find ways of integrating context into the interpretation of results.

The newness of the sociometric badge also represented a more surprising and unexpected challenge. In fact, as this methodological tool is yet to be widely tapped, we in "Operational Leadership" could not find any studies applying the sociometric badge in similarly demanding and rapidly changing contexts. This, in turn, meant that prior research

could not help confirm our findings. Given the high claims from the inventors, we find it surprising that other researchers have yet to study teams in more complex contexts. Further, I argue that the sociometric badges' sole focus on predictable environments have, albeit unintentionally, led to negligence of the group dimension opposition, described as team member's capacity and willingness to criticize and challenge the status quo (Sjøvold, 2014b). As far as I can find, none of the studies applying sociometric badges mention any concepts, or ideas, that relate to critical behaviors in teams. This is clearly a weakness, as the critical functions are essential for facilitating team development and ensuring teamwork of high quality.

6.2.2.1 Speculative thoughts

The book *Honest Signals: How They Shape Our World* was published in 2008 (Pentland, 2008). The book was written before the technical article from Olguín et al. (2009) that presents the development of these badges. Indeed, both Kim et al. (2012) and Olguín et al. (2009) argue that the sociometric badges need to be theoretically developed, as well as triangulated with other methods, in order to provide robust and valid findings. The rest of the work from Pentland and his colleagues seems to be purely inductive, while theory development will often benefit from being both deductive and inductive reasoning (Miles & Huberman, 1994). This interpretation stems from of the user manual Solutions (2014), as illustrated in Table 7, which is tightly related to the book *Honest Signals* (Pentland, 2008). As displayed in Table 7, it also appears that the badges use a formative measurement, instead of reflexive measurements. In psychology and social science the reflexive measurements are usually the standard (Bollen, 1989; Bollen & Lennox, 1991; McGrath, 1981). Table 7 also shows that influence is measured through vocal data, while leaving body movements out. Paper 3 (Unfolding Influence), however, clearly shows that body language is an important part of influence. This is also included in my suggestions in Table 8. If my interpretations in Table 7 are correct, this is a clear weakness. I would argue that most people would agree upon that body language is highly important in order to understand influence in group interactions.

Sociometric Solutions, the MIT spin-off, is now known as Humanize. They still publish work in scientific journals, but, as far as I have been able to see, there has been less focus on groups and more work on networks and larger systems. Indeed, Pentland and colleagues talk about groups, but they use long time-spans in their studies, in which the big data give more general impressions than unique insights. Additionally, it is noteworthy that

these studies are done in relatively stable contexts (e.g. universities, banks, data server company) and not contexts that can change dramatically within few seconds. According to the Spin Theory, this indicates that efficacy in these contexts is established through significantly different interaction patterns than found in teams that excel through uncertainty.

In my opinion, the limitations also highlight possibilities for future research. In particular, as the sociometric badge allows for objective, real-time data, it could pave the way for instantaneous feedback systems. At the same time, the badges can help overcome the classical problems of subjectivity, in-group bias, and memory effects associated with questionnaire-based measurement and interviews. In the future, I hope that the research community will continue the advances of this technology.

6.2.2.2 Ongoing development

In the spring of 2016, the project "Operational Leadership" connected with a person who has decoded many aspects of the badges that have been outside of the research groups' competences. His findings reinforces our thoughts about creating a new hardware that is possible to attach to the head in a non-disturbing way. Such a device would clearly help to measure interactions when groups sit around tables during meetings. In addition, the developer has created new software in Linux that can extract huge spreadsheets within five minutes. This will be highly valuable, as the ISS software usually have to run through for several hours provide us with the same data files.

We have also connected with a dyad of post-docs in Toulouse, France, who are helping us with creating a new interactive software for graphical illustrations of the data. They build different data structures that should help us to play with raw data, and so try to advance the Spin Theory with sensor technology. At the same time, we are in touch with research groups at NTNU (e.g. Department for Engineering Design and Materials). There a handful of doctoral scholars in these milieus who have recently started to tap into the sensor technology topic, and we hope to collaborate more with them in the future.

As this technological development continues, it will become easier to study live operational teams. Primarily, we expect the technology to become both cheaper and easier to access. While operational frontline teams often are hard to study in real time, this can become much easier with adequate sensor technology. As an example, we could equip all teams and supervisors that attend the Magellan exercise (described in Paper 1: Facing uncertainty), with wearables. In this way, supervisors can use live data and give immediate feedback to cadets,

and at the same time we can collect extensive data for research purposes. Such wearables also create a potential for studying live military teams (e.g. SOF-teams), and thereby gain data from real operations without disturbing or exposing anyone for danger. Operational Leadership will continue to work with RNoNA on the development of these badges, as we have mutual interests in the topic. This is clearly a strength for the project, as RNoNA has the opportunity to run several identical exercises in a relatively short time span.

Moreover, collecting such sensor data from platforms should be highly interesting, and being able to provide instant feedback has the potential to enhance their leadership developments. The future developments and prospects for the project "Operational Leadership," the Spin Theory, and sensor technology are truly exciting.

7 Concluding Remarks

7.1 Practical implications

This thesis has several practical implications. Reading the whole work will help leaders to gain a theoretical and practical perspective that might challenge their current mental framework, especially if they use other theoretical lenses in their work. At the same time, I argue that Part I and each individual article make unique contributions that help to understand how teams adapt to ambiguity and uncertainty. In addition, practitioners and new scholars can extract the literature review chapter and use it as a tool to position their own work, as well as create an overview of the huge field of group studies. In this way, the review pinpoints research gaps for future work, but it can also be used to also categorize and find relevant literature, and thus stay clear of pitfalls that can arise when combining different domains. While I personally missed such a framework, I have also seen its usefulness through discussions with masters students and practitioners, who all have struggled with the various and often contradictory perspectives.

As the empirical papers stand by themselves, each of them also contributes with specific managerial implications. Reading the whole thesis, though, should give managers a holistic perspective and understanding of how to enable groups to adapt and handle changing and novel contexts. One fundamental understanding is that leaders are responsible for properly aligning the teams with their operational context. At the same time, leaders are not alone. The teammates are responsible for ensuring efficient leadership by helping the group to adapt and exploit the available contextual resources. Improving group interactions builds on the concepts of expanding the range and balance of implemented group functions, developing

the internal team-oriented shared mental models, and adjusting influencing behaviors by ensuring a collective contribution within the team. Seeking to develop collective leadership and reducing the formal leader's influence should be an overall goal. Such collective actions are important traits of teams that are able to operate with advanced dynamics and thereby handle uncertain and complex situations. It is also vital to understand whether the overall contextual organizational strategies and structures helps or hinders teams' ability to adapt.

Concentrating solely on tasks and outcomes is not enough for teams that have to handle novel and ambiguous surroundings. Instead, this thesis' findings illustrate that teams that are become able to excel through uncertainty spend significant resources on developing their internal group interactions. The cornerstone in such work is a continuous focus on mutual respect, joint curiosity, willingness to learn, room for trying out and expanding behaviors, and a collective interest in the group. Such "soft" sides of team development are in stark contrast to many of the commercialized, and popular, team building interventions used by many organizations (e.g. paintball, rafting, and ski-trips). Despite their popularity, such activities have yet to empirical proof that they help enable efficient teamwork.

Thus, enabling groups to adapt and handle uncertainty does not have to be a costly in monetary terms. Instead, leaders should allocate time and room for fruitful discussions, reviews and planning, all aimed towards a collective shared purpose of developing the teams. This means that improving group interactions relies on a continuous longitudinal focus, which can be mentally demanding, frustrating and not necessarily a fun process in itself. Nevertheless, such "soft" processes help to advance the interaction patterns that are needed to innovate and handle uncertainty. In the end, being a part of a team that can turn the impossible into the possible should be a highly rewarding task for most frontline teammates.

7.2 Further work

While I argue that this thesis provide some steps towards demystifying the secrets that cover team interactions, there are several possibilities for advances. One possible direction is to target the limitations and suggestions for further research found in each paper. Another possible direction is follow up the unanswered gaps from the literature review. Also, the sociometic badges, or similar innovative sensor technologies, provide an open field for ambitious scholars (see Keyton, 2016). While developing such equipment seems demanding, my discussions illustrate that this work can become highly rewarding for the ones who dare to invest and pursue this option.

There are also other research gaps that should be pursued. Research on contextual impact deserves more attention. If the research community could develop and agree on frameworks that help to understand various contexts, including environments that can change promptly, this would certainly help to set the stage for more generalization and rapid theoretical development.

Two other, broad and underdeveloped, topics are virtual collaboration and multicultural teamwork. In their basic nature, I claim that these topics hold no different demands than the groups I have studied. Nevertheless, at the same time, the usage of video technology can hamper the ability to catch teammates' verbal and non-verbal communication. Communicating through a screen might hamper the ability to advance group dynamics towards a high LoP, as the interactions become more static and mechanical. While "normal" groups can facilitate several rapid interactions synchronously, using a video screen usually forces one single person to communicate at a time. Researchers who pursue this field should try to include the latest technological trends, as well as investigate different contexts. Multicultural groups provide several possibilities, and multinational companies make possible interesting studies in this domain. My personal experience from the project "Operational Leadership" is that aspects around multinational teams are hot topics in the industry, creating several possibilities for theoretical advances.

As teamwork is such a huge part of our life, from early kindergarten and playgrounds to complex work settings, there are many other "non-frontline" team studies that have huge potential for future advances. As an example, understanding more of how positive or negative experience with teamwork in preschools and universities influence individuals, teams, organizations and societies should be an interesting study. Senor and Singer (2009) claim that the extensive team training conducted in the mandatory Israeli military service helped the country to become an innovative hot-spot. Similar ideas could be tested out by approaching various schools with smart longitudinal research designs, and investigating the impact of teamwork experience over time.

Our research group has several papers that address various aspects of these topics. The work I am involved in looks into topics such as: the use and development of sociometric badges; decision making under extreme pressure; efficient team leadership in the frontline of war, different aspects of team dynamics in top management teams and how these teams influence the organization, including teamwork and organizational changes, multinational teams, including Norwegian and South-Korean participants, as well as Norwegian and Polish, Russian and Indian collaborations. In addition, I have quite a lot of data from different types

of projects; one of the project failed dramatically and cost the organization more than a billion NOK. The natural overall goal is that this work, in the not too distant future, can utilize these various aspects of team research to create validated practical theories.

7.3 Conclusion

Team leaders are responsible for facilitating the team dynamics that are necessary to excel through uncertainty and ambiguous tasks. The team leader must therefore help the team to understand when it should, or when it should not, follow formal routines and processes. The leader, however, is not an island. Efficient team adaption depends on a collective responsibly that ensures that the team exploits all available contextual resources. This requires teammates to utilize the whole range of their behavioral repertory, while simultaneously pushing, or holding, back personal influence in order to enable every member to contribute equally with unique knowledge and skills. Enabling such behaviors is not straightforward, and requires a will to develop imprinted dynamics and perceptions, as well as continuous training in order to maintain the advancements. Fundamentally, gaining deep knowledge, building respect and showing interest and willingness to learn are all vital activities in order to succeed with this process, and can require severe investments in mental efforts and time.

Working with the frontline teams alone is not enough to ensure high performance when chaos arise. Team leaders must ensure that the overall operational purpose is deeply understood between all members, which includes tailoring organizational strategies and practices towards operational efficiency. This includes decentralization of leadership and enabling leaders to use a philosophy that enhances more than the single authoritarian leader. In addition, the organizations must create room for planning, discussions, and reviews of all task- and team related aspects. Importantly, the structures must also facilitate some levels transparency between the teams, and thereby creating space that ensure interteam collaborations. For teams that operate within uncertain and ambiguous contexts the ability to utilize every available resource can represent the difference between successful innovative solutions or failure with potentially deadly outcomes.

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Part II: The Articles

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Article 1:

Facing Uncertainty: Developing Adaptable Teams

Submitted to Work.

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Abstract

BACKGROUND: The Royal Norwegian Naval Academy wishes to increase their understanding of efficient teambuilding interventions.

OBJECTIVE: The purpose of the work is to understand how to enable teams to adapt and excel through uncertainty.

METHODS: We use mixed methods and follow four teams of naval cadets through an 11-week teambuilding exercise. The intervention is a transatlantic crossing onboard the sailboat Statsraad Lehmkuhl, aimed to educate cadets various topics around teamwork and complex marine environments.

RESULTS: Three of the teams were able to develop their interactions and thereof display a broader behavioral specter. The fourth team did not experience such development, in spite of attending the same journey. Thus, the teams that developed were willing to invest time in team related aspects in addition to their operational tasks. In contrast, the fourth team, which failed to develop, did not spend time on such "soft topics" and focused mainly upon their operational tasks.

CONCLUSIONS: Teambuilding should be tailor-made to the specific purpose and context of the team, as each team has unique behavioral challenges to overcome. Teambuilding interventions can truly be mentally demanding, while this study suggests that they do not need to be costly.

Keywords: teambuilding, team development, team dynamics, group functions, uncertainty

1. Introduction

The increased application of team-based work structures has fueled the quest to better understand how successful teams can be efficiently trained and developed [1-4]. Teambuilding is an instructional strategy intended to enhance team performance, yet its design seldom reflects its outcome. Despite scholars' increasing attention to this matter, they have had only limited success in showing a positive relationship between teambuilding and team performance [5-7]. Notably, the teambuilding literature tends to comprehend several different perspectives and aspects, and therefore apply an inconsistent definition of the term [see 2, 5, 6, 8, 9-12]. Sjøvold [13] defines teambuilding as "long-term, systematic, and goal-oriented tasks, focusing upon normal work tasks in a relevant context, in which the purpose is to improve a team's performance so that it can meet the demands of its surroundings" (p.71),

which we apply as it focus explicitly on enabling teams to efficiently maneuverer in their normal environments.

We study teams of Norwegian naval cadets that perform their operations in settings characterized by shifting goals and high levels of stress, complexity, and uncertainty. These factors impose stringent demands on the teams' ability to innovate within changing circumstances, and that the teams' performance depends upon their adaptability. Thus, we ask: *what are the essential factors in order to create teams that are able to uphold high performance in a dynamic and complex operational context.*

Sjøvold [14] divides teambuilding into *team training* and *team development*. The *training* interventions focus on upholding familiar behavior patterns within the team, and therefore relates to repeating and drilling on familiar tasks for the sake of increased efficiency. Team *development* exercises, on the other hand, aims to expand team members' repertoire of behavior, thus enabling the team to become adaptable and capable of innovating and handling uncertainty. It follows that teambuilding intervention designs must be tailor-made and realistic, and in order to target distinctive team processes, one needs to acknowledge the complex and dynamic nature of teams [15]. The distinction between training and development is useful in order to grasp different aspects of the team development intervention. However, the naval cadet teams needed both kinds of exercises in order to enable high performance [16]. While their ability to adapt is vital for high performance, they do operate with considerable periods of more straightforward and stable tasks and contexts. In such, being able to shift their interaction patterns as a dynamic entity, in order to cope with the context, is vital for success.

We use mixed methods to evaluate four naval cadet teams' development over an 11-week live exercise at the Royal Norwegian Naval Academy (RNoNA). Our findings indicate that continuous focus on internal dynamics help teams to become flexible, and thus able to innovate in order to excel in uncertain and chaotic circumstances.

2. Group dynamics and development

We define a group or a team as "three or more people who share a common goal and interact to achieve this goal" [17]. The notion of "three or more" is important due to the change in complexity when expanding a dyad to a triad [18]; RNoNA teams seldom operate as dyads.

Naval military teams operate in a context in which their mission and purpose might seem relatively straightforward. Stability and predictability, however, is not persistent. The

naval military teams form the point of the spear in the Navy, and operate in a context that can change dramatically, Examples of relevant contextual elements include technological failures, natural forces, laws and regulations, or unexpected events that affect the teams directly or indirectly through their allied forces. Due to this complexity, the teams can rarely pinpoint a definite answer for the best solution in their operations. Instead, they maneuver with perceptions of 60-90% of what they believe is optimal and resolve further complications as they arise [19]. Due to this, naval groups should behave as an *innovative team*, which is "capable of interacting in a way that enables them to use technology in new ways, even during complex situations complicated by mental pressure and uncertainty". This definition advances those often used to describe extraordinary teams or teams involved in various high risk operations [e.g. 20, 21-23], as it emphasizes the idea of performance in a dynamic context [see 24, 25-27]. The capability to learn, adapt, and innovate on the spot [28, 29] constitutes the core of an innovative team, as these teams must continuously adjust their interactions and solve problems as they arise.

Group dynamics, defined as the constant shift in polarization among sub-groups or individuals in the group [30-32], must adapt to the situation at hand for the team to be effective. When performing familiar tasks in stable contexts, less complex dynamics are required. Whereas situations characterized by chaos and demands for novelty and high-quality communication, require more advanced dynamics. The concept of four *group functions* is well documented, though under different labels, by several researchers [e.g. 26, 31, 32, 33, 34-42]. Sjøvold draws in this previous work and labels the group functions as: *control, nurture, opposition, and loyalty* [4, 13, 14, 17, 43, 44]. The *control* function, which allocates team assets and clarifies goals, is supported by active, analytical, task-oriented, and autocratic behaviors; the *nurture* function, which creates the group identify, involves active, caring, empathic, and spontaneous behavior. The *opposition* function triggers the team's corrective activities, and is maintained by active, critical, assertive, and self-sufficient behavior; the *loyalty* function sustains the group norms and is displayed by passive, conforming, and obedient behavior.

The extent to which a team member is able to display behavior supporting each of the four group functions emerge from what they feel comfortable with [45]. If group members have strong expectations of another person's behavior, they often unconsciously adjust their actions to reinforce the expected behavior. Ergo, the individual's behavioral preference can become a self-fulfilling prophecy, and hence lead to expectations of stereotypical behavior

from the group members [46-48]. Members of teams with less advanced dynamics tend to limit their behavior to social roles supporting specific group functions, establishing dysfunctional dynamics that are hard to change [49-52]. Indeed, such limitations within the RNoNA teams will hamper their ability to adapt and maintain high performance during changing conditions [16].

Instead, the RNoNA teams should be able to overcome any fixed role-structure so that all team-members are able to support each group function when needed. Hence, the concept of splitting teambuilding into development and training is salient. The RNoNA teams must *develop* their group functions in order to become adaptable and aligned with the context, but also *train* to maintain the acquired dynamics, while continuing to train on basic drill and procedures. For the RNoNA groups, such teambuilding includes a vast amount of repeatable drills in stable environments, as well as frequent and sudden exposure to uncertainty, in order to ensure high performance in various contexts. This paper aims to shed light on how such teambuilding affect the performance within a naval cadet team intervention.

3. Method

We applied an *embedded, single-case design* [53], in cooperation with RNoNA, which was investigated using both quantitative and qualitative methods.

3.1 Case description

The data were collected from four naval cadet teams attending the RNoNA teambuilding exercise, *Magellan*, in 2014. Magellan is a transatlantic crossing exercise, which plays out over 11 weeks on a three-masted, square rigged barque with the objective of educating cadets on the topics of team development, seamanship and leadership under demanding maritime conditions. Only some of the cadets had experience with sailboats and none with sailing a big ship such as Statsraad Lehmkuhl. The ship was stripped of any high technology equipment, which makes cooperation and shared responsibility imperative to ensure a successful crossing. This setting gives the cadets extensive leeway to execute their tasks, based on their self-interpretation of current circumstances. This implies that a detailed blueprint for what represents a success or failure is non-existent. Furthermore, this intervention embraces the idea of team training, as well as development. There are several daily routines and tasks that need to be executed efficiently, but at the same time, the teams operate with high levels of uncertainty and the requirements can change instantly, which requires the teams to display a wide spectrum of group functions in order to adapt. Such demanding exercises will often lead

to changes in team dynamics [16, 17], and RNoNA bases its educational program on the understanding of social interaction processes.

The RNoNA staff acted as external resources, trying to help the teams to facilitate discussions that could help to uncover latent disagreements, implicit perceptions and barriers to team development. These discussions included making deeply hidden attitudes more explicit [see 54], as well as enabling teammates to efficiently interpret nonverbal behaviors [see 3, 55, 56]. This means that discussions and instructions were given directly to the teammates. To illustrate, a member showing only interest in tasks, and displaying merely controlling behaviors will be told to try out new roles, and the team is at the same time asked to help this member to display such behaviors. At the same time, overactive members are told to create room for others, and inactive members are told to crave more space. Further, the instructors helped to facilitate discussions to help teammates gaining deeper insights and understanding in each other's behaviors and perceptions, and by this opening up for a broader specter of group functions. Such discussions were not limited to action debriefs, but were implemented throughout the entire process of planning, executing, and reviewing tasks. Importantly, the cadet teams were in charge of solving the mission, while the instructors focused on setting the overall stage, as well as giving feedback in order to help the teams to develop through the exercise.

3.2 Participants

This study involved a total of four teams, with eight members in each (age range = 20 - 27). The participants included both female (F=6) and male (M=26) cadets with a military service backgrounds that ranged from one to eight years, and ranks ranging from Sub-Lieutenant to Lieutenant. These teams established a military quarter on board the vessel. The quarter divided the 24-hour day among themselves into four shifts, depending upon the tasks they had in front of them. There were also other teams on board, creating other quarters and focusing on separate tasks. For instance, if our focal teams were in charge of sailing and navigating, other teams cleaned and prepared food. The four teams were analyzed in fine-grained detail, based on interviews and surveys that achieved a response rate of 100%. Prior to the study, they had been training as intact teams for two months. RNoNA staff functioned as facilitators, subject matter experts (SMEs), educators, and instructors throughout the entire exercise. The staff were all officers in the Norwegian Navy, with military ranks ranging from Sub-Lieutenant to Commander.

3.3 Data Collection

3.3.1 Qualitative data

Before the exercise, we had three initial meetings with a subject matter expert (SME) to understand the context and discuss the research topic. In addition, we conducted six in-depth interviews from the Magellan exercise. These interviews were aimed towards interpreting the quantitative data, and gaining a deeper understanding of the results. The interviews involved two instructors ($I_{i,}$ (i = 1,2)) and one cadet (C_j (j = 1,…,4)) from each of the four teams. The interviews used a semi-structured format, and ranged from 0.25 to 0.5 hrs. We had a twofold purpose in conducting the interviews. *First*, we wanted to obtain what Smith, Flowers [57] describe as a phenomenological understanding of the interviewees' subjective perceptions of the topic, thereby drawing on the interpretive traditions within qualitative research. *Second*, the interviews were considered an essential step in placing the quantitative results in their social and cultural, as well as theoretical, context [58]. Interviewees were asked questions about their thoughts on aspects such as team leadership, team development, and advanced team dynamics, as well as team-specific questions such as why they thought their teams developed as they did over the course of the exercise. The interviews were recorded, transcribed and categorized, and all informant identifications were coded in order to ensure anonymity.

3.3.2 Quantitative data

The quantitative data were gathered using the Systematizing the Person-Group Relation (SPGR) instrument; which is a method with strong construct and predictive validity with regard to the analysis of team dynamics [44, 59]. The present study is based on self and peer ratings using the standard SPGR 24-item behavior scale, in which each item asks the respondent to provide ratings according (0,1,2) to whether he/she perceives a specific behavior to have *never or seldom occurred* (0), *sometimes occurred* (1), or *often or always occurred* (2). In such, the survey captures how respondents actually understand their own and each other's behaviors, and the unique algorithms constructs the quantitative results [44, 59]. Participants responded three times during the exercise: at the beginning, approximately halfway through, and upon completion. The four group functions represents poles in two of the underlying dimensions in SPGR: Control-Nurture (C-N) and Opposition-Dependence (O-D) [43]. Each of the poles consists of two vector as explained in Table 1 [4, 13, 14].

Table 1

The SPGR Behavior Vectors

Behavioral vector	Code	Typical behavior
Ruling	C1	Controlling, autocratic, attentive to rules and procedures
Task-Orientation	C2	Analytical, task-oriented, conforming
Caring	N1	Taking care of others, attentive to relations
Creativity	N2	Creative, spontaneous, emotional
Criticism	O1	Critical, opposing
Assertiveness	O2	Assertive, self-sufficient, blunt
Loyalty	D1	Loyal, obedient, conforming, dutiful
Acceptance	D2	Passive, acceptance of the group

From a third SPGR dimension; Reservation-Innovation we extracted what we labelled the *energy* score of the groups. Energy is a measure of group behavior supporting engagement, and constructive team-work. We also we extracted a measure called *polarization* which represents the degree of subgroup-formation versus cohesion. Lastly, we use the standard deviation of dominant behavior expressed in the team, which is labelled *influence.* High levels of influence indicate an uneven distribution of dominance and influence in the team.

4. Results

Table 2 displays the average results of how the four naval cadet teams described their *group functions*, *energy* scores, and *polarization* values at the start, half-way and the end of the exercise. A two-way paired t-test documents that Team 1 went through a negative development, while Team 2, 3, and 4 experienced a positive evolution through the journey. In Table 2, the *group functions* use a scale from 1-9, where 1 is the minimum and 9 is the maximum score, while *energy* is rated on a scale from 1-9, with 1 as the lowest and 9 the highest level. The *polarization* values typically range from 1-8 where low scores document low levels of polarization (sub-group formations). Finally, *influence*, typically ranging from (0.8-5) illustrates the distribution of dominance in the group. Hence, low levels indicate equal dominance among teammates, and high levels document skewed distribution of dominance.

Table 2

Average self-evaluation of the basic group functions, energy, polarization and standard deviation of dominance within the different navel cadet teams

	Team 1			Team 2			Team 3			Team 4		
	Start	Half-way	End	Start	Half-way	End	Start	Half-way	End	Start	Half-way	End
Control												
C1	3.69	3.89	3.39	4.14	5.02	4.70	4.97	4.90	4.32	4.97	4.45	4.45
C2	6.83	5.90	6.26*	6.35	6.26	7.03**	5.83	6.08	6.08	6.22	7.41	7.59***
Nurture												
N1	6.92	5.60	6.60	6.67	6.60	7.53**	5.45	5.70	6.35**	7.16	7.50	8.16**
N2	1.45	1.58	1.42	2.08	2.58	1.58	1.45	1.45	0.38***	2.06	1.49	2.06
Opposition												
O1	0.95	1.45	1.18	2.46	2.37	2.37	2.46	2.46	2.08	2.64	2.33	2.06*
O2	3.71	2.15	2.21***	4.41	3.57	2.55***	3.19	2.64	2.06***	3.39	2.21	2.64*
Dependence												
D1	6.92	6.60	6.60	7.21	6.64	7.35	5.72	6.17	6.89***	6.78	6.85	6.50
D2	7.41	6.89	7.64	7.07	7.73	8.59***	5.02	6.10	7.10***	7.07	7.48	8.05***
Energy	4.17	3.67	3.64	4.06	4.13	6.33***	4.42	4.52	5.42***	4.44	5.66	6.25***
Polarization	2.83	2.76	3.71	4.02	3.81	2.59	3.23	2.95	2.19	3.99	2.41	2.14
Influence	1.97	2.28	1.91	3.31	2.96	1.91	2.91	2.66	2.07	2.58	1.28	1.16

Note. *p=.05; **p=.01; ***p=.001

4.1 Team 1

The team displays a negative development in six behavioral vectors, whereas two of them, C2 and O2, are significant at the end of the trip. This means that the group-members have decreased their ability to use analytic and task-oriented behavior, and are less assertive and less able to raise their voice. In addition, while not being significant, their energy decreased through the voyage. While starting energy that were similar to those of the rest of the quarter, Team 1 ended with significantly lower scores than the other teams at the end of the journey. The polarization values illustrate a similar negative trend, which means that the team operates with less advanced dynamics with a more fixed role-structure. In addition, the low influence value, which is quite static through the journey, indicate that the power is relatively evenly distributed within the team. Seen together, the values in group functions, energy, polarization and influence document a group with high polarization and relatively few efforts towards advancing the group's performance.

C_1 confirms that this team did not experience development: "*This group is extremely dependent on personal penchants. Some normally lead the discussions, some bring out new ideas, some are more restricted, and some take on a nurture role. People usually hold the*

same position in the group". Furthermore, C_1 claims that there were typically two or three individuals that took charge and initiative when the situation called for it. This claim also echoes I_1, who posits that some groups struggle with the existence of an individualistic attitude, which relates to focusing too much on the task, thus also neglecting the focus on other parts within the team dynamics. Quizzed about how the team handled unforeseen situations, C_1 stressed that the group struggled with suboptimal communication: "*The communication is poor; we are not on the same wavelength and disagree with our purpose as well as we hold a different situational understanding. As a consequence, we cannot agree upon how to solve the assignment at hand*." Nevertheless, it is argued that the team manages to remain dedicated to their tasks while they also try to provide alternative solutions to given problems. The latter, accordingly, is an attribute given to a single individual in the team, which is also described as the supporting beam in the team's operations. Notably, C_1 explains that the low focus on alternative team performance attributes, such as creating and maintaining good relationships, results from a lack of genuine interest in one another, as well as a general idea of that such effort will not be worthwhile.

I_2 suggests that Team 1's negative development may be related to several reasons that include a poor fit among group members, experience with teamwork before the exercise, or simply that the team comprises late bloomers. The latter is explained from I_2 as "initial struggles." Such early struggles give a few teams a learning curve that is extraordinarily steep; so when they finally "crack the code," their group dynamics will change dramatically. However, I_2 highlights that such development is seldom seen without the instructors' help and interference, and the progress can be highly mentally demanding for the involved team. Altogether, the findings document that Team 1 failed to develop its group functions, and operated with less advanced dynamics throughout the voyage.

4.2 Team 2

At the end of the voyage, Team 2 showed that they had improved their score on five group vectors, with three significant positive findings in C2, N1 and D2, while O2 had a significant decrease. This means that the team focused more on setting the direction through analytic, task-orientation, while also being able to take care of their teammates through the end of the intervention. In addition, while showing more accepting and trustful behaviors, they also decreased their ability to activate opposition behaviors through less assertiveness. The energy level in the group increased, while the polarization and the influence values decreased, meaning that the quality and speed of the group functions shifted toward greater

efficiency among all the members by the end of the journey, thus resulting in advanced dynamics. This evolution is linked to several incidents, C_2 explains "*During the hurricane, two of our members became seasick. We handled this by laughing, and I feel that episode tightened us as a group. Likewise, we were assigned extensive amounts of work towards the end of the exercise, thereby forcing us to choose our course of action. As we were faithful to the team's choices and decisions, this also forced us to become more cohesive*." Outside observers of this team describe the most prominent sign of development advanced dynamics by noticing that they started eating their dinners together.

The interviews revealed that some teammates tended to stick to specific group functions. This is attributed to preponderant behavior patterns, while the exercise helped these persons try out new social roles when required. The findings illustrate that teammates who demanded a lot of space in the team were able to step back, and create room for more restricted teammates to show a wider spectrum of group functions. C_2 suggests that this was a result of guidance from instructors. I_1 confirms this, and explains that this is a common advice in order to accommodate the problem of team members who act like "bulls in a china shop." Being able to make room to activate all of the teammates' group functions is seen as a result of their communication development, and I_1 explains this by: "(...) *when someone brings up a suggestion and I don't agree with it, I choose to emphasize the parts of the suggestion that I find feasible – rather than immediately attacking and thereby also cutting the legs off of it. Hence, everyone is allowed to feel that they contributing. I believe we all increased our abilities to display such attitudes*."

The team's ability to stay proactive in order to tackle unforeseen events is contingent upon having the leeway to work with their group functions. At the same time, developing and implementing such practices is not straight-forward and misunderstandings tend to happen, implying that team members sometimes interpret each other differently, and might perceive the situation differently. The voyage, however, has helped them reduce these failures, as they have been able to advance their group dynamics through a wider usage of their group functions and higher energy. Nonetheless, the findings also show that there are elements in their dynamics that restrict this team from operating as an innovative team, but their development is on the correct course.

4.3 Team 3

As displayed, Team 3 went through some positive development through the exercise. The group expanded the range in four vectors, whereas N1, D1 and D2 are significant

changes. At the same time, the ranges of N2 and O2 have declined. This means that the team has a higher collective orientation, and displays more passive and conforming behaviors, and that it is showing less assertive and critical behavior. Table 2 also show that the team has increased their energy, and lowered their polarization values and influence scores, meaning that the interaction patterns are more efficient and the dominance within the group has become more distributed. This positive development is explained by the team members' open and honest ways of communicating, as well as a genuine interest in each others' personal development. Also, C_3 argues that the team invested considerable effort in maintaining healthy relationships: "*We arranged private conversations with teammates in order to get to know each other better. These meetings, which revolved around team members' private matters, usually lasted about half an hour, and we talked to a new person every day. Socialization was highly important for us*". I_2 highlights that this genuine interest in understanding each other was essential to the team's ability to perform well during the stormy conditions in the Atlantic Ocean.

The interviews displayed that three to four team members were more influential than the others. In order to work out this issue, the team implemented a process whereby each member was assigned specific tasks according to their level of influence. As an example, one member was told to be more hesitant to allow less influential individuals to increase their presence. Such specific tasks, assigned to each individual, but shared with the group, advanced the team's development. Notably, when the team faced unforeseen events, members had a tendency to fall back into comfortable behavior patterns, despite their despite their effort and desire to display a wider range of group functions.

A part of their improvement was illustrated through the increased ability to utilize short and concise communication during stressful events, as C_3 stated: "*The total number of words has decreased - we have become quite good at this*." Altogether, the data describe a team that has advanced their group dynamics, the full usage of group functions still needs development to be able to handle pressure and uncertainty.

4.4 Team 4

The SPGR measurements document that Team 4 has significantly developed C2, N1 and D2 in a positive direction. At the same time, the group has significantly decreased both the O1 and O2 scores. This illustrates that the team has had some substantial shifts in their behaviors. From a situation in which the overall scores were relatively low, which indicates that the opposition functions were quite salient at start, the group now focuses more on their

relations and procedures with fewer critical voices. Further, they display more acceptance instead of raising critiques. The team has also significantly raised their energy during the intervention, while also substantially decreasing their internal polarizations and unequal dominance. From being a team with slow dynamics and dominating actors, the team has advanced toward a higher collective interplay by the end of the journey. While this development is extreme for the group itself, they do not differentiate themselves from Team 2 and 3 after the voyage.

This evolution is coupled closely with personal development within the team. C_4 said: "*We were encouraged to test out new social roles, and those who enhanced this challenge were rewarded with a greater development. Some seem less willing to embrace this journey due to personal attributes like shyness. Still, everyone is somehow motivated to try, and my team managed to accomplish this*." As such, it aligns with the instructors who explain that personal development and group development were tightly interlinked, as it is crucial to be curious and willing to step out of one's comfort zones to solve novel challenges. This team, accordingly, generated, and benefitted from, a high level of openness and genuine interest in helping each other to develop as a group. This is also seen through the camaraderie that evolved in the team throughout the voyage. Notwithstanding, there is still potential for further progress, especially since role structures were documented to have tendencies of being less flexible during stress and uncertainty. While discussing this topic, C_4 reasons that it is difficult to create mental changes in terms of what individuals are most comfortable with in such a short time span, albeit this is an area of focus.

In light of the distribution of behavior in the team, the group functions document a considerable positive change. C4 exemplifies the ability to adapt and use a range of group functions: *"During a storm between Cape Verde and the USA, we faced several challenges and obstacles. We had not appointed a formal leadership role, and everyone had to contribute to fill the social role functions that were needed. This role alignment was quite severe for all of the teammates, and at a point one of the crewmembers almost fell overboard because of the storm. Nonetheless the team remained efficient and confident enough to demonstrate leadership without any second-guessing. We clearly overcame a barrier - there were no longer any passive bystanders*."

The data illustrate that this group has become better at understanding each other's behaviors; as C_4 recounts: "*We arrive from different places and hold diversified experiences, but then we have developed a specific language that emerges through our team when we approach the task at hand. All of us have internalized a deeper understanding of the*

expressions that are applied. Because of this, the processes are more efficient when we work toward a common goal – team members recognize and comprehend the social role functions that are needed, and in such also how to prioritize." Based on these findings, there are indications of a group that is capable of working with the complex interplay found in an innovative team. Still, further progress is required to break out of the tendency to fall into a fixed social role structure, thus maintaining advanced group dynamics over time.

5. Discussion

For the RNoNA teams, the Magellan exercise is a teambuilding exercise that naturally incorporates both training and development. During the journey, the groups must continuously improve their performance by solving familiar routine tasks, as well as break out of the patterns as situations change and thereby adapt to uncertainty. Ideally, all of the teams would improve their ability to adapt, and thereby ensure higher performance under uncertainty and changing environments. However, one of the four teams actually decreased their ability to adapt, despite participating in the exact same exercise. Furthermore, the fourth team seems to have gone through a *relatively* larger positive development than the other teams. Notably, the results do not indicate that Team 4 is able to demonstrate higher performance than Team 2 and Team 3 after the journey. Instead, the data indicates that this group has improved from a starting point with unequal dominance, strong polarizations, and low levels of cohesion compared to other teams. This means that Team 4 had severe internal obstacles to overcome. These findings underscores the case for team-building exercises that are tailor-making for each specific group, as each group faces different behavioral challenges in increasing their performance.

Our results suggest that the teams that improved actually *developed* the range of their behavioral group functions, and thus advanced their group processes in order to maintain high performance. Yet, when facing high levels of stress and uncertainty, all of these teams reported tendencies of fall back to more routinized patterns that limited their range of behaviors. Such setbacks indicate that the teams still need *training* to maintain their newfound interaction patterns, as they fail to operate as an innovate team under difficult conditions. These findings are important, as they illustrate that proper teambuilding is not a single event [8]. Teambuilding requires focus, effort, and time in the team's normal context.

Furthermore, our findings illustrate that it is not enough to focus only on tasks, structures, individual skills, and other input factors to understand team performance. Hence, we expand the view of research domains who typically explain group performance due to

such traits [see 60, 61-65], The results indicate that highly task-oriented teams fail to develop their group interactions. Instead, the three teams that focused on social interplay advanced their ability to perform under stressful and complex conditions. By this, our work replies to scholars asking for more information about team dynamics [15, 66-67], especially by increasing the understanding of team performance in changing and uncertain contexts.

Clearly, the three teams that did develop contained members who were willing to spend time and resources, even during off-duty hours, in order to improve, as they saw personal development and team development as mutually dependent. This development was in large centered around interpreting and complying with feedback given by instructors and other teammates. Providing feedback is a cornerstone in successful team-building exercises [1, 69-71]. Importantly, the feedback should not be seen as an end in itself, but as a means by which teams are made aware of their strengths and weaknesses, allowing them to initiate appropriate actions to adjust their behaviors. As emphasized by instructors, team development does not necessarily imply friendship between A and B, but rather complete openness about individuals' strengths, weaknesses, and priorities. This openness helps to unravel implicit attitudes and knowledge, and in this way create a deeper understanding among teammates [72, 73]. Consequently, building such deep understanding is a prime element of promoting openness in a team. By combining the subconscious attitudes with the more explicit overall goals, teams can work efficiently as fully concordant [54]. The presence of such openness, in turn, allows teammates to challenge established practices, ask questions, and attempt to assume functional roles that are outside their comfort zones. Such environments and practices will help the group to develop toward being an innovative team. In our findings, the teams that were willing to improve, and so possessed such capabilities, were also the teams that achieved the most significant degree of development.

Groups often become more tightknit through time as teammates form personal ties [69, 74], and in combat units these bonds can be extremely powerful [19, 75]. The naval cadet teams had been working as intact groups before the Magellan intervention, but the journey forced them upon each other with no place to escape. Breaking established group is undoubtedly challenging. This simply indicates just how much time and effort the successful teams had to invest in order to advance their group dynamics. Importantly, for military front line teams that are exposed to combat and life threatening situations, implementing open, but often mentally stressful discussions, will aid in conflict resolution, tension release, and keeping teammates mentally balanced [69]. In fact, the team that failed to develop during the intervention did not care to invest in such mentally demanding discussions, nor did they focus

on anything other than the specific work tasks. This team's results highlight the importance of teammates' personal willingness to invest and improve their own spectrum of group functions in order to develop the whole team towards higher performance.

The instructors posited that a preponderance of cadets find it difficult to state their opinions regarding certain matters. Our quantitative findings also documented this, as all of the teams decreased their ability to utilize the opposition function through the journey. Being able to constructively criticize *and* suggest alternative solutions, however, are critical abilities in order to ensure team development [76-78]. Sjøvold [79] also argues that activating and balancing the opposition group function within the team is the hardest task, as negative individual interpretation can lead to lack of motivation and interest [80, 81]. If teammates display a limited set of group functions such negative traits can turn into locked polarizations and conflicts. It can be hard to raise a critical voice in groups without training in using constructive criticism through the opposition functions. In such situations, individuals who try to give a critique can be ignored or even thrown out of the group [77, 82]. Our findings highlight the usefulness of external facilitators to help teams in implementing this group function.

Members able to identify and perform behaviors supporting any group function when needed characterize a team with advanced group dynamics. This group ability is of pivotal importance to enhancing rapid adaptation, as well as learning and innovation [13, 16, 28, 83]. It is therefore crucial to be able to understand the purpose of the teambuilding, and help the team to align to this purpose. This means that the RNoNA teams will most likely fail if they try to improve their performances through more generic processes [see 84], or by directly comparing themselves with teams in different settings and industries [see 11, 85]. Instead, teambuilding interventions must be tailor-made to overcome both the internal and contextual challenges faced by the specific group in order to increase performance, but it does not have to be a costly practice. Motivating individuals to increase their performance by focusing upon their own and their peers' behaviors, while also creating opportunities for open discussion, seems to be cornerstones in advancing teams' capability to adapt and handle complexity.

6. Limitations and conclusions

Although the SPGR data were gathered during the journey, the main limitations are the lack of real-time observations, a limited numbers of participants and that we conducted our interviews after the intervention was finished. In addition, it would have been nice to have clear performance assessment tools [16]. However, making the tools available for everyone is

not of RNoNA's interest due to several natural reasons and we could not get such data. In addition, a broader study which incorporate several aspects of group dynamics (e.g. influence, cognitive perspectives as shared mental models and leadership) should be of high interest. However, the ability to target various topics within one paper is limited. We argue therefore that these restrictions do not only represent limitations of the present study, but also potential for future research. Although the tide of research covering team interventions in different formats has been rising, the focus on team development has been less comprehensive. We therefore call for a continued attention to team development, and thereby to the dynamics inherent in team processes. We also argue that more cross-fertilization among disciplines should exist, in order to facilitate new and improved findings. In addition, we support the call for a combined use of observation and surveys to evaluate team dynamics [59]; whereby technological developments have enabled the use of devices that capture "big data" of real-time interaction patterns [3, 67, 86].We propose that combining such technology with interviews and surveys will yield a more holistic and solid foundation to team investigations.

Creating high performance teams through teambuilding is not open to interpretation as a single task, nor as straightforward social intervention. Instead, efficient teambuilding stems from collective efforts designed to improve behavior patterns within the team. The teams that are willing to devote time and effort to understanding their teammates, while establishing an environment of curiosity, respect, and openness, seem to function more effectively than the teams that focus only on their work tasks. Furthermore, the findings also document that teambuilding is a continuous exercise. Understanding the differences between *development* and *training* is important. Development, in this regard, relates to expanding teammates' behavioral group functions in order to advance the group dynamics and is done through opening each teammates' perception and will to test new social roles. Training, on the other hand, aims to upkeep the advanced social roles and new behaviors, and is vital in order to maintain the advanced dynamics. Practitioners may find this paper interesting, as it should be possible to apply our findings and conclusions to any team's operational context. The core of the findings, creating open discussions and individual motivation to contribute, points to the advantages of keeping teams intact rather than changing personnel in the hope of improvement. This suggests that teambuilding interventions must be tightly linked to normal work settings in order to improve performance. It is therefore essential for practitioners to understand where to put focus: do the groups under consideration need training, development or both?

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Article 2:

Team Adaption: Uncovering Differences in Shared Mental Models

Submitted to Military Psychology.

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Abstract

This paper contributes to understanding how team-related shared mental models (SMMs) evolve in military cadet teams. The data stems from the first year at the Royal Norwegian Naval Academy, which prepares Norwegian naval cadets for modern maneuver warfare. By using quantitative methods that investigate teammates' perceptions of each individual's behaviors, we document that SMMs tends to be sticky and hard to change. In addition, we present a tool that helps teams to make the theoretical construct SMMs more explicit and thus assist team-related discussions tailored to increase the teams' collective understanding.

Keywords: military cadet teams, shared mental models, behaviours.

Team Adaption: Uncovering Differences in Shared Mental Models

The idea of teammates' shared mental models (SMMs) is well established as a theoretical construct within the team research domain (e.g. Badke-Schaub, Neumann, Lauche, & Mohammed, 2007; Bolstad & Endsley, 1999; Cannon-Bowers, Salas, & Converse, 1993; Espevik, 2011; Espevik, Johnsen, & Eid, 2011; Lim & Klein, 2006). SMMs refers to the level of shared knowledge within the group. Higher levels of SMMs help team members to interpret and explain the group's purposes, contexts, and behavior patterns (Healey, Vuori, & Hodgkinson, 2015; Klimoski & Mohammed, 1994; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000; Salas & Cannon-Bowers, 2001). Due to this, the level of SMMs is considered a vital performance predictor for adaption, learning, communication, innovation, and the understanding of risk (Eid, Johnsen, Bartone, & Nissestad, 2008; Espevik, 2011; Espevik et al., 2011; Espevik, Johnsen, Eid, & Thayer, 2006; Healey et al., 2015; Kolbe et al., 2014; Marks, Zaccaro, & Mathieu, 2000).

While there are several categorizations of SMMs (e.g. Cannon-Bowers et al., 1993), a predominant approach has its origins in Mathieu et al. (2000), who divided the concept into task- and team related SMMs. The task-related SMMs relate to the perception of the task itself, including how the environment and technology may influence the demands. Team-related SMMs describe the collective understanding of teammates' behaviors, attitudes, and interaction patterns.

If we can better measure how group members' understand their peers' behaviors, tasks and environments, we should also be able to better understand the interaction patterns within the team, and thus also the group's abilities to adapt to changing tasks and contexts. In addition, advancing the detailed knowledge of the teams' SMMs will help to facilitate fruitful

discussions that can help teammates to resolve misinterpretations and, by this, assist behavioral change in groups. Therefore, we ask: how do team-related SMMs develop over time?

We study teams from the Royal Norwegian Naval Academy (RNoNA). As part of RNoNA's preparation for modern maneuver warfare (see Clemons & Santamaria, 2002) and contextual demands (see Johns, 2006), they use theory, simulation, and live exercises (see Mjelde, Smith, Lunde, & Espevik, 2016). RNoNA's educational program puts stringent requirements on the participating teams to adapt and handle high levels of mental stress, uncertainty, and complexity often without knowing when and how the exercise will end. This article, with the tools presented, should valuable for all frontline teams that wish to increase their ability to adapt and ensure high performance.

Inside of Teams

Healey et al. (2015) reasons that, in order to establish efficient performance, both task-related and team-related SMMs must be shared in the group. This argument seems reasonable, but in complex settings, in which the task might change over time, we argue that individuals have unique knowledge that can increase success rates if made explicit. If a team experiences full agreement at all times in uncertain and ambiguous situations, there is reason to fear problems such as stereotyping, and self-fulfilling expectations (Brophy, 1983; Carpenter, 1995; Word, Zanna, & Cooper, 1974), groupthink (Janis, 1972, 1982) or the Not-Invented-Here syndrome (Katz & Allen, 1982). Thus, we agree with researchers who argue that understanding team-oriented SMMs is vital for team performance, especially when the tasks are novel (Cannon-Bowers et al., 1993; Marks et al., 2000; Mathieu et al., 2000; Sjøvold, 2014). It is through high levels of team-oriented SMMs that groups can establish fruitful discussions and challenge the status quo.

High degrees of SMMs do not require identical perceptions in teams. Instead, high degrees of SMMs stem from collective respect and understanding of teammates' different attitudes, viewpoints and behaviours. Thus, high levels of team-related SMMs make it possible to extract and accumulate group members' unique knowledge and, by this, broaden and challenge eventual myopic task-oriented perspectives held in the group. Although SMM is a mature construct in group-research theories, we agree with recent researchers (e.g. Mjelde et al., 2016; Uitdewilligen, Waller, & Pitariu, 2013) who argue that the concept is still open for more development.

More than 20 years ago Klimoski and Mohammed (1994) claimed that SMMs qualified as a hypothetical construct, meaning that it is more than a theoretical metaphor. They reason that SMMs are an emergent characteristic that explains team behaviours as a whole. Uitdewilligen et al. (2013) argue that the research on SMMs is limited to a static perception, with restricted understanding of the dynamic nature of SMMs and performance. We reason that these restrictions stem from the predominant methodical choices. SMMs are typically measured through respondents' perceptions of topics such as distribution of resources, situational awareness, learning, and other performance indicators (see Espevik et al., 2006; Lim & Klein, 2006; Mathieu, Rapp, Maynard, & Mangos, 2010; Mohammed, Hamilton, Tesler, Mancuso, & McNeese, 2015; Smith-Jentsch, Mathieu, & Kraiger, 2005). While these topics are *linked* to team-related SMMs, we claim that such measurement does not tap into the behavioural *core* of team-related SMMs. Instead, such methods measure various perceived outcome variables and use the variance in the answers to predict the quality of the inputs.

At the same, attributional bias, by which teammates attribute positive outcomes to internal processes and negative aspects to external forces is well-documented (see Heider, 1958; Kelley, 1967; Staw, 1981), meaning that the traditional strategy for measuring SMMs can lead to incorrect results. To illustrate, a team that experiences a stable context and straightforward operations can, due to their successful actions, rate themselves with high scores on learning. In contrast, a team that has to overcome severe obstacles due to unexpected events might rate themselves low on learning, due to mental exhaustion, and blame the external environment for their problems. However, it is arguably the latter team that has been exposed to situations that facilitate the most learning; while the former could run their operations on pure routine. Therefore, we argue that the core of team-related SMMs lies within the perceived and understood *behaviours* of individuals within groups. Focusing on behaviours, however, makes the team-related SMMs hard to grasp and discuss, especially as compared to the more tangible, or visible, task-oriented parts of this construct.

Perspectives held in the team. Enemies might have the same – or even superior – technological opportunities, or they might outnumber the RNoNA teams. Thus, preplanning is useful, but the RNoNA teams must also understand when to abandon the plan, and start to adapt and innovate to be able to move on. To utilize effective teamwork, it is essential to be able to mobilize men and resources to be flexible and reduce friction (von Clausewitz, 1989). As such, it is important to understand the implemented perspectives in the group (Hannah, Uhl-Bien, Avolio, & Cavarretta, 2009). At the same time, groups tend to develop certain

norms that guide the social interaction patterns (Sherif, 1936; Sorrels & Kelley, 1984), and these can be hard to change (Gersick & Hackman, 1990; MacNeil & Sherif, 1976; Rohrer, Baron, Hoffman, & Swander, 1954). In addition, there is often a meta-norm that teammates should not discuss their "regular" first-level norms (Hackman & Morris, 1975). Indeed, avoiding, or not discussing, certain topics can become problematic for groups operating in the extremely chaotic context of warfare, especially when implemented perspectives hinder teammates' ability to raise critical questions or bring new information into the group.

A military Special Operation Forces (SOF) operator describes how SMMs facilitate efficient teamwork when he says that he understands his teammates better than his wife, and that he knows their thoughts and how they will act before they act (see Danielsen, 2015). Through training, the SOF- teams have learned to read a range of verbal and nonverbal behaviors (see Hurley, Clark, & Kiverstein, 2008; Pentland, 2008), which helps them to excel through various complex settings. Simons (1997) explains that it is their mental capacity – not the strength and weapons - that make SOF-teams extremely adaptive. A military context can change in a split second, demanding new adaptable team behaviours to succeed (Danielsen, 2015; Mjelde et al., 2016). Hence, it is impossible to predict a definitive answer and a definitive measure of performance; it would only be theoretical, based upon knowing the opponents' interactions. Therefore, we claim that frontline warfare teams have adapted and performed as close to optimally as possible when they complete their missions without undesirable outcomes.

Behaviors and interactions. Sjøvold (1995, 2002, 2006a, 2006b, 2007, 2014) combines well-documented characteristics of group-dynamics, groups' purpose, and the operational context (e.g. Bales, 1950; Bales, 1953, 1985; Bales, Cohen, & Williamson, 1979; Bion, 1961; McGrath, 1991; Mills, 1967; Parsons, Bales, & Shils, 1953; Schutz, 1958; Tuckman, 1965) into an integrated theory. He argues that the group's actions are not merely instrumentally related to the task, but also to the transactions in building (or deconstructing) relationships within the team (Sjøvold, 1995) - an idea that correlates with the description of group dynamics as the perpetual shift between polarization and unification (Bales, 1950, 1999; Polley, 1987).

These relationship transactions frequently appear in studies of small group dynamics, and are encompassed in Sjøvold (1995) as four basic group functions, labelled *control*, *nurture*, *opposition*, and *dependence.* These group functions describe the social behaviour patterns that are exposed by the group members and help to create social roles and relationship bonds within the group. *Control*, is supported by structured, analytical and task-

oriented behaviour. *Nurture*, shows caring, socially oriented, and empathic behaviour. *Opposition*, is exhibited by behaviour that is critical and assertive; and finally, *dependence* is displayed by conformance, loyalty, and submission. Initially, these social roles arise from natural comfort zones (Hare, 2003), which again can generate predominant expectations from other members to maintain that particular group function (Likert, 1961; Merton, 1948; Word et al., 1974). Teammates deploy these group functions through a spectrum of communication patterns, both verbal and non-verbal, and the perceptions of these patterns create the teams' SMMs.

According to Sjøvold (Sjøvold, 1995, 2006a, 2014), group dynamics relate to the shifts among these four basic group functions Thus, teams must *balance* the various group functions efficiently to deal with the tasks and problems it faces. A team will therefore benefit from being able to employ all functions simultaneously, as well as to shift among the functions when the situation calls for it. An adaptable team is therefore able to utilize and change the group functions rapidly through a complex interplay by focusing on contextual demands through supportive behaviour. RNoNA approaches this through extensive focus on teamwork, which includes the ability to have intense discussions and ask critical questions when needed. Hence, it is important to understand the effects of diversified team-related. This also means that tools that can help to make these SMMs explicit or visual should be useful in facilitating fruitful discussions and deeper collective understanding within teams.

Methods

The data stems from cadets' first year at RNoNA. This year focuses especially upon developing leadership skills and establishing effective team processes, which are fundamental for efficient performance in naval military contexts. The first data collection was done early autumn 2015, the second collection in early spring 2016, and the third was done after the final live exercise *Telemakos* in June 2016. This exercise is named after Telemachus, the son of Odysseus and Penelope in Greek Mythology. Telemachus is a central character in the "Homer's Odyssey", which describes his search for news about his father and how he transforms from a boy to a man. Telemakos simulates a real mission and is the first year's final intervention. The exercise runs for one and a half weeks, and presents operational challenges under high physical and mental stress combined with a minimum of sleep and food. Telemakos creates a rapidly changing context, which involves the risk of loss and injury to personnel and materiel. The cadets engage with the exercise as a real front line operation

(see Mjelde et al., 2016). Exposing detailed information from the interventions (time-lengths, content, and so forth) might diminish the effectiveness of future exercises.

Participants

This study involved a total of 4 teams of first-year cadets at RNoNA. Each teams was comprised of 8-9 persons, (age = 21 - 30), ranging from no prior military experience to several years of military experience. There were both female (total of 7) and male (total of 29) members in all groups. In addition, we received internal performance scores from Telemakos. These scores stem from RNoNA officers, who work as subject matter experts (SMEs).

Data Collection

The quantitative data were gathered using the Systematizing the Person-Group Relationship (SPGR) instrument (Sjøvold, 2002) (response rate = 100%). This instrument has high construct and predictive validity for the analysis team dynamics (Sjøvold, 2002, 2014). The present study is based on self- and peer-ratings through the standard SPGR 24-item behaviour scale, in which each item asks the respondent to provide answers according to whether a specific behaviour occurred *never or seldom* (1), *sometimes* (2), or *often or always* (3). The members' ratings of themselves and their peers illustrate how they view each other's mental models by describing how often they notice certain behaviours in the group (see Sjøvold, 2002, 2014). SPGR is founded on a factor analytical space comprising three dimensions: Control-Nurture, Opposition-Dependence, and Withdrawal-Synergy (See (Sjøvold, 2002, 2006b, 2007). The SPGR instrument constitutes a set of analyses that are extracted from more fine-grained analyses of group typology (Sjøvold, 2002, 2007, 2014).

Average Field analysis. How teammates *perceive* each other's behaviours is displayed graphically in the Average Field analysis (see Figure 1), which is an efficient tool when investigating group dynamics (Sjøvold, 2002, 2006b, 2014). The field analyses are presented on a template composed of three sectors. Behaviours that support the "Control" group function are plotted in the upper sector, behaviours supporting "Nurture" are found in the bottom right, and finally, behaviours supporting "Opposition" are plotted in the bottom left sector.

Individual members are presented as circles of different *sizes* and *colours*. First, the *size* of the circle reveals how much influence the person perceived to hold. Second, the *colours* indicate the supported group functions. A yellow circle indicates a balanced spectrum of behaviours; a blue circle documents task-oriented and analytical behaviour; a green circle

shows friendly, informal, open, and democratic behaviour; a red circle display a critical and disputatious behaviour; a light grey circle exhibits cautious and obedient behaviour; and finally, a dark grey, small circle illustrates a person who is perceived as resigned and uninterested in the team as a whole.

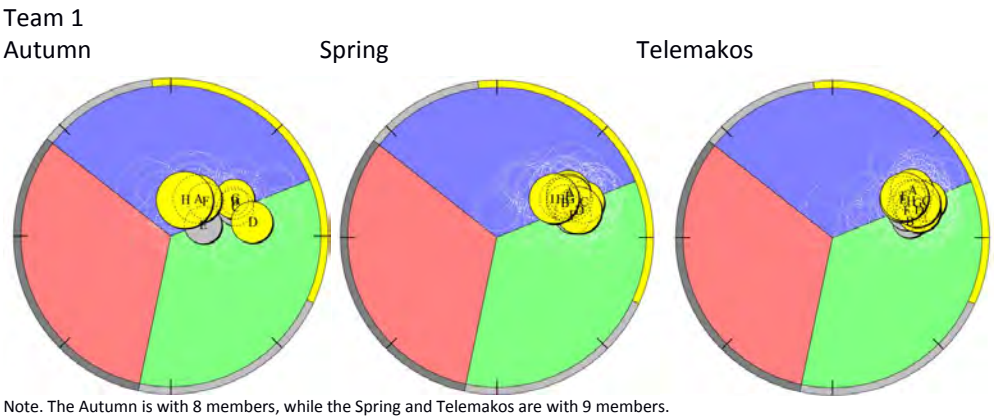
The Euclidian distance between the circles shows the relational closeness between different teammates. Hence, the field analysis documents the members' perceptions of subgroups and polarizations in the team. Furthermore, the Average Field analysis displays each individual respondent's rating as white dotted circles. Thus, the wider the dispersion of dotted circles, the more divergent the team members' mental models. Additionally, the colours in the periphery delimit sectors of behaviour that hold information regarding the team's interplay. First, the yellow border encapsulates an area that supports constructive and goal-oriented teamwork; second, the light grey border describes behaviour that is sometimes necessary but, in excessive amounts, is damaging for the team; and finally, the dark grey border indicates behaviour that restricts constructive teamwork.

Results

Average Field Analysis

Figure 1 presents the Average Field analysis from the four teams, and illustrates how the teammates perceive each other's behaviors in the early autumn, early spring, and after Telemakos.

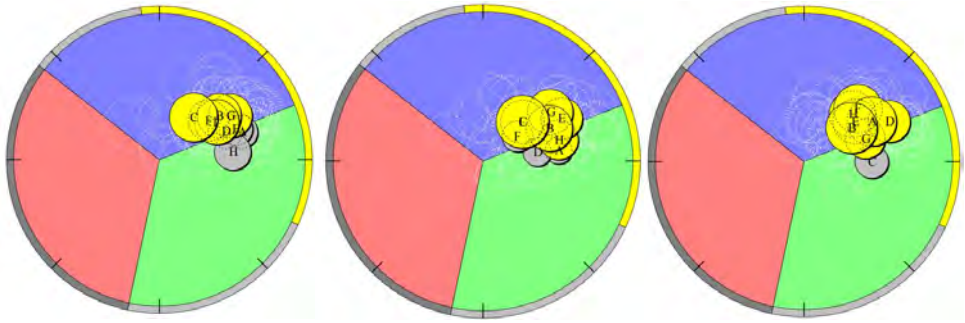
Figure 1



Note. The Autumn is with 8 members, while the Spring and Telemakos are with 9 members.

Team 2

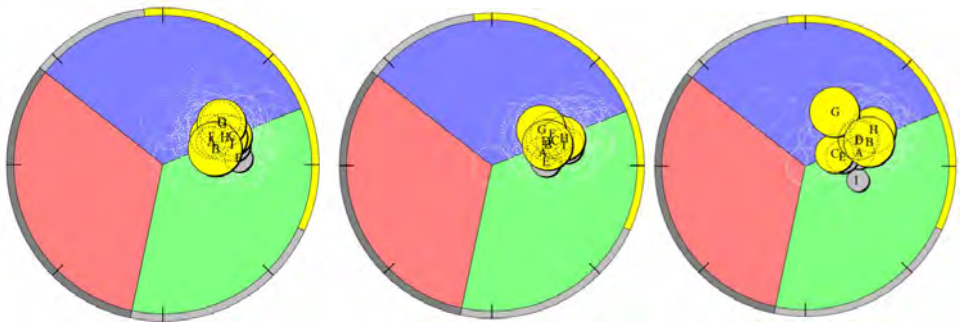
Autumn Spring Telemakos



Note. The Autumn and Spring are with 9 members, while Telemakos is with 8 members.

Team 3

Autumn Spring Telemakos



Team 4

Autumn Spring Telemakos

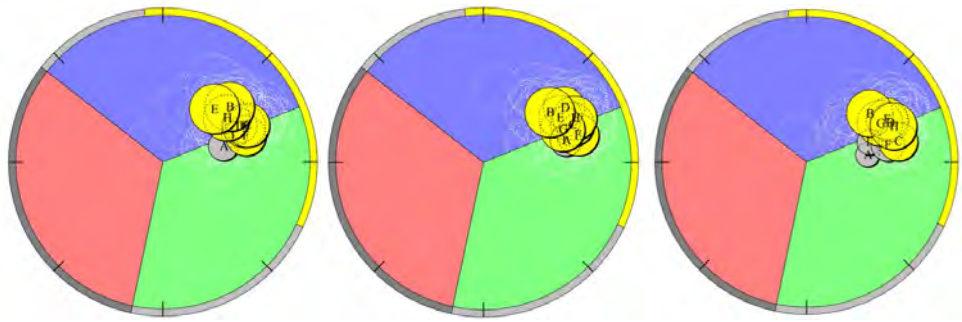


Figure 1: The Average Field analysis of the four cadet teams, showing how their internal SMMs evolves through the first year at RNoNA.

Team 1. In the autumn, the team describes themselves as relatively clustered around the middle of the diagram, and towards the border that indicate productive teamwork. The members B, C, and E are seen as obedient and less influential in the team, while H is

influencing through rather authoritarian and critical actions, but is still able to balance the behaviours. The rest of the members are perceived with rather equal influence and balanced behaviours. Looking at the individual answers, the diagram illustrate that the teammates held unaligned SMMs.

The next two measurements are with 9 members, and the shift starts with member E. That is, old E is now F, F becomes G and so on. In the spring, the teammates have changed their internal perceptions, by moving their scores more into the zone for supportive teamwork. B and F (old E) are seen as passive and dependent, while the rest balance their behaviours. I (old H) demands considerably less space than before, and has started to show more nurturing than critical behaviours. As in the first measurement, the teammates held divergent perceptions of internal behaviours.

After Telemakos, the team continues to behave as highly cohesive within the area of constructive teamwork. B and F are still seen as obedient, while the rest of the members show balanced behaviours and quiet influence. The individual answers, however, remain divergent, meaning that the internal SMMs are not aligned. When comparing the three measurements, the team has developed positively through the year, as they are more cohesive and share influence. However, the team's divergent SMMs are salient through the whole year.

Team 2. The autumn measurement illustrates a quite cohesive team with productive team processes. C is the most influential and critical member, while A, D, E, and H are seen as obedient. The rest of the teammates balance their behaviours through relatively equal influence. In addition, the individual answers demonstrate unaligned SMMs.

Spring measurements show that the group has gone through a few changes. The team's perceived behaviours lay more within the constructive zone. A, D and F behave obediently, while the rest of the team balances their behaviours, but with more distributed influence than at the first measurement. As in the autumn, the teammates perceive each other through divergent internal perceptions.

Notably, the original member A is not a part of the Telemakos measurement, meaning that all members change their name; the previous B is now A, the earlier C is now B, and so on. This measurement display a more cohesive team than in second measurement, with more diversified influence. Member C (previously D) is still seen as passive and obedient, while the rest balance their behaviours. The teammates' individual answers are still spread, inducing unaligned SMMs in the group. Team 2 has developed in a positive way through the year. While their internal perceptions did not evolve much from autumn to spring, the teammates displayed a positive development after Telemakos. Thus, the teammates seem to have more

equal influence, with one passive member and seven members able to balance their behaviours. In addition, the whole group has moved more into the constructive zone. At the same time, the individual answers indicate unaligned SMMs through the whole year.

***Team 3*.** The autumn data illustrates a rather cohesive team within the constructive area. Teammates holds various levels of influence, while B demands most space and A, E and I are passive and obedient attendants. The rest of the members balance their behaviours, while the individual answers demonstrate unaligned SMMs.

In the second measurement, the team describes themselves more or less the same way as earlier. There are a few changes though; the individuals are slightly more equal in influence, while A, C, D, E, and I are seen as passive and obedient. As in the first measurement, the group members describe each other's behaviours through divergent perceptions.

Telemakos changes the internal perceptions in Team 3. The group moves slightly towards the centre of the diagram, meaning that they display behaviours that are more critical. B and G are the most influential actors, while the rest of the members show diversified levels of influence. A, E and I are seen as passive actors, while member I is seen as starting to become a satellite outside of the core of the group. In this team, the relational distance between G and I has become salient and, with the difference in influence, this suggests that these two do not collaborate effectively. Teammates' individual answers, the SMMs, continue to be divergent.

***Team 4*.** The first data set shows a quite cohesive team within the productive yellow area. While most of the group balances their behaviours, A, D and I are perceived as passive and obedient. Further, the individuals' influence varies within the group, and their specific answers are rather divergent. As such, the teammates have unaligned SMMs.

Next, the spring shows a slightly more cohesive team than in the first measurement, whereas the influence is also more distributed. The members A and I are still seen as obedient, while the rest balance their behaviours. Individuals' specific answers still indicate unaligned SMMs in the group.

The third measurement, Telemakos, indicates a less cohesive team than before. A, F and I are now described as obedient and the rest of the members hold highly unequal influence. While still being in the constructive area, the individual answers still show unequal SMMs. Team 4 has gone through minor internal behavioural changes during the first year. While they had a positive development from the first to the second measurement, the third diagram illustrates a return the old behavioural from the autumn.

Quantitative Results

Table 1 presents the quantitative measurement of SMM-values, polarization values and influence values in the teams from the autumn, spring and Telemakos. SMM values, typically ranging from 1-5, indicate whether or not the group members have divergent perceptions of social roles (low scores) consistent perceptions (high scores). The polarization values, with a typical range from 1-8, reveal eventual subgroups or persons operating as satellites outside of the core of the team. Thus, the polarization values also indicate the level of cohesion in the team, where low scores describe low levels of polarization and higher levels of cohesion and vice versa. Lastly, the influence values, typically ranging from 0.8-5, describe the distribution of influence in teams, with low scores indicating equal distribution and high scores indicating unequal distribution (Sjøvold, 2002). Importantly, these three value-ranges originate from similar front line operational teams, meaning that they are not necessarily similar for other contexts. In addition, Table 1 shows the overall internal SME scores from Telemakos. These performance scores range from 1-7 (unsatisfactory to exceptional performance) with 4 indicating "expected performance".

Table 1

Measurement of team-related SMMs, polarization, influence from the early autumn, early spring and after Telemakos, and overall score from Telemakos

	Autumn			Spring			Telemakos			
Team	SMM	Polarization	Influence	SMM	Polarization	Influence	SMM	Polarization	Influence	Score
1	2.76	3.34	3.52	2.59	1.49	1.85	2.61	1.55	1.90	4.01
2	3.09	2.53	2.36	3.07	3.18	3.65	3.01	2.60	2.38	4.,83
3	2.77	2.80	3.60	2.39	2.71	3.35	2.71	3.66	4.09	4.49
4	2.79	3.04	3.48	2.54	2.32	2.50	2.55	3.26	3.62	4.29

Table 1 supports the visual findings in Figure 1, showing that the groups' changes stem from their perception of polarization- and influence scores, while the SMMs values are quite stable through all measurements. This means that the teammates describe the usage of group functions differently, but they seem to agree upon internal changes in polarizations and influences. These behavioral traits, however, are probably easier for teammates to see and describe as they change. Additionally, the SMEs' performance ratings indicate that the four teams received scores near 4 on all indicators from Telemakos.

Discussion

To excel through the brutality of frontline warfare the RNoNA groups must be able to exploit and combine the unique knowledge possessed by individuals. However, teammates tend to spend far more time discussing common information, and thereby pay less attention to unique inputs (see Kozlowski, Chao, Chang, & Fernandez, 2015). Thus, small contextual abnormalities are often ignored, which is alarming as they can escalate and inflict serious harm (Cannon & Edmondson, 2005). This makes the ability to read teammates' behaviors and efficiently utilize relevant group functions crucial, as this will facilitate team dynamics that ensure high performance. Clearly, the ability and possibility to question and efficiently challenge the perspectives presented in the group are essential when uncertainty and ambiguity arise. Developing, and establishing high levels of SMMs, however, is not easy. The studied teams have been intact since they started at RNoNA in the autumn more than 9 months before Telemakos. This means that they have gone through several interventions in order to develop. While the perceptions of polarizations and influence changed during the year in all teams, the teammates' viewpoint of internal behavioral group functions, or the teams' SMMs, stayed rather stable through the year.

The teams consists of 8-9 members. This means that developing high degrees of team-related SMMs is demanding, as everyone has to establish a deep understanding of each other. Just looking at quantitative measurements of how the team perceives itself, does not give precise information. The visualizations, however, give richer descriptions. To illustrate, Team 1's shared influence after Telemakos stems largely from how the group describes that the original member H (becomes member I in the spring measurement) changes through the year. In addition, member C starts to demand more space in the group, as he moves out of a passive position. Hence, the combination of the visualizations and quantitative measurements give deep insights.

The quantitative results illustrate that first impressions of teammates' behaviors are rather sticky (see Gersick & Hackman, 1990), indicating that groups must invest significant time and effort in order to increase their collective internal understanding. While lacking contextual and qualitative data, it is natural to assume that the negative changes in Team 3 and 4 are due to the high pressure during Telemakos. This means that these teams most likely had potential for internal improvements before Telemakos, which especially relate to the data on Team 3. Team 3 had the most passive and obedient members after the second measurement, and rather diversified shared influence. While it could be coincidence (e.g. injuries, sickness), Telemakos put so much stress on teammates that they might fall back to their behavioral

comfort zone, whereby the collective needs are suppressed. This seem to drive these teams into a negative internal development. On the other side, Team 2 showed a positive internal development after Telemakos. While it is speculative, the negative development in the second measurement can relate to unknown internal processes in advance of the measurement. However, we reason that this group actually used the negative development as something constructive and started to work more with internal actions before Telemakos. In addition, it could be that Telemakos, as a live mission, actually forced the team to use what they have learned at RNoNA and, due to this, commit to the overall goal. The reality and stress might have encouraged the team to fully engage and use their knowledge.

Furthermore, we cannot establish a valid connection between the performance ratings and SMMs from Telemakos, but we do find the notion of average SMMs and the average expected performance interesting. At the same time, these internal ratings stem from 10 days of real-life teamwork in highly uncertain environments. Due to this, it might be difficult to separate the nuances when rating performance. Also, Danielsen (2015) illustrates the tendency to give low grades in order to try to stimulate teams to continuously reach higher and not build up an ego. Similar grading philosophies can truly exist at RNoNA. However, this indicates that our findings are relatively robust, and help to shed light on the groups' ability to perform in highly uncertain settings.

The dominant methods today, in general, handle SMMs as theoretical output-constructs, with some limited potential as tools for feedback and enlightening discussions. Handling SMMs as a purely theoretical construct, we argue, has less value for practitioners, as the construct becomes hard to grasp and discuss. As an example, just giving a team a quantitative score and telling them to work with their team-related SMM will indeed be challenging. If the team starts up without proper guidance, this can easily lead to frustrations, locked polarizations, and unbalanced use of group functions.

The visual results in the Average Field analysis can help to spark more concise and fruitful discussions with direct feedback on how teammates describe individuals' behaviors, and by this describe how perceptions actually have changed over time. This means that the theoretical construct SMMs becomes more explicit and easier to understand for practitioners. Individuals base their perceptions of peers' behaviors on biased mental framing. That is, individuals usually describe themselves from a favorable position within the team, and use this as an anchor to describe teammates' behaviors. At the same time, Mead (1934) verifies that individuals use, and interact with, other people in order to adjust their self-image. Hence, if a person's mental self-perception bias is strong, the adjustment will become inefficient. By

using the graphical illustrations from the Average Field analysis, individuals, and teams as a whole, can understand the range of their perceived behaviors. Thus, if differences in team-related SMMs are brought to light, teams can spark discussions that untie implicit attitudes and knowledge between teammates, resulting in deeper understanding within the groups (see Huber & Lewis, 2010; Lewis, 2004), and thus also higher performance (Healey et al., 2015). The premise for efficiency, adaptability, and thereby high performance is definitely not through identical SMMs, as this could lead to negative consequences, but through *understanding* and *acceptance* of the teammate's perspectives

Concluding Remarks and Limitations

By using a framework that measures how teammates perceive each other's behaviors, this paper illustrates the development of team-related SMMs in military groups. Our findings illustrate that the team-related SMMs are sticky and hard to change. Even if the studied teams spend significant time on team-oriented development tasks during their first year, the SMMs-values are stable. This does not mean that the teams fail to change their behavioral patterns, as the groups' viewpoint of internal cohesion and influence evolves. The invested groups, however, displayed mid-level values of SMMs, giving them a clear potential to continue to develop. This suggests that military frontline teams should be kept intact, since developing team-related SMMs demands significant investments and efforts from the team.

The limitations in this study center on the lack qualitative and contextual data, which could have helped to explain anomalies and changes in the teams. In addition, future studies should try to follow several teams, and continue to establish a validated performance measurement tool for such studies. By collecting extensive performance data, it will become possible to establish a more solid understanding of how team-related SMMs affects various performance outcomes. Gaining a greater understanding of SMMs and contextual differences should also be of great interest for future research.

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Article 3:

Unfolding Influence: Sociometric Data and Group Dynamics

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Unfolding Influence: Sociometric Data and Group Dynamics

Abstract

The advent of "big data" technologies make it possible to seek a deeper insight in team processes. In the present empirical study, we engage in this quest through wearable sociometric badges. This innovative technology is capable of capturing real-time interaction data, and we try to use it to reveal the distribution of influence within group processes. We collect our data in high-fidelity simulations used to train naval cadets. This dynamic and open-ended simulation forces the teams to utilize the full range of team dynamics in order to adapt to an ever-changing situation. Our findings unveil how the influencing teammates affect the team behaviors through both non-verbal and verbal communication, where the influential members hamper the group's ability to use a full range of behaviors. A solid understanding of the distribution of influence is vital for enabling teams to efficiently align to their environment and task at hand.

Keywords: teams, influence, group dynamics, sociometric badges, sensor technology, big data.

1. Introduction

Humans have operated in groups since our early ancestors and thus developed psychological mechanisms designed to influence each other (van Vugt & Ronay, 2014). The group's distribution of influence affects its dynamics; influential teammates have the capacity to alter the behavior of the whole group (Nissestad, 2008; Sjøvold, 2007). Influence in teams does not necessarily follow formal roles. Instead, influence intervenes in social interplay inside of groups and can propel, or hamper, teammates' behavior patterns, and hereof affect the team's performance (Stålsett & Sjøvold, 2016a). Influence is an incontestable part of our primate heritage, and it is easier to influence people to follow you than to use persuasion (van Vugt & Ronay, 2014). Ergo, influence is a vital part of team processes.

Some researchers claim that the dominating research perspectives have handled team processes as a "black box" (see Kozlowski & Bell, 2003), with static unidirectional cause-effect perspectives (e.g. Braun & Kuljanin, 2015; Cronin, Weingart, & Todorova, 2011; Kozlowski, 2015;). This situation leads scientists to ask for openness towards new theories and more advanced methods in order to understand team dynamics and team performance in a relevant context (e.g. Carter, Asencio, Wax, DeChurch, & Contractor, 2015; Ilgen,

Hollenbeck, Johnson, & Jundt, 2005; Johns, 2006; Kozlowski, Chao, Chang, & Fernandez, 2015). A key concern in this development is to advance and invigorate empirical research through innovative technology in order to open the black box that encloses team processes (see Carter et al., 2015; Kozlowski et al., 2015; Pentland, 2012). We respond to the calls by asking: Is it possible to utilize sensor technology to unfold the distribution of influence within group processes?

This study employs wearable sociometric badges capable of capturing 'big data' from real-time interaction patterns, assisted by observations and recordings. As such, the research design triangulates several methods through qualitative and real-time quantitative data in order to strengthen the levels of robustness and credibility of team effectiveness research (e.g. Braun & Kuljanin, 2015; Kim, McFee, Olguin, Waber, & Pentland, 2012;). The data originate from groups that partake in high-fidelity simulation exercises at the Royal Norwegian Naval Academy (RNoNA). These exercises put stringent requirements on the participating teams to adapt to high levels of mental stress, uncertainty, and complexity.

2. Team dynamics

By defining a group or a team as "three or more people who share a common goal and interact to achieve this goal" (Sjøvold, 2006, p. 17), we argue that the complexity within interaction patterns alters significantly as a dyad expands to a triad (Simmel, 1955). This complexity also includes the distribution of influence in the group. Teams' interaction patterns should differ according to the task and context. This means that interactions that are efficient in stable conditions with known tasks differ from the ones that will help to innovate and excel in chaos and uncertainty (Ancona & Caldwell, 1992; Edmondson, 2012a, 2012b; Heldal & Antonsen, 2014; Stålsett & Sjøvold, 2016a; Stålsett, Sjøvold, & Olsen, 2016). Ergo, influence in groups should differ according to the operational setting.

A group's actions are not merely instrumentally related to the task, but also to the transactions in building (or deconstructing) relationships within the team (Sjøvold, 1995). This is an idea that correlates with the description of group dynamics as the perpetual shift between polarization and unification between sub-groups or individuals in the group (Bales, 1950a, 1950c, 1999; Polley, 1987). These shifts center around various group functions, which are well documented from several researchers (e.g. Bales, 1950b, 1950d, 1953, 1985; Bales, Cohen, & Williamson, 1979; Bion, 1961; McGrath, 1991; Mills, 1967; Parson, 1953; Parsons, Bales, & Shils, 1953; Schutz, 1958; Sjøvold, 1995; Tuckman, 1965). Initially these functions

spring from behavioral comfort zones, which again generate predominant expectations from other members to maintain particular group functions (Word, Zanna, & Cooper, 1974). How well people are able to breach these comfort zones depends on the distribution of influence in the team. Consequently, teams containing undistributed influence will also operate with slower shifts between polarizations and unifications; meaning that they display static and limited interaction patterns. This means that unbalanced influence will affect, and potentially hinder, the group's ability to handle uncertainty and high levels of stress (Stålsett & Sjøvold, 2016a, 2016b; Stålsett et al., 2016). It follows that influential teammates can create a group climate in which their prominent group functions prevail and guide the group's behaviors (Bion, 1987; Sjøvold, 2006), thus creating potential for locked polarizations and conflicts. Consequently, the RNoNA teams, which operate in changing environments and highly uncertain settings, will therefore benefit if team members are capable of balancing their influence with passivity over time. Such balanced behavior creates room for the rest of the group members to interact and take actions. Ergo, if the RNoNA teams advance their overall interaction patterns, they also become more adaptable and able to maintain high operational performance.

The negative effect from over-influencing individuals in team dynamics are well-proven from several researchers and various domains (e.g. Bales, 1954; Blenkinsop & Maddison, 2007; Conger, 1990; Danielsen, 2015; Hogan, Curphy, & Hogan, 1994; Launonen & Kess, 2002; McChrystal, Silverman, Collins, & Fussell, 2015; Sjøvold, 2014a; Sjøvold & Stålsett, 2016). However, as far as we know, using sociometric badges to try to uncover influence in team dynamics is a new approach.

3. Research design

3.1. Participants

This study involved a total of two teams at the RNoNA, each comprised of five experienced officers with up to 20 years of prior military service (age range = 24 - 44). The participants included one female and nine male operators. RNoNA staff functioned as instructors, subject matter experts (SMEs), and educators during the exercises. The SMEs were all officers in the Norwegian Navy, with military ranks ranging from Sub Lieutenant to Commander.

3.2. Case description

The empirical evidence in this article stems from the investigations undertaken during the *controlled free-play* (Mjelde & Smith, 2013) simulation exercise *Aden,* performed at the RNoNA in November 2014. *Controlled* implies that the assignment has a pre-set framework, which includes a main mission, sub-missions, orders, intelligence reports, time schedules, and a command and control hierarchy. On the other hand, *free-play* relates to the extensive leeway participants have to execute their tasks based upon self-interpretation of their missions and current circumstances. A major implication of controlled free-play is that a blueprint of what represents a success or a failure is non-existent.

The Aden exercise involves scenarios set out in complex maritime environments, used to improve team dynamics and prepare the teams for live exercises. Simulation exercises are important for RNoNA, as the high performers during the simulation interventions are also the high performers in real life settings (Stålsett & Sjøvold, 2016b). Notably, in such simulations, military ranks irrelevant; the cadets are supposed to improve *with* their teammates. Aden is a modern and realistic anti-piracy scenario played out in the Gulf of Aden with high levels of sophisticated technology. The scenario is an overt operation, in which one would expect to find communication, coordination, and cooperation requirements similar to those in modern naval military operations. To ensure high complexity is the simulation also constrained by political influences, rules of engagement, and international regulations. The exercise ran for 1 hour and 20 minutes, and included two breaks for feedback from the SMEs.

3.3. Data collection

3.3.1. Qualitative data.

Each of the teams were observed closely by one researcher during the exercise. In addition, we observed a day of full lectures, including pre- and debriefs, as well as scheduled breaks. We recorded the simulation exercise for both teams, and made extensive notes through the day. To validate our findings, we discussed the results and data with the Dean of RNoNA, who was one of the SMEs.

3.3.2. Sociometric badges.

We collected data by equipping the participants in the study with wearable sociometric badges, devices that capture and characterize team interactions through fine-scaled data of speech patterns, body movement, and face-to-face interactions and measure individual and

collective patterns of human behavior (Kim et al., 2012; Olguín et al., 2009; Pentland, 2008, 2012). The sociometric badge hangs around the neck like an identification badge and collects precise real-time data in a highly efficient manner. In sum, the badge captures four types of signals. First, radio sensors detect physical proximity between badge wearers. Second, infrared (IR) sensors measure whether two badge wearers are facing each other. Third, the badges capture speech features without recording conversational content, thereby ensuring participant privacy. Fourth, an accelerometer measures the movements of the badge wearer. We briefed participants on the purpose and technical features of the sociometric badge prior to the exercises, as the participants had not previously been acquainted with this technology. Subsequently, specialized software (Sociometric Datalab) processed the data and exported them to a spreadsheet format for further analysis.

3.4. Sociometric data analysis

The sociometric data allow us to understand people in the context of their social network and not as isolated individuals (Pentland, 2008). Ergo, the context is vital to understand the results, and the analysis of sociometric data between teams should therefore be comparative in design. We approach this by observing and collecting data from two groups participating in the same simulation exercise, as well as by discussing the findings with an SME. The data obtained from the sociometric badges may serve as the basis for a number of different analyses and, even though the teams are small, the data generated are comprehensive. Therefore, one has to develop a clear-cut strategy to identify purposeful data and the ways to examine it (Braun & Kuljanin, 2015; Guzzo, Fink, King, Tonidandel, & Landis, 2015; Kozlowski et al., 2015). In addition, the sociometrics lack construct validity and need to be triangulated with other methods for robust findings (Kim et al., 2012); meaning that theoretical development is neccecary for future advancment (Olguín et al., 2009; Kozlowski et al., 2015). Our line of inquiry was therefore to select a set of representative sociometric measures that reveal influence, and triangulate this with the observations in order to pioneer into an early framework.

To understand how the team members use their bodies to interact, we chose the measure “body activity” and “body movement consistency” (Sociometric Solutions, 2014). These data come from the 3-axis accelerometer signal. The signal is sampled at 50 Hz, allowing it to capture most of human movement (Onnela, Waber, Pentland, Schnorf, & Lazer, 2014), as 99% of the acceleration during daily human activities is contained below 15 Hz (Mathie, Coster, Lovell, & Celler, 2004). The values vary between – 3*g* and +3*g*,

where $g = 9.81 m/s^2$ is the gravitational acceleration (Olguín et al., 2009; Onnela et al., 2014). The body activity uses absolute values of the first derivate from the accelerometer sampling, thereby providing a highly reliable measure of an individual's activity. Body movement consistency is a measure of how consistent or inconsistent a team member's body activity are.

The volume analytics come from microphones that collect nonlinguistic vocal data. It samples at a frequency of 8 kHz, while using an array of band-pass filters to analyze the data (Olguín et al., 2009; Onnela et al., 2014). We have chosen to use "volume activity" and "audio consistency" (Sociometric Solutions, 2014). The first, volume activity, is the average absolute value of front amplitude, while audio consistency measures the consistency of each badge's audio amplitude

To analyze speech patterns, we have chosen the "turn-taking" analysis and "the number of successful and unsuccessful interruptions" as data. These data consist of several concepts (Sociometric Solutions, 2014). First, a *speaking segment* is a continuous speech made by a single person. Second, a *turn* is a speaking segment occurring after, and within 10 seconds of, another speaking segment. A speech segment must be made within 10 seconds after the previous one ended in order to be considered a turn. Third, *self-turns* occurs when someone starts speaking, pauses for more than 0.5 seconds (but less than 10 seconds), and then resumes speaking. Fourth, s*uccessful interruptions* emerge like this: Teammate X is talking. Teammate Y starts talking over X. If X talks for less than 5 out of the next 10 seconds, then Y successfully interrupted X. Finally, *unsuccessful interruptions* are as follows: Teammate X is talking. Teammate Y starts talking over X. If X talks for more than 5 out of the next 10 seconds, then Y unsuccessfully interrupted X.

Sociometric data can be extracted down to the precision of a second, pinpointing the details in the interaction data. For our purposes, such detail is unnecessary and provides cluttered data. Therefore, we extracted the data on a 4-minute sampling, whereby one data point is 4 minutes, giving us 32 data points for Team 1 and 37 data points for Team 2. In addition, the figures illustrate the two pauses, spanning between 1 and 6 data points in the graphs for Team 1, and 1 and 6 data points for Team 2. This gives a perception of what happened through the session, and helps to explain the average findings that we have displayed in tables. As the sociometric spreadsheets display up to eight digits, we have reduced them to four in order to show the fine-grained differences among the teammates.

Reducing the number of data points can produce some biases. However, by triangulating the collection with observations and recordings, we claim that our data represent

the process in a validated way and the reduction helps visualize the interactions better. In addition, there is a weakness in the average data as some participants forgot to turn off their badges during the pauses. In Team 1, team member B-1379 turned on the badge before entering the exercise, and member B-1542 forgot to turn it off during the short second break. In addition, teammate B-1539 in Team 2 forgot to turn off the badge during the first pause, and B-1540 also had it on for a minute. These breaks, however, were mostly lead by the SMEs, and the groups were standing still and talking and moving only when addressed directly. Ergo, the potential bias from this is highly limited, when taken into the account in the analysis.

We did our observations analytics and sociometric analytics separately. This means that we did not know which particular participant that carried the specific badge before we triangulated the data. We did this to validate our finding without being biased. Team 1 consisted of the participants B-1379, B-1380, B-1381, B-1541 and B-1542, while Team 2 had the members B-1378, B-1382, B-1539, B-1540 and B-1543.

4. Results

4.1. Qualitative Findings

In general, we observe two teams with quite different dynamics, particularly related to their energy levels. Team 1 displays low engagement, meaning that the group seems to be careful and restrained. It is a friendly atmosphere, in which they focus on their tasks, but display slow group dynamics and somewhat limited behavior range. However, none of them tend to freeze into specific roles. We did not notice any tough dialogs, critical concerns or resisting questions through the session, which could mean that the group members have a problem raising critical thoughts, or acting fully open about their ideas and opinions.

We notice that the team uses a mix of both verbal and non-verbal communication, depending on the situation. The group members' levels of influence are unequal; two members stand out with less influence than the others (B-1379 and B-1381). These members seem to be more dependent and follow the orders and demands from the rest of the group. While not really being excluded from the rest of the members, it appears that one of these two low influencing members (B-1381) is less involved with the rest of the group; almost like an outsider. On the other side, this group also has a person who craves more space in the group than the rest (B-1542). Through the influencing behaviors, this person is more active in both verbal and non-verbal actions than the rest of the team. Hence, this individual acts as a hub in

the team, by being the decision maker and craving information; the rest of the teammates seem to provide information and ask for suggestions and solutions.

Team 2 is a more energetic group, meaning that the teammates interact quite rapidly and seem more engaged. The members' behavioral range seem somehow limited within a friendly, but task oriented, atmosphere. Such traits appear in both verbal and non-verbal communication patterns, and a significant part of the coordination happens through non-verbal signals. We did not observe any tough discussions, nor did we notice any prominent critical questions. As in Team 1, this shows tendencies of teammates have problems raising critical concerns, or acting fully open about their ideas in order to challenge the status quo. There was an unequal level of influence in the team, in that two members (B-1540 and B-1543) are differentiated from the rest of the group. In this pair, especially one member (B-1543), shows a higher activity rate, and is the one who intervene and makes most of the decisions. In addition, we also noted a member who seemed more dependent and less active in the group (B-1539). Contrary to the findings in Team 1, the obedient person, is more within the center of group, almost hiding, while following orders and directions.

We were not able to see any particular change in behaviors after the first break in either of the teams. Notably, this can be a consequence of the short period of time that they operated before the next break. After the second break however, both teams made some changes to their dynamics. Particularly, the most influential members seemed to de-emphasize and hold back on their previous actions. These adjustments came out of specific feedback from the SMEs, who told them to create more room for the rest of the group. The rest of the team, however, did not seem to significantly change their actions towards being more influential, even though every member received specific behavioral feedback to work on from the SMEs. Instead, the observations illustrated that members in both groups scaled down their actions, still relying upon the members who were most influential in the beginning.

4.2. Sociometric data

4.2.1. Body movements

Table 1 display the average score of the body movements for Team 1 and Team 2, thus also a measure of how they use their body to interact. Body activity scores are normative and should be understood from sample to sample (Olguín et al., 2009; Onnela et al., 2014). The body movement consistency varies from 0 to 1, where 1 indicates no changes in activity level, and 0 indicates the maximum amount of variation in activity levels.

Table 1.

Average scores of body activity and consistency.

	Team 1					Team 2				
Data	B-1379	B-1380	B-1381	B-1541	B-1542	B-1378	B-1382	B-1539	B-1540	B-1543
body activity	0.0046	0.0054	0.0057	0.0061	0.0092	0.0118	0.0133	0.0087	0.0130	0.0143
BM consistency	0.9908	0.9886	0.9923	0.9863	0.9830	0.9753	0.9685	0.9792	0.9650	0.9649

Note. BM Consistency = body movement consistency

A two way unpaired t-test reveal significant differences ($p<.001$) *between* the teams body activity and body movement consistency. An ANOVA single factor test disclosed significant ($p<.001$) results for both body activity and body movement consistency *within* both Team 1 and Team 2. By looking into the average scores in Table 1 show that the members in Team 1 display quite similar activity and consistency levels. B-1542 sticks out as the most active and least consistent, meaning that this person also demands most room in the team. This corresponds with our observations, where we described B-1542 as the most influential member. As the qualitative data also described, B-1379 stands out as the least active in the group, while B-1381 is the most consistent member. Figure 1a and 1b graphically display the process data from the consistency and activity data. In general, these findings correspond to our qualitative data, with relatively few changes after the breaks. However, SMEs told B-1542 to step back a little and create more room to the rest of the group, and the data confirm that this happened. The teammates seem to follow B-1542's adjustments by lowering their body movements as well.

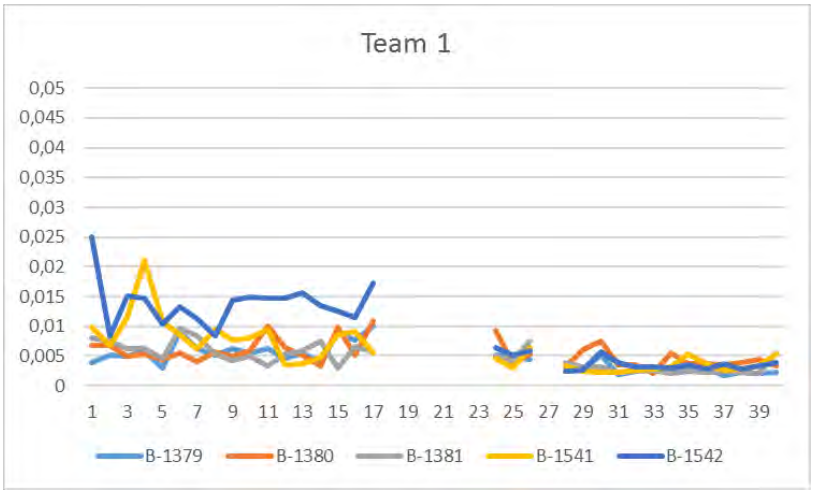

Figure 1a. Body activity measures for the teammates in Team 1 through the whole exercise, including the two brakes.

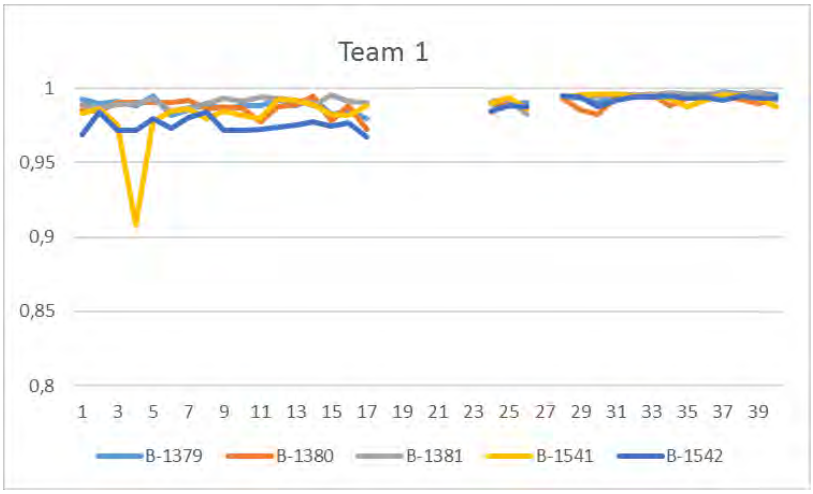

Figure 1b. Body movement consistency measures for the teammates in Team 1 through the whole exercise, including the two brakes.

Team 2's average scores, from Table 1, reveal that the members display some inconsistent body movements and activity; ergo teammates show some level of variations in their movements. Team members B-1382, B-1540 and B-1543 average score suggest that they have relatively similar body movements, with B-1543 as the slightly more active and inconsistent. At the other end, B-1539 displays the most consistent movements and least

activity. Figure 2a and 2b, however, give a deeper understanding than it is possible to extract from the average scores. The figures show that B-1543 is clearly most active and inconsistent before the breaks, but adjusts the behaviors into the third period, which affects the average scores. In addition, B-1382's average scores change due to the highly inconsistent movements and a high level of activity in the last period. By studying both graphs, it is also possible to see that the severe change in movements from B-1543 in the first period (data point 15-17) seem to be followed by B-1539, indicating that these two interacted more intensely here. Figure 2a and 2b follows the qualitative findings, illustrating a group in which members adjust relatively quickly. In addition, the visualizations show that the group adjusted the behavior after the most influential member from the first period, B-1543, into the last period.

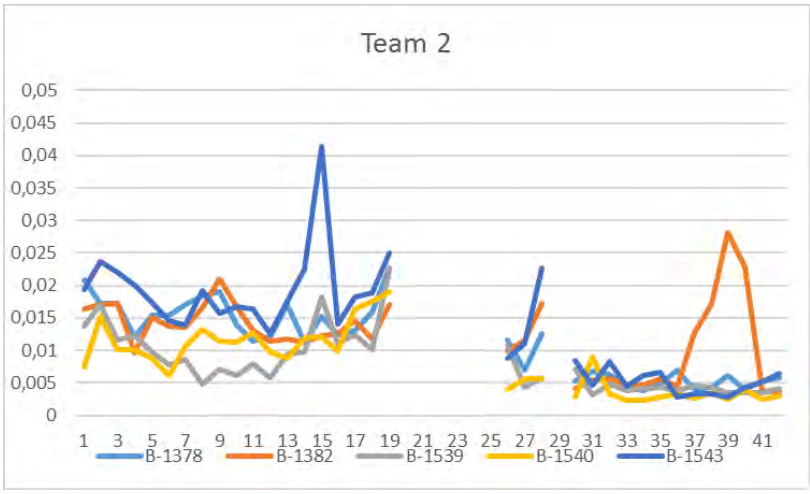

Figure 2a. Body activity measures for the teammates in Team 2 through the whole exercise, including the two brakes.

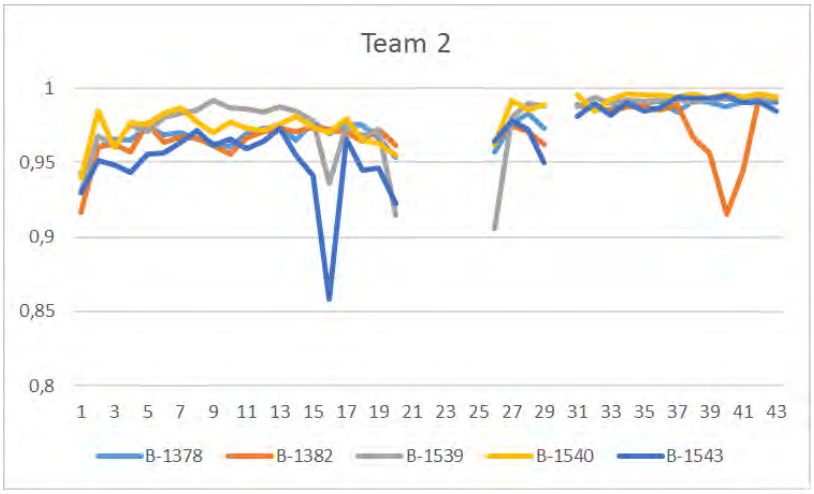

Figure 2b. Body movement consistency measures for the teammates in Team 2 through the whole exercise, including the two brakes.

By comparing the results, the sociometric data illustrate two teams with different dynamics. Team 1 is less active and holds high consistency in their body movements, which aligns with the atmosphere and slow shifts seen in the qualitative data. In contrast, Team 2 displays more activity and inconsistent body movements. This also aligns with the qualitative findings, as this team interacted quite rapidly and seemed more energetic. The person with the most consistent behavior in Team 2, B-1539, is actually more inconsistent - and almost as active as the most influential person, B-1542, in Team 1. Taken together, the data show that the rest of the team follows the behavior of the most influential person, even if this person tries to adjust and open up for others to demand more space in the group.

4.2.2. Volume analytics

Table 2 exhibits the average scores of the volume activity and the audio consistency in Team 1 and 2. As such, the volume activity uses a normative scale and should be understood from sample to sample (Olguín et al., 2009; Onnela et al., 2014). The volume consistency ranges from 0 to 1, with 0 as full consistency and 1 no consistency.

Table 2.

Average scores of volume and volume consistency.

	Team 1					Team 2				
Data	B-1379	B-1380	B-1381	B-1541	B-1542	B-1378	B-1382	B-1539	B-1540	B-1543
volume activity	0.0112	0.0129	0.0112	0.0121	0.0102	0.0144	0.0187	0.0117	0.0110	0.0120
audio consistency	0.6389	0.6322	0.7241	0.6186	0.4790	0.7325	0.7709	0.7482	0.6151	0.6345

The two-way unpaired t-test did not discover any significant differences ($p>.05$) *between* the teams' volume activity and audio consistency. An ANOVA single factor test revealed no significant findings ($p>.05$) *within* Team 1 for body activity and body consistency, while the measurements showed significant results ($p<.001$) in Team 2. Following this, the average scores in Table 2 shows that the teammates in Team 1 display quite similar volume activity, meaning that the average absolute values of the volume is about the same level in the group. The audio consistency findings, illustrate that there are no significant differences. Nevertheless, this actually means that their average scores illustrate that they all are relatively inconsistent lot in their volume. B-1542 is more inconsistent than the rest of the group, meaning that this person varies the audio volume the most, while B-1381 stands out as the most consistent. The findings confirm our qualitative data, where B-1542 was seen as engaging at several levels of verbal communication patterns and B-1381 described as being more passive and a bit as a satellite outside of the core of the group. The volume activity in Figure 3a confirms the average scores, as the visualizations show a group with quite similar volume. However, at data point 11, B-1541 seems to raise the volume. B-1380 follows this escalation, and while also B-1542 seems to increase the volume slightly, while B-1379 and B-1381 do some incremental adjustments. When the volume drops around data point 16, the whole group drops. In the last period, B-1542 has clearly lowered the volume, leading the whole group to lower the volume. Figure 3b, which shows the volume consistency data, confirms these findings. Here it is possible to see how B-1542 keeps changing the volume, especially in the first part of the session. From the perspective of B-1542, it seems like the rest of the teammates tend to adjust to this person, which means that B-1542 adjusts the volume to address different teammates. In addition, the data after the second break confirms that B-1542 adjusts its influence in order to give more room to the rest of the teammates, leading the group to become more consistent.

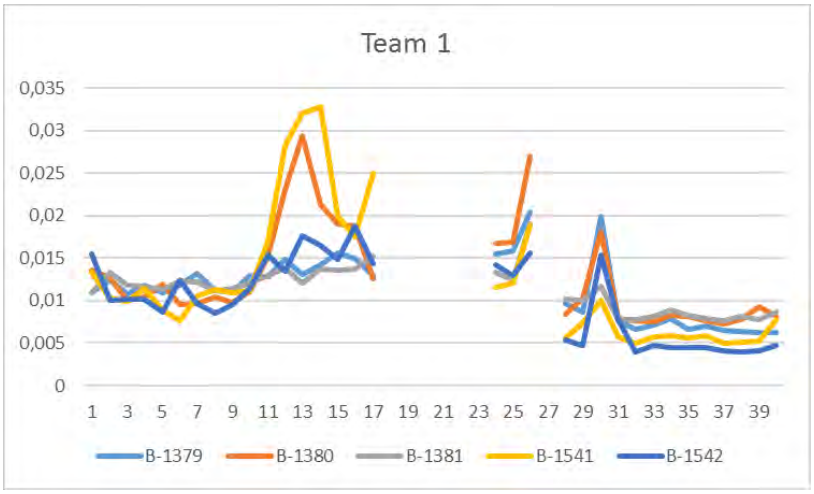

Figure 3a. Volume activity measures for the teammates in Team 1 through the whole exercise, including the two brakes.

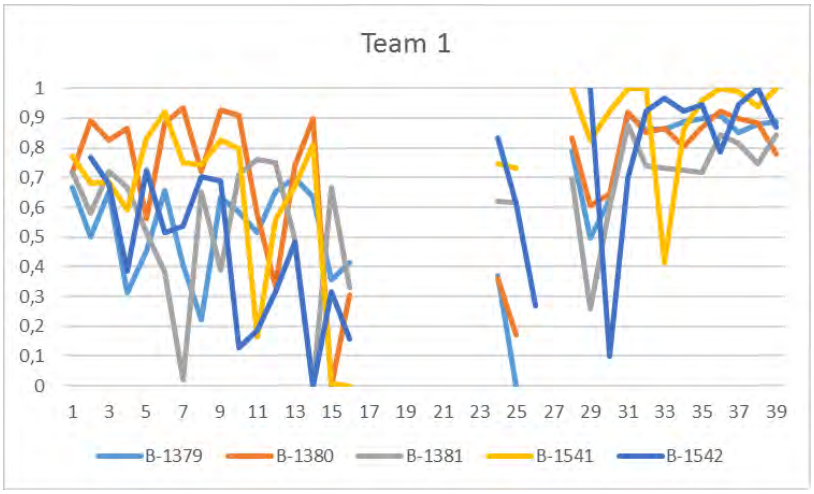

Figure 3b. Volume consistency measures for the teammates in Team 1 through the whole exercise, including the two brakes.

Table 2 illustrate similar patterns that support previous data regarding Team 2, whereas the members significantly vary both their volume activity and consistency. In this, B-1382 displays some higher levels of volume activity compared to the rest of the team. B-1540 is the most inconsistent in Team 2, tightly followed by B-1543, whereas the other members display relatively similar results. Furthermore, the process visualization in Figure 4a supports previous findings. It illustrates a group in which B-1382 uses higher volume activity in the

first period, while this person displays lower scores in the last period. The SMEs told this person to rely less on high voice activity to communicate with the group. In the last period, the whole group lowers their voice activity. Figure 4b also expands the understandings from the average scores found in Table 2. B-1542 varies the tones actively through the first period, and uses less variation after being told to step back. The intense inconsistency in the last period from B-1540 will therefore affect the average score, leading the average score to give a biased impression. When looking at the graphs before the first break, it is profound that clearly B-1540 is not the most inconsistent person in the group. B-1382, however, uses an inconsistent volume quite a lot, but is also told by the SMEs to adjust this, which is seen after the second break in the figure. Again, from the perspective of B-1543, the rest of the participants follow this person's inconsistency and adapt to it. The data seem to support the idea of B-1542 and B-1539 interacting tightly around data point 15, as described in the body section. The volume analytics, however, also illustrate that B-1382 is a part of this interaction through vocals, which we also saw in the qualitative data.

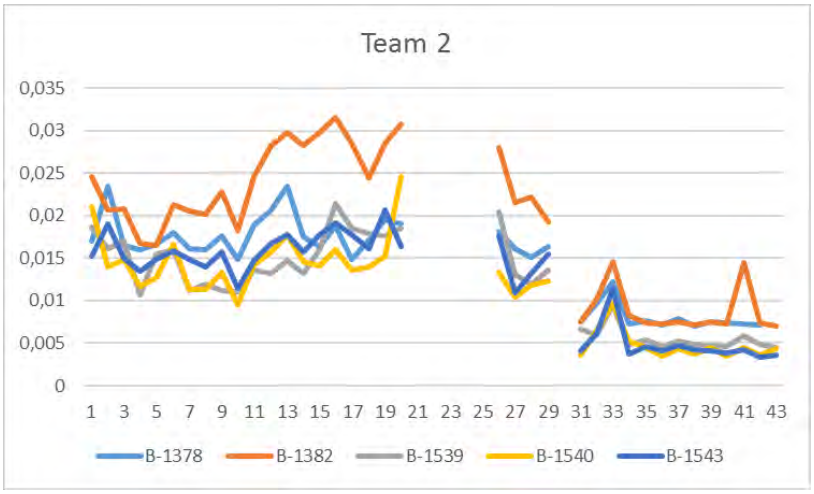

Figure 4a. Volume activity measures for the teammates in Team 2 through the whole exercise, including the two brakes.

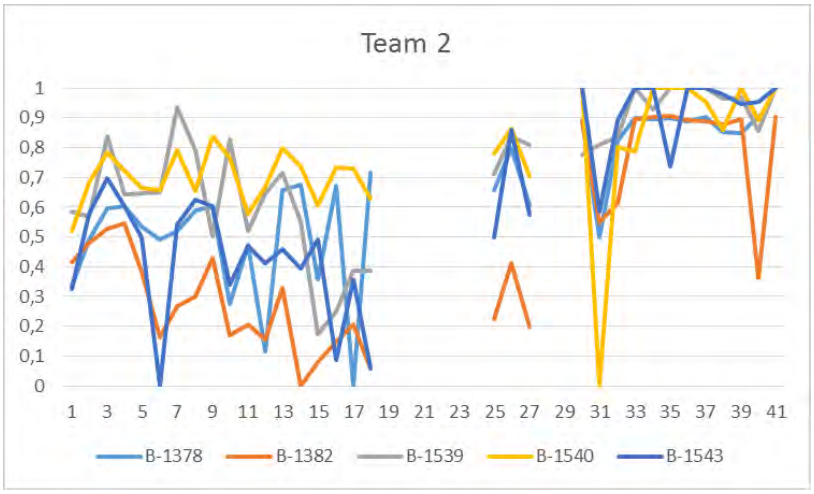

Figure 4b. Volume consistency measures for the teammates in Team 2 through the whole exercise, including the two brakes.

When comparing the two groups there were no significant findings, but the average scores in Table 2 display that B-1542 in Team 1 is the least consistent participant of all the participants in both teams. This supports the fact that this group seemed to struggle with their interactions, using several layers of tones when speaking to each other. This was especially striking when observing them, where B-1542's volume inconsistency was prominent. As such, the inconsistency relates to the observed slow shifts and undistributed influence in the group. While Team 2 also had an undistributed influence, whereas the significant results within this team relies to the observation of a more energetic team. The members we observed as most influential, are actually not the ones who score highest on the volume activity. They, however, have the most inconsistent volume.

4.2.3. Speech patterns

By conducting a two-way unpaired t-test, we found a significant difference ($p<.01$) *between* the teams' number of total turns, whereas Team 2 conducted the highest number of turns. Going deeper into this, Team 2 had a significant ($p<.01$) more successful interruptions than Team 1, while the difference between the unsuccessful turns was not significant ($p>.05$). *Within* the teams, both teams showed significant (Team 1, $p<.01$; Team 2, $p<.05$) more successful interruptions than unsuccessful interruptions. Figure 5a and b visualize the turn-taking analysis and the number of successful and unsuccessful interruptions for Team 1. First, Figure 5a illustrates whom each participant takes turns after, including self-turns, and the

number of total turns from each individual. Thereafter, Figure 5b displays how the interruptions evolve in the group. From Figure 5a it is clear that the turns are undistributed in the team, whereas B-1542 takes most turns and self-turns are an important contributor to this person's high numbers. The data also show that the B-1381, observed as the obedient member outside of the core, has the least number of turns. While B-1381 has few turns in general, B-1542 actually takes the least turns after this member, which could imply that B-1542 ignores the turns coming from B-1381, and does not contribute or follow up this person's input. B-1381 has some successful interruptions, while having no unsuccessful interruptions. Ergo, the few times this member speaks, others listen. This can also be seen in that the rest of the team members take turns after B-1381, meaning that they answer and follow up the few times this person speaks. From the observations, this seems reasonable, as B-1381 struggled to get into the group and the SMEs told this person to interfere more, and the group was told to facilitate this. B-1542 has relatively few unsuccessful interruptions and seems to be within the group standards of successful interruptions. However, SMEs told B-1542 to step back, which the behavior and volume data illustrated, meaning that most of these interruptions and turns came early in the session.

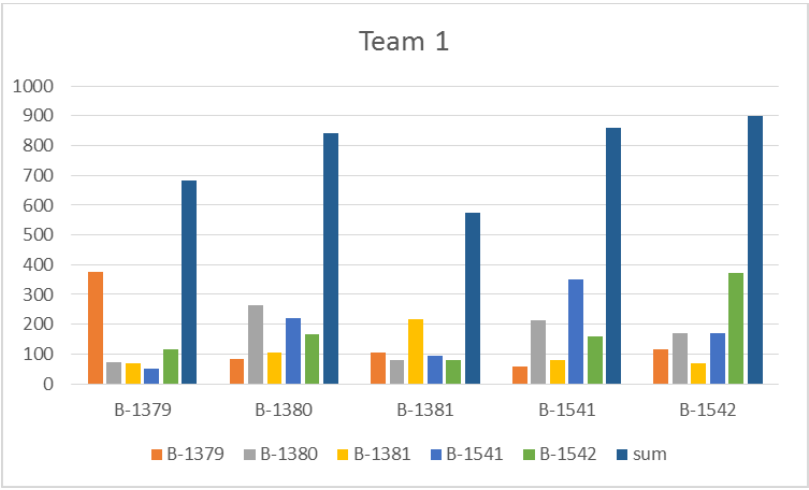

Figure 5a. Turn talking, including self-turns and the total turns from each group member in Team 1.

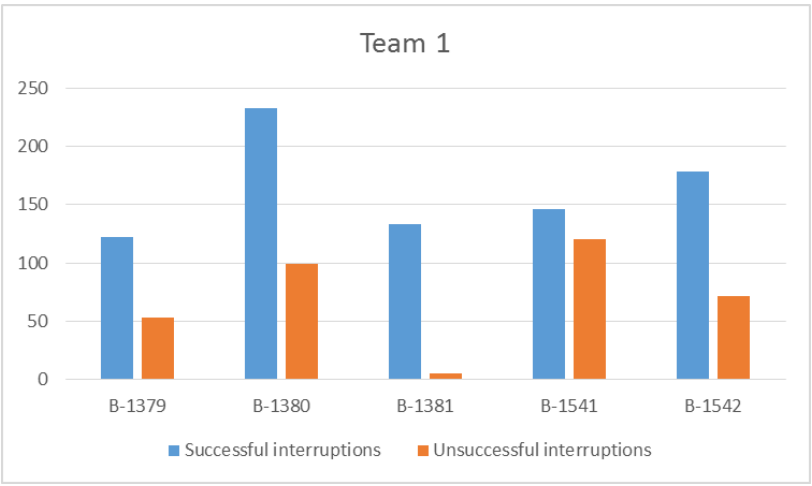

Figure 5b. The number for successful and unsuccessful interruptions in Team 1.

Figure 6a shows that B-1382 talks the most in Team 2, while B-1542 follows tightly. The data displays that there is an unequal distribution of who group members take turns after, and all tend to score relatively high on self-turns. B-1543, however, is the exception with more balanced order. These findings relate to B-1543 being most inconsistent, herby adjusting both volume and body signals to the one that is approached. In Figure 6b, the number of interruptions in the group seems relatively distributed except from two findings. First, B-1382 has high scores of unsuccessful interruptions, which also relates to the amount of turns this member takes. However, as the member does not influence the group properly, people seem to ignore some of the attempts. Thereafter, B-1539 has the lowest number of turns, which should be even lower, as this person forgot to turn off the badge during the first break. The turns during the break consist of self-turns, indicating that the total input from B-1539 to the group is somewhat lower. Hence, B-1539's interruption scores are wrong, especially the successful ones. It is also noteworthy to observe the low number of unsuccessful interruptions from B-1540. This indicates that, when this person speaks, people listen. This finding suggest that B-1540 has more influence in the group than we could observe, and by this can change the dynamics if sought after. In sum, these findings build on the patterns discovered previously, with B-1542 as the most influential and B-1539 as the least influential. In this, it is worth noting that unsuccessful interruptions can also be short confirmations, like yes, no, "mhm" and so on. However, such expressions do not change the fact of being influential or not. For the influential members, this means that they confirm information or make short decisions, while the less influential individuals confirm and obey orders.

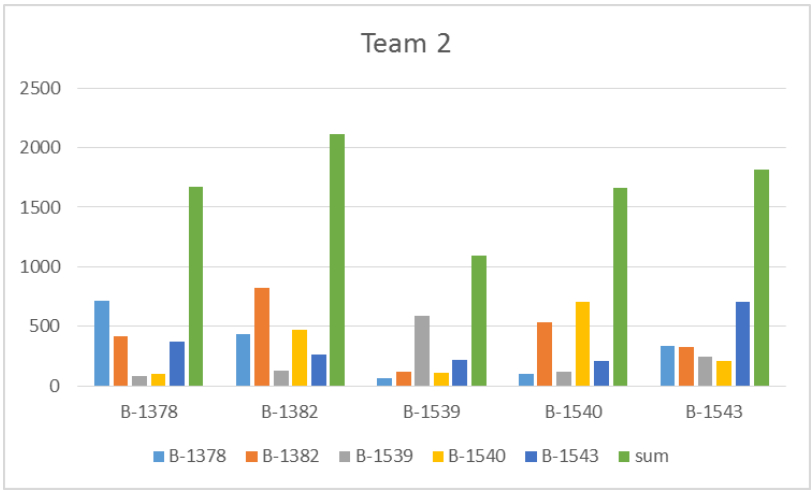

Figure 6a. Turn talking, including self-turns and the total turns from each group member in Team 2.

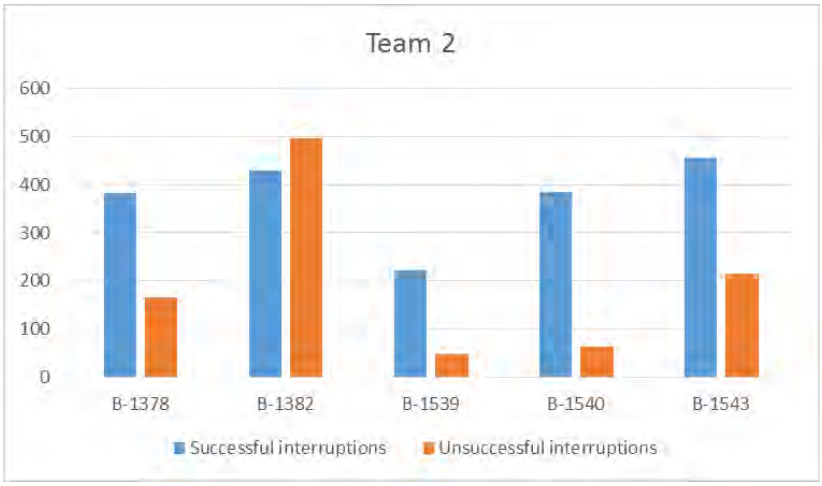

Figure 6b. The number for successful and unsuccessful interruptions in Team 2.

The speech analysis reveals two teams with different dynamics, which supports the previous qualitative and quantitative results. While there is distributed influence within each of the teams, the way this comes into practice is quite different. Thus, the numbers of turns and interruptions within these teams are significantly diverse. As such, Team 1 is less active, with slower group dynamics, while Team 2 operates with higher energy and more intense group dynamics.

5. Discussion

The visualization of the big data truly gives more information than an average numerical score. While the latter gives some information on a group environment, it does not take into account the processes inside of the team. The teams clearly had different dynamics and interaction patterns, and both had unequal distribution of influence. While we were able to observe that the teams changed their dynamics in the last session, this was even more striking through the big data. Even if the most influential members intended to create room for the rest of the group by adjusting and down-scaling their behaviors, the rest of the teammates did not grasp this opportunity. This suggests that influence, which is a part of our ancestor primal heritage, follows social roles, and is not easy to change.

However, by understanding more of the influence in teams, it is possible to challenge the established group patterns. For military frontline groups, this is highly important as they rarely have a clear answer of the best solution. Instead, they operate with ideas of 60-90% of what they believe is optimal and solve the process as it endures (Sjøvold & Stålsett, 2016). Knowing how to work with teammates' influence through decision-making is therefore vital for operational excellence. Even if these teams are able to solve extraordinary missions, they are trained to be humble, respectful, and operating with shared influence (Danielsen, 2015). This prevents creating heavily influential individuals, or subgroups, that hinder the group's ability to display the advanced dynamics needed to succeed and survive.

By visualizing the team processes, it is possible to follow the interaction patterns in the team instead of looking at them as static constructs. Indeed, the average scores give some information, but the entire story is not uncovered. Leaning on average scores can sometimes lead to the wrong conclusions. This is important, since the variance in the data vary intensely, as illustrated in the visualization of the group interactions. While the graphics help to uncover influential teammates, they also show the least influential members, as well as demonstrate how the actions from the most influential person affects the rest of the team. It is possible for researchers to observe social roles, the speed of the group dynamics, and eventual locked polarizations, but the process has previously been hard to restructure. While some group-measurement tools (see Sjøvold, 2006, 2014b; Stålsett & Sjøvold, 2016a) can give graphical interpretations about the group dynamics, they do *not* give process data. As such, the process data will help to establish deeper understanding of group dynamics and group performance. It also provides useful knowledge that can triangulate with group-measurement tools and observations.

There was an interesting trait within Team 2. Even if this group contained a very influential team member, we also uncovered that there was a second member with high influence. We saw this trait in our observations, while the sociometric data confirmed it. The more surprising tendency was that this member had almost no unsuccessful interruptions. Without being able to uncover why, we attribute this to historical happenings in the group, whereas this member has been told to adjust behaviors in order to open up for others in the team. If this holds, the adjustment has lead the dynamics into what we revealed, while the previously most influential member still holds high status in the group. Understanding how teammates perceive each other (see Stålsett & Sjøvold, 2016b) is therefore also vital in order to understand influence and team dynamics.

For these teams, the findings have some clear implications. If the simulations were done in a stable context with known tasks, such unequal distribution of influence would be expected to ensure high performance. However, this is not the case in this exercise. The data clearly reveal that the groups were influenced by the actions of one member, instead of being a team with members that balance their influence level. This means that the chosen data from the sociometric badges triangulates with our observations, and that it is possible to use this technology to measure influence. The sociometrics also appear promising for efficient feedback purposes. For RNoNA and others, this means that the sociometric badges lead to fewer observations, and that they may also become unnecessary, when conducting team exercises that focus on developing the distribution of influence. The implementation of the badges should be straight forward, and future exercises will thereof require a minimum amount of instructors.

Researchers emphasize that speaking time has a strong correlation with individual influence in a group (e.g. Mast, 2002; Stein & Heller, 1979), while body language is often left out in these studies (Pentland, 2008). Military teams, however, often operate in total silence (Danielsen, 2015; Tucker & Lamb, 2007), relying only upon embodied interaction patterns. Therefore, ignoring nonverbal communication is clearly a weakness, as reading body signals is a vital part of team processes. In fact, just drawing on verbal communication in this particular study could lead to incorrect conclusions, as the most influential members did not necessarily crave the most vocal airtime. However, by investigating different kinds of vocal interactions, combined with body language and our qualitative data the findings are quite solid.

In one of the teams, the one who actually spoke most also spoke the loudest. This person also had the highest number of unsuccessful interruptions, while clearly not being

highly influential in the group. The most influential persons, however, were quite average on their amount of speaking, using a volume that was about the average of the rest of the group. These influential persons used a profound inconsistency in their volume; meaning addressing each participant with an efficient tone is important, not trying to use high vocals to reach out.

6. Conclusion

By anchoring the work in established theories, and triangulated the sensor data with qualitative findings we have illustrated that it is possible to use sensor technology to unveil the distribution of influence in teams. The data from the sociometric badges make it possible to track team dynamics through time, and by this gain deeper knowledge of the secrets found within team processes. As humans, we tend to describe others' behaviors based upon our own biased perspective, meaning that the results from big data can be used as an objective measurement. While helping to understand more of the interaction patterns in teams, and thereby handling teams as dynamic entities, such objective data are efficient for feedback purposes. The graphical illustrations provide unique insight, and highlight the fact that each team is unique and has specific challenges to overcome in order to operate efficiently. Influence is indeed a vital part of the group dynamics, and not easy to change. Due to the complexity of group processes, influence should be measured through both vocal and non-vocal interactions, as upon just vocal data can truly give an incorrect impression of the distribution of influence in a team. This has previously have required observations or advanced self-reporting measurements, while the sensor technology in the sociometric badges should be cost effective and straight forward to implement. In such, the efficient implementation should be easy to adopt for any organization that wants to use leading technology in order to understand and develop their teams' distribution of influence.

While big data enriches the understanding of team dynamics, it also demands extensive research and further theoretical development. This development also includes sampling enough data from various contexts to be able to create validated scales for the normative measurements. The sociometric badges we used were able to extract an extensive amount of data, which can be supplemented with several other kinds of data. Mining data, however, should not become an obsession in itself, as it can lead to reliable, but invalid findings. Instead, future development will benefit by connecting established and validated theories with new technology. We therefore call for more contextual research, which combines established practices with big data. This work should also aim to combine the

objective data from sociometrics with and understanding of how people perceive each other, as this is important for understanding team behaviors.

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Article 4:

From Routine to Uncertainty: Adaptable Teams within Integrated Operations

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Abstract

Through a multimethod design in oil and gas installations, we study leadership as the ability to mobilize effective teams in a setting where operational failures may lead to catastrophic consequences. This industry has invested substantial resources into risk and crisis management, emphasizing evidence-based procedures, drills, and centralized leadership. Recent accident reports indicate that relying on fixed procedures and centralized leadership may escalate a crisis, and do therefor call for new leadership perspectives. Furthermore, the paper indicates that the intense usage of technology to cooperate reinforce polarization and in-group bias that may reduce the leader's ability to establish interteam cooperation and handle chaotic situations. We discuss these challenges, and suggest finding inspiration from modern maneuver warfare to innovate organizational practices.

Keywords: *teams, team leadership, inter-team collaboration, crisis leadership, high risk.*

From Routine to Uncertainty: Adaptable Teams within Integrated Operations

Team performance is strongly related to leadership behaviors and the team's context, (Heldal & Antonsen, 2014; R. Hogan, Curphy, & Hogan, 1994; Kaiser, Hogan, & Craig, 2008), and teamwork has become the modus operandi in most organizations (Edmondson, 2012a; A. Martin & Bal, 2006). However, it is reported that up to one third of teams are either under-performing or directly failing (Edmondson, 2012a; Govindaran & Gaupta, 2001). This reveals that leaders needs to improve their skills (J. Hogan, Hogan, & Kaiser, 2010; R. Hogan et al., 1994), and start to focus the interaction with their upon their teammates in a dynamic context (R. Hogan, 2007; Morgeson, DeRue, & Karam, 2010; Avolio, 2007). Within this context, threats and crises can change the operations dramatically and demand extraordinary leadership skills to solve the situation. Traditionally, crisis management relies on a hierarchical top-down leadership, where the main focus is to execute operations founded on rigid routines, rules, procedures, and resources available in normal operations (Hannah, Uhl-Bien, Avolio, & Cavarretta, 2009; Krabberød, 2014; Rimstad, Njå, Rake, & Braut, 2014). However, such practices are based on anticipated problems, and may therefore be inefficient – and maybe even harmful (see Kahneman & G. Klein, 2009; Tinmannsvik et al., 2011; Weick, 1993) – when the map no longer fits the terrain. We aim to expand the knowledge about crisis settings by asking: *How do the shift from routine to crisis operations affect interteam collaboration?*

This is a multi-method single case study anchored within the team oriented oil and gas (O&G) industry operating in the North Sea. The offshore O&G industry creates a unique context as it uses advanced technologies and operates under highly uncertain conditions, which have contextual implications for the involved teams' actions (Johns, 2006). The daily operations revolve around strict routines and procedures that help workers function efficiently, as well as minimize risk and uncertainty. It follows that the normal operational mode builds around a tight collaboration between the experts found in the onshore team and offshore-located operational teams. This collaboration tightly linked through advanced video and communication tools. The normal mode, however, can - and sometimes does - change rapidly. According to Petroleumstilsynet (2013), the North Sea annually experiences threats that have the potential to escalate into major disasters. Examples of such incidents include the Alexander Kielland in 1980, Piper Alpha in 1988, and Deep Water Horizon in 2010. Team leaders can therefore be pushed to solve problems that exist on the edges of what is possible, and performance should therefore be viewed upon the teams' ability to successfully innovate and solve the problem at hand.

Leadership and Team Dynamics

In the 1950s the Australian psychologist Cecil A. Gibb used the term «distributed leadership» to emphasize the dynamic relationship between influence and group processes (Gibb, 1954). He suggested that leadership should be viewed as shared functions among all members of a group, including the leader, and not as a concept solely connected to the formal leader. His view, which was held by most group sociologists at the time (e.g. Bales, 1950a, 1950b; Mills, 1967; Parsons, Bales, & Shils, 1953), is in line with the concept of leadership that we advocate in this paper. Thus, we define leadership as "the process of facilitating individual and collective efforts to accomplish shared objectives" (Yukl, 2013, p. 23). According to this definition, the leader must not only evaluate what behavior or action is appropriate in specific situations, but also what team member is the most appropriate for carrying out the action (Sjøvold, 2007). Nonetheless, Zander and Butler (2010) point out that the majority of leaders believe the formal leader is the only one who is allowed to lead. Ergo, it not straight forward to establish decentralized leadership in situations characterized by chaos and uncertainty.

We will, however, argue that it is especially important to establish such collective

leadership practices in order to succeed in dangerous and complex environments – a view that is acknowledged by modern military doctrines (e.g. Norwegian, American, Israeli, and more) (Sjøkrigsskolen, 2009; Sjøvold, 2014a) and modern maneuver warfare (Clemons & Santamaria, 2002; Danielsen, 2015; McChrystal, Silverman, Collins, & Fussell, 2015;; Shamir, 2011; Sjøvold, 2014a, 2016;). Leadership skills in maneuver warfare are seen as the ability to facilitate efficient team dynamics according to the operational context, thus enabling the teams to work towards a common goal, helping team members embrace uncertainty and solve problems.

The Spin Theory of Small Groups. In this paper, we base our discussions on the Spin Theory of Small Groups (Sjøvold, 1995, 2002, 2006a, 2006b, 2007, 2014b), which define a team as: "three or more people who share a common goal and interact to achieve this goal" (Sjøvold, 2006b, p. 17). The Spin Theory attempts to integrate leadership with well-documented aspects of group dynamics, as well as the group's dynamic relationship to its immediate context. The Spin Theory asserts that leadership effectiveness is relative to the characteristics of the context in which the team operates. In stable and well-known situations with standardized tasks, the most effective team dynamics and leadership practices are quite different from the efficient decentralized leadership behaviors that should be used to propel the same team through chaotic situations with complex tasks and high levels of physical and mental stress.

We introduce three central constructs in order to grasp the core of the Spin Theory:

Basic group functions. Albeit under different labels, the existence of four quite similar functions is well documented in theories of group development (e.g Bales, 1950a, 1950b, 1985; Bales, Cohen, & Williamson, 1979; Bion, 1961; McGrath, 1991; Mills, 1967; Parson, 1953; Parsons et al., 1953; Schutz, 1958; Tuckman, 1965). In the Spin Theory these *four group-functions* found the first construct and are labeled: *control, nurture, opposition, and dependence* (Sjøvold, 2006a, 2006b, 2007, 2014b). The *control* function enhances allocation of group resources and goal achievement and is supported by active, analytical, task oriented, or even autocratic behavior, while the *nurture* function enhances the social glue that creates group identity and is supported by active, caring, empathic, or even spontaneous behaviors. The *opposition* function represents the group's corrective means, and is supported by active, critical, assertive, or even self-sufficient behavior, while the *dependence* function upholds the group norms and is supported by passive, conforming, and obedient behaviors. The group functions

that predominate in a group will vary according to the situation and task at hand, along with the overt behavior of the team leader.

Balance and group dynamics. The second construct, *balance,* refers to these shifts of active functions and should not be confused with the idea of equilibrium that would indicate that all functions are present in equal strength at all times. Balance is better described by the term "on the edge of chaos" used in complexity sciences (Langton, 1989), representing a third state that is not chaos and not order but where both chaos and order seem to appear simultaneously. The usefulness of the construct balance is seen when observing the often hard to explain abrupt changes in team dynamics (Sjøvold, 2014b).

Group dynamics are defined as the constant shift in polarization and unification between subgroups or individuals in the group (Bales, 1950a, 1950b, 1999; Polley, 1987), and the four group functions seem to represent poles in the polarization (Sjøvold, 1995, 2007). How well a team handles these polarizations depends on how the leader facilitate the role-structure in the group. Group members display these social roles depending upon what they feel comfortable with (Hare, 2003). If teammates hold strong beliefs about an individual's role structure, they usually alter their own behavior automatically in order to see this behavior in their teammate. This means that the individual role preference can develop into a self-fulfilling prophecy, and therefore also lead to stereotypical presumptions from the rest of the group (Word, Zanna, & Cooper, 1974). For example, a likable person tends to take on a nurturing role in the team and a bossier person a more controlling role. If such a fixed role structure becomes part of the group's normal function, the team will suffer since the execution of the group functions depends on actions of specific individuals due to their social roles. It follows that such less advanced group dynamics contain more permanent polarizations, which can also induce conflicts within the team. On the other hand, if all members are able to perform behaviors that support all four group functions – and are not restricted by the expectations of others or the constraints of social roles – the speed of communication and decision making will significantly improve as the group dynamics advance. In the latter case, we say that the group display a flexible role structure and advanced dynamics, where the polarizations are frequent, brief and without any fixed pattern of poles or members. Ergo, an essential part of a leader's job is to fill or bring to the team whatever functions are needed to accommodate the team's needs in their operational situation (McGrath, 1962; Parson, 1953; Zaccaro, Rittman, & Marks, 2002). This is challenging in nature, and

Stogdill and Bass (1981) refer to balancing of optimizing productivity and caring for employees simultaneously as the "leadership dilemma".

Level of purpose. How efficiently the social roles shifts within the group forms the core of the third construct, *level of purpose* (LoP). This construct is defined in relation to the context the group confronts. In a well-known situation and standardized tasks, fixed role structures are often the most effective, while enabling a flexible role structure is mandatory when confronting complex tasks in chaotic situations, for the team to be effective. A group with fixed and more restricted role structure is said to operate on a *low LoP*; while a team with flexible and advanced role structure is said to operate on a *high LoP* (see Sjøvold, 1995, 2006a, 2006b, 2007b, 2014b). It should be noted, however, that the LoP should not be confused with phases of group development or similar concepts.

The leader is supposed to enable the team to change between different dynamics to match the situation at hand. Thus comparing dynamics in basketball teams and police Delta Force teams (see Dyer, Dyer, & Dyer, 2013) can be misleading and lead to inefficient leadership practices. Importantly, a group operating on a high LoP is able to switch leadership practices and dynamics in order to adapt to routines and standardized tasks, while leaders that enforces fixed and strict role structures, interaction patterns found at low LoP, will most likely see their team fail to adjust to novelty and uncertainty. The team leader is therefore responsible for enabling and facilitating group functions that are best suited to the context at hand (Marks, Mathieu, & Zaccaro, 2001).

How well the team leader succeeds in this effort depends on how advanced the group dynamics – or the group's LoP – is. A group operating on a low LoP needs a demanding and authoritarian leader, who also is responsible for supporting and balancing the four group functions. Conversely, within a team operating on a high LoP, the formal leadership role diminishes as most members contribute to this function and responsibility. High LoP dynamics are therefore slower (but more advanced as they include all social roles) than low LoP dynamics. This means that high LoP teams are better suited to accumulate learning and utilize their resources in order to adapt, learn, innovate and solve their tasks.

Shared mental models. The leader's obligations include aligning the team members' understanding of their purpose and internal interaction dynamics, which is the idea of *shared mental models* (SMMs) (Cannon-Bowers, Salas, & Converse, 1993; Mathieu, Heffner, Goodwin,

Salas, & Cannon-Bowers, 2000; Sjøvold, 2014b). People use mental models as a tool for systematizing the comprehensive information provided by the environment (Johnson-Laird, 1983; Sjøvold, 2006a, 2006b), allowing the involved members to take action based on their interpretations and conclusions. Cannon-Bowers et al. (1993) divide the mental models into several categories, and focus upon separate mental models for understanding technology and social interactions patterns. In our study, we focus on the latter category. Therefore, we align with researchers who say that teams' understanding of interaction patterns have the biggest influence on their performance, especially when the tasks are more uncertain and novel (Cannon-Bowers et al., 1993; Marks, Zaccaro, & Mathieu, 2000; Mathieu et al., 2000; Sjøvold, 2014b). Coinciding SMMs have been found vital for safety, learning, communication, and efficient performance (Espevik, 2011; Espevik, Johnsen, & Eid, 2011; Espevik, Johnsen, Eid, & Thayer, 2006; Nissestad, 2008). Diverging SMMs may therefore affect the team's performance in a negative way when novelty and complexity arise. Danielsen (2015) exemplifies in her research on Special Operation Forces (SOF) units how teams at a high LoP operate. She describes them as "one living entity", where the group is more important than the individual, and the team's SMMs are vital for success. Hence, the SOF teams' leadership practices and high LoP help to identify efficient team dynamics in order to adapt and innovate during extreme pressure

The majority of the daily teams leadership practices for the O&G groups in our study require the teams to follow fixed procedures, comply with internal rules, and adhere to the formal roles. In terms of the Spin Theory, they normally operate on a low LoP. Groups that operate most of their time on a low LoP tend to develop distinct norms that control their social interactions (Sherif, 1936; Sorrels & Kelley, 1984), which can be hard to change (Gersick & Hackman, 1990; MacNeil & Sherif, 1976; Rohrer, Baron, Hoffman, & Swander, 1954). Often they have meta-norms dictating that members of the group should not discuss their "regular" first-level norms (Hackman & Morris, 1975). Therefore, when groups' normal operations require low LoPs for efficient operation, their leaders have an overwhelming challenge to enable the teams to move through unforeseen and complex situations. We aim investigate how the leaders enable their teams to switch from routine to crisis operations. Such situations tend to appear abruptly in the O&G-industry, and require quite similar leadership styles and dynamics as military SOF teams display when they work with the unknown.

Research Design

We conducted an embedded single-case, mixed methods study (Yin, 2009) to investigate our research question within an O&G company in Norway.

Case Context

Integrated operations (IO) has propelled into a standard way of operating within the O&G industry. This standard includes technical critical systems, defined by Rushby (1994, p. 213) as "..[systems] whose malfunction could lead to unacceptable consequences. The unacceptable consequences depend on the context and could include loss of life, damage to the environment, or disclosure of sensitive information". The IO structure has led to new processes and routines, which include an increased usage of innovative technologies as the core of the operations (Albrechtsen, 2013), especially for ensuring efficient collaboration between off- and onshore teams. This enables the organization to perform several complex activities – which traditionally were done offshore – at onshore locations (Grøtan & Albrechtsen, 2008). Moving and centralizing knowledge bases to onshore offices set new standards for leadership and team dynamics, thus increasing the importance of efficient offshore-onshore collaboration.

The IO structure has changed the way the O&G organizations operate during normal and stable conditions – with more standardized working methods – and that may imply less critical thinking and engineering (Haavik, 2011). Nevertheless, standardization is always dependent on human interpretation, and many decisions needs to be done offshore. On the other hand, most of the organizational structures utilized during crisis modes have *not* changed after the implementation of IO (Grøtan & Albrechtsen, 2008; Tveiten, Lunde-Hansen, Grøtan, & Pehrsen, 2008). In such, it is still the offshore teams that are considered the active part, and who therefore both comprehend the risk scenario and implement the solutions. Subsequently, the onshore teams and resources are less active and only give feedback if they are asked or invited (Sintef, 2012; Tinmannsvik et al., 2011).

Threats in this industry can vary from what seems to be minor human or technical errors, to events arising out of the natural surroundings. An example of the latter was the 15.5 meter high wave that suddenly struck the COLS rig outside of Norway in 2015, killing one person and injuring four. It follows that creating a full understanding of all possible risks on a platform is close to impossible. Instead, highly dynamic teams and efficient leadership are needed to be able

to hinder possible treats to escalate. The offshore teams in this IO structure follow a shift rotation where the individuals belong to a minimum of two teams, which also includes some responsibilities during night hours. Conversely, team members onshore follow normal daily working hours. Therefore, the onshore team collaborates with all of the different offshore teams, while the all of the offshore teams do not necessarily meet or collaborate with each other.

Data Collection

Systematizing the Person-Group Relationship. The quantitative data were collected with the Systematizing the Person-Group Relationship (SPGR) instrument; which has a strong construct and predictive validity (Sjøvold, 2002, 2007). We utilized a SPGR 24-item behavior scale, and sent to all group members. Each item in this scale asks the respondent to provide self-ratings, *and* ratings of all teammates, to describe if the respondent thinks the rated object displayed a specific behavior: (1) *never or seldom,* (2) *sometimes*, or (3) *often or always*. The SPGR tool is constructed on a factor analytical space comprising the respondents' behaviors according to the four group functions. As the basic group functions are supported by a distinct set of behaviors, respondents' ratings, on average, yield a snapshot of a group's most predominant behavior. Therefore, the members' ratings of themselves *and* their teammates illustrate how they perceive each other's social roles based upon how often they notice a certain behavior (Sjøvold, 1995, 2002, 2007). The SPGR tool founds a set of analyses that are extracted from fine-grained analyses of the social fields, patterns of polarization, and different team typologies (Sjøvold, 2002, 2007, 2014b). Hence, it is possible to get a visual understanding of the variance in the ratings. This makes it possible to investigate how each of the respondents perceive its own, and the teammates' behaviors. In this paper, however, we have used the algorithms to create quantitative results.

To understand team dynamics in normal settings, we sent the survey electronically to seven teams; six located offshore and one onshore. The offshore teams contained six members, with at least one female member in each group; the onshore team was composed of five males. 38 of the 41 members answered the survey. The six offshore teams were asked to evaluate their own team members and their specific team as a unit. In addition, they also evaluated the individuals inside the onshore team and the onshore team as a unit. At the same time, the onshore

team was asked to evaluate themselves and two of the six offshore teams. All of our respondents had a diverse academic background and were within the age range of 30-60 years old.

In order to understand how leaders perceive ideal leadership behaviors, we have also collected SPGR data on this topic. To try to understand and create a norm of ideal perceived leadership behaviors in standard operations, 292 leaders within the focal company have answered a SPGR survey during the timespan 2011-2015 (a total of 5 years). As offshore teams also adapt to the crisis mode, we used the autumn of 2015 to collect SPGR data from 14 leaders, to understand how they perceive the efficient crisis leader. This was done to investigate whether there are any differences in how platform leaders comprehend an ideal leader during normal situations and an efficient leader during crisis modes. The demographics from those who answered the leadership behavior surveys followed the offshore and onshore team descriptions; about 1/6 were women and all respondents varied in age and academic training.

Interviews. To get an overview and insight of the topic and context (Daft, 1983), we started with a total of 11 meetings with executives where we read through internal information and discussed the context, problems, and our research question. During the period of 2014-2015, we visited one of the organizations' administrative buildings and borrowed their video conference equipment. We used a semi-structured interview guide to conduct 12 in-depth interviews – lasting from 1 to 1½ hours – with different leaders. Four of these leaders belonged to onshore teams, and eight others belonged to offshore teams. The respondents were anonymized.

In general, our qualitative work has been anchored in the principles from McCracken, (1988). Thus, we focused upon letting the respondents tell their story by discussing the topic during the interviews, emphasizing that we would not lead them to the answers. We asked the interviewees general questions about their utilized leadership style, but we also had more specific requests when we wanted more insight within certain topics. The latter strategy was used actively when respondents built the discussion around leadership during uncertainty and novel situations, as well as to gain insights from the organizational structures that handle threats. The work was documented by written memos and summaries from the initial meetings, and we recorded and transcribed the interviews before all the data was coded to theory.

Results

Results During Normal Operations

To compare results between the offshore and onshore teams, we used the average SPGR score from the former as they consisted of five teams. As displayed in Table 1, the two-way unpaired t-test did not reveal any significant differences ($p>.05$) in the way the teams described their own basic group functions. Tables 1-3 use a scale from 1-9, where 1 is the lowest score and 9 is the maximum score of the possible behavior.

Table 1

Average self-evaluation of the basic group functions from the five offshore teams, as well as the onshore team's values.

	Offshore	Onshore
Control	5.26	5.44
Nurture	4.02	3.50
Opposition	1.90	1.81
Dependence	6.90	6.50

Note. No significant findings.

Table 2 illustrates how the offshore teams describe the onshore team's behaviors and vice versa. There was a significant difference ($p<.001$) in the teams' perception of their counterparts' controlling behavior. Each group of the function can subdivided into two similar, but marginally correspondent categories (Sjøvold, 2002, 2006,2007, 2014b). As we found a significant difference in the perception of the control function, we subdivided this function into the categories *Ruling* and *Task orientation*. The results of from how the teams describe these categories are presented in Table 3. As we can see, the offshore teams perceive the onshore team as more ruling ($p<.01$), as well as utilizing more task oriented behaviors ($p<.05$).

Table 2

Offshore teams' description of the onshore team and the onshore team's portrayal of the offshore teams' behaviors.

	Offshore vs Onshore	Onshore vs Offshore
Control	6.39***	4.79***
Nurture	3.15	3.82
Opposition	2.19	1.71
Dependence	6.78	6.55

Note. ***p=.001

Table 3

Offshore teams' description of the onshore team's control functions, and the onshore team's portrayal of the offshore teams' controlling behavior.

	Offshore vs Onshore	Onshore vs Offshore
Ruling	5.56**	3.50**
Task orientation	7.16*	6.10*

Note. *p=0.05; **p=0.01

The t-tests document that there are no significant differences in how each of the groups describe their intrateam behaviors. The prominent significant finding is found in the interteam descriptions of how the control function is utilized, where the onshore team is described as utilizing more controlling behaviors. Table 1 also shows that the onshore team members describe themselves as slightly more controlling than the average found in offshore teams; however, this perception difference is not significant. Notably, the offshore teams actually perceive the onshore teams as more controlling than the onshore's own intrateam behavioral descriptions.

Level of purpose (LoP). The SPGR tool helps to measure elements that are important to the understanding of the dynamics within a team, and shows if the teams are operating on a high or low LoP based upon their intrateam evaluations. The offshore results were based on the average score from the five involved teams. In such, the polarization values – with a typical range from 1-8 – illustrate if there are subgroups within the team and indicate the level of cohesion in the teams, where low scores document low levels of polarization and higher levels of cohesion. In general, Table 4 shows that all of the teams have polarization tendencies, while the onshore team is struggling with a considerably higher level of polarization than the average

within the offshore teams. Following the same logic, the SMM values, typically ranging from 1-5, indicate if the perceived behaviors within the teams are diversified or consistent; the data displayed in Table 4 shows that the team members varies in their perception of each other and, therefore, have relatively low levels of SMMs. Further, influence values – typically ranging from 0.8-5 – show whether the team members are equally influential or not, where higher scores mean a more unequal distribution of power. From Table 4 the average score tells us that the offshore team members operate with some unequal distribution of influence, which also holds true for the onshore team. The last element in Table 4, LoC, shows whether the groups contain members that struggle with raising critical concerns. The average offshore score shows that 57% of the team members rarely provide critique, while 50% of the onshore members act in a similar manner.

Table 4

Measurement of the polarization, SMM, influence, and LoC as an average value for the five offshore teams, and the intra team values for the onshore team.

	Offshore	Onshore
Polarization	2.96	4.95
SMM	2.54	3.03
Influence	2.05	2.12
LoC	0.57	0.50

Note. SMM = shared mental models; LoC = level of contradiction.

Altogether, the quantitative findings from Table 4 demonstrate that all of the involved teams operate on a fairly low LoP. This is not surprising, as it mirrors their daily work, which is characterized by standardized procedures and routines.

Qualitative data. The team behaviors are displayed through the description of a generally friendly atmosphere, where the daily operations are based upon strict rules and procedures. These findings are especially apparent for the offshore teams, who see themselves as a family with strengths and weaknesses. Military jargon and referrals are prominent, especially when discussing how they use the normal settings, often mentioned as “peace time”, as a foundation to prepare for crisis settings. Obviously, the offshore platform creates an environment where subordinates and leaders live closely together, which forces the latter to understand and handle the balance between being a friend and a leader – a challenge that is not always

straightforward. Within this milieu, however, the teams have clear boundaries, indicating that team leaders tend to favor their own team and attribute negative traits to external parties. Leadership behaviors are viewed as characteristics of the leader's technical expertise and personality, which means that leadership varies from team to team. In addition, there are evident patterns of communication problems between the offshore teams. These problems are not limited to the misunderstandings caused by specific jargon within the teams; they are especially distinct during discussions of details and specialized knowledge. Expert knowledge is highly respected, and it is therefore not particularly popular to criticize, or raise questions, when someone has given their professional view. Problems and discussions are usually solved by the team leaders, or brought up the chain of command for a solution – ending up on the platform leader's desk.

The platform leader is expected to have the best overall understanding and is the one with the final authority, which also is the equivalent to being responsible for the overall risk picture. In such, it is said that he has at least three roles to fill: 1) being an administrative manager, 2) being a leader by creating a common goal and direction, and 3) being "the commander" and give concise orders and commands that are definite. The role requires an obligatory yearly training session that ensures that the platform leader is aligned with the organization's desired leadership style. Hence, the training addresses the organization's sought after leadership perspectives from the "command and control" structure, and imprint a focus on behaving task-oriented and authoritative, as well as being able to make – and implement – decisions under pressure.

Evidences of negative traits are noticeable during the discussions of the collaboration between offshore and onshore teams. The offshore leaders see their peers onshore as more controlling and task oriented. Thus, the offshore teams often feel that their onshore counterparts lack the ability to fully understand the context and the risk the offshore teams operate in. This leads to the offshore teams' frequent rejections of knowledge transfer attempts and innovative solutions initiated by the onshore side. A repeating comment is "*you must have been here for a while to understand,*" related directly to the risk they experience at the platform. The offshore teams often ask for customization for their specific platform, while an onshore member said, "*innovation, it is almost ironic; it would be an innovation for us as an organization if we could use more standardization."*

The onshore leaders claim that they are not a leadership team, but a group of leaders, indicating that they are struggling with their internal cooperation. The overall perspective within

this group is that platforms are a uniform context, enabling the organization to standardize most of their normal operations. Moreover, as the onshore team is located physically far away from the platform, they highlight that they lack the feeling of anxiety and stress that can arise offshore: "[…] *we do not have any risk in here, the worst thing that can happen here is that the coffee-machine shuts down. Out there however, you know you have a giant gas tank right underneath yourself, and you are more aware of what you are doing. For us (onshore), it might feel more like playing a computer game; even if you understand theoretically what is going on, you are just too distant from the possible danger – and we can therefore ask to push the boundaries more, we must be aware of that*." Thus, onshore teams are afraid of influencing their offshore peers to take actions that might expose them to more risk than necessary.

It follows that there are rather severe difficulties with communication and knowledge transfer between the off- and onshore teams. This is largely explained by the use of technological communications tools, which enables a mechanical communication style where the team leaders take the most influencing roles in the discussions, while humor and irony – natural parts of their normal intrateam communication – must be omitted. Additionally, while discussing this topic the onshore leaders reflected upon the previous findings by claiming that it is almost impossible to bring novel solutions offshore without either traveling there, or having some solid personal relationships to utilize. This last point is also highlighted by the offshore leaders as the most important factor in accepting onshore information and knowledge: "*it does not matter if you have been onshore for 10 years, you do not become an expert because of that. You must be in the field, attend the operations and learn in that way*." Having offshore experience is seen as fundamental for enabling efficient collaboration and understanding.

Results During Crises Modes

The difference between leadership behaviors in normal situations and crisis modes. We collected SPGR data to document how the organization perceives ideal leadership behaviors during normal operations, and how they describe an efficient leader under crises modes. In order to uncover the differences in perceived behaviors between these two modes, we conducted a two-way paired t-test based on the average group functions. The results from the t-test on the average group functions are displayed in Table 5, which documents that the respondents describe an efficient crisis leader with significantly (p<.001) less nurture and dependence functions than

the ideal leader in normal settings. Table 5 uses a scale from 1-9, where 1 is the minimum and 9 is the maximum displayed behavior.

Table 5.

Average evaluation of the basic group functions for the described ideal leadership behaviors and efficient crisis leadership behaviors.

	Ideal behavior during normal situations	Efficient behavior during crisis
Control	6.39	6.57
Nurture	3.73	1.86***
Opposition	2.18	2.07
Dependence	6.99	4.07***

Note.***p=.001

Qualitative data. Because incidents and impending situations can quickly evolve into major crises within this high-risk context, preparations through continuous drill exercises are seen as important aspects in everyday activities. To make sure that the framework and formal roles are well known, everybody goes through at least one emergency drill every period they are offshore. These trainings are described as relatively standardized scenarios, with some occasional novelty introduced into the situation. In addition, the whole leadership team also attends a specific training session every second year to ensure that they are aligned with the overall organization's procedures. The drills emulate routines and practices – sometimes with surprising consequences. Once during a real evacuation people ran into the lifeboat with their rescue suits in their hands, still wrapped up in plastic containers, ready to do the drop into the ocean. The response afterwards was that this is how they trained, and they were taught not to smudge them, so actually wearing the suits did not even cross their minds as they focused blindly on following orders. In addition, there were tendencies to panic when the person in charge of the lifeboat actually released the emergency bolt to make the drop – this had also never happened during training. Several comparable examples were described, indicating that the ways the trainings are performed create standards that are hard to change as the stress levels increase during real scenarios.

During the crisis mode, the organization changes from well-structured and possessing autonomous leadership behaviors to a more rigid command and control style. In this setting, the platform manager is the undisputed leader; he takes full responsibility and is involved in more or less all of the decisions that are made. While leadership in standard operations was seen as dependent on the personality of the leader, the crisis setting forces the platform leader to be tightly connected with a formal leadership role, one normally associated with a traditional military hierarchy's power and command structure. Whereas the leaders, if needed, significantly change their behaviors "*[...] if it is not how you prefer to behave, you act a bit – raise your voice and make sure that you are confident enough to create trust and safety within the team*." Being authoritarian and focusing on rules are traits regarded as vital leadership behaviors needed to succeed. If a leader fail to behave according to these expectations, the risk of losing the respect and integrity in the team is profound; and trying to regain what is lost is described as close to impossible.

During a diesel fire on the helipad – quite a dramatic situation that involved 35 meters high flames and loss of communication antennas – the involved platform leader explains that his job was to coordinate information, make decisions, and make sure that those decisions were implemented. In addition, he focused on keeping calm and demonstrating that he was on the task and working proactively. Interestingly, the frontline teams did not notice or report that the helicopter-personnel were safe, as they had performed an emergency take-off when they saw the fire; and due to the lack of communication antennas, they were not able to contact the helicopter crew until several hours later. Fighting this fire was demanding and pushed the involved personnel to the edge; some members actually froze and panicked, while others performed as they were trained to, and therefore helped solve the crisis. The leader says the successful recovery was a result of some degree of luck – the incident happened at a relatively safe place – good routines, and great frontline performance, as well as proper leadership.

Evidently, the operational structure completely changes when the alarm sounds, and the offshore teams adjust to the routines and procedures that they have previously drilled during the training sessions. Notably, this indicates that the onshore team withdraws from an active part into a supportive role – only becoming involved if invited. The offshore teams try in general to rely on the expertise they have available on the platform, and are reluctant to bring in anyone else. People are expected to step into their given roles and execute their assigned tasks – without

raising questions or critiquing – whereas there is little tolerance of failures of any kind. The platform manager must approve all exceptions from established routines; however, such exceptions are definitely to be avoided. As each crisis mode is followed by a post-crisis review, which emphasizes the importance of executing the formal routines, the involved leaders can get into serious trouble if they deviated from the standards, even if both the intention and result is seen as positive. Nevertheless, the leader in charge does whatever he thinks is necessary in the situation, and deals with the consequences afterwards.

Conversely, the offshore leaders claim that leadership starts when the regulations and procedures stop, herein embracing rapid decisions and clear orders. Such decisions also involve though choices, and are understood as a source for error. The results and outcomes can therefore vary in quality, and negative outcomes are largely explained by external factors outside of the leader's control. It is clear from the interviews that is the teams find it difficult to handle uncertainty and novelty, especially due to time pressure, the strict routines, and the complexity of ordering everyone in the same direction.

Discussion

Our findings show that the utilized leadership practices found in normal settings in our studied teams facilitate dynamics that are typical for teams operating on a lower LoP. Allover, the interteam collaboration points to struggles to establish a common understanding of the risks and details of a given situation. The in-group bias seems to hinder the teams in their attempt to reach for, as well as accept, new information and solutions. This bias is obvious, and tendencies of groupthink (Janis, 1972) and the Not-Invented-Here syndrome (Katz & Allen, 1982) are profound in the data. Some of the trouble can be related to context; the use of technological communication tools, as well as the fact that the IO structure enforces more routines, rules, and critical data structures, therefore possibly less engineering and human critical thinking (Haavik, 2011). The team leaders are obviously influenced by and try to align to the technological driven and routine oriented context, as the usage of the control and dependence functions within the groups are prominent. Relying too much upon big data and critical systems, though, might provide a false sense of security and become problematic when threats strike (Holloway, 1997; Kozlowski, Chao, Chang, & Fernandez, 2015; Rushby, 1994; Sull, Homkes, & Sull, 2015). To compare, the SOF teams adapt to novelty and uncertainty through leadership and team dynamics,

not technology and weapon systems. Teamwork is always the core in extreme military actions, and so should it be within the O&G settings.

The displayed leadership activities within the IO teams do not enable team efforts that can help to overcome the barriers in either normal or crisis settings. Contrary to facilitating interactions that open up curiosity and critical exploration between the team members, the leaders are in charge of coordinating and assembling information, decision-making, and giving directions. Such leadership behaviors give rise to concern, as the IO structure is supposed to be a catalyst that rapidly connects and transfers relevant expert knowledge, thus facilitating interteam collaboration, learning, and innovation. Instead, the implemented leadership style enforces team behavior that shows a limited interest in the environment outside of their boundaries and tasks.

Although the leadership practices vary due to personal preferences, there is ample evidence that illustrates the teams favor the idea of having a strong single leader. We also found that the preferred ideal leadership behaviors are theoretically capable of eliciting active participation from everyone in the team. The actual leadership findings, however, show the contrary, as the teams contain only a few influencing members, and display low abilities to raise critical questions and thereby challenge established truths. Notably, the leadership behaviors seem to satisfy intrateam needs as long the context remains stable, although there are clearly some obstacles within the interteam collaboration. These findings can be related to a sub-optimization, as the team leaders try to boost the performance within their specific group without a clear understanding of the general strategy, thereby not aligning properly to the overall organization (Sull et al., 2015).

The data indicate that the onshore team is perceived as more controlling than the teams offshore. Notably, the results also show tendencies of more polarization in the onshore team – but these findings are not significant and are profound behaviors within the offshore teams as well. Admittedly, the team members seem to be aware of the polarizations and the diversified mental models, but due to the low will to provide critique they fail to raise questions that help challenge and overcome these problems. In addition, the low levels of shared mental models indicate that the team members hold different perceptions of their colleagues and tasks, which again relates to the fact that they tend to look into the rules and routines for solutions. While the overall power is held by the offshore teams and the platform leader, the purpose of the collaboration with the onshore members might be seen a bit undermined. The onshore team, in

fact, works as a hub within the IO structure, and is responsible for coordinating and facilitating contact with the larger network. Due to the findings, however, the question may be raised as to whether or not the offshore teams and leaders really understand the rationales and tasks of their onshore peers.

Our results also show that the respondents describe the efficient crisis leaders with less focus on nurture and dependence functions, which again contribute to more salient autocratic and task dominant leadership behaviors. This is actually contrary to the findings that show that the efficient leaders in chaotic and dangerous situations are the ones who display truly empathic and vigilant behaviors toward their subordinates (Bachman, 1988; Sjøvold & Stålsett, 2016). These studies illustrate that that one of the most important traits of leaders with supreme performances were their friendliness and genuine interest in subordinates, even in the chaos of frontline warfare, while the average performing leaders followed behaviors more similar to the ones we have documented.

It would be reasonable to assume that the teams' LoP should be lifted upwards to be able to cope with complex and uncertain situations. In contrast, it seems quite the opposite. Instead of enabling dynamics that advance the team's LoP, the platform leader steps up as the supreme leader, and forces people into fixed roles – indicating that he is enabling even slower and more static dynamics than found during normal operations. The leaders in the studied company claim that this strategy is based on the military approach to uncertainty and threats. This way of interpreting advanced military strategies, however, is actually quite wrong and outdated. Alberts (2007) suggests renaming the command and control perspective "focus and convergence," in order to help the military – and others – to leave the imprinted original ideas. Military teams that truly surpass expectations in novel and uncertain situations have clearly left the single authoritarian leader, and embraced collective leadership with advanced interactions. These leadership behaviors build upon continuous training, whereas utilizing the full range of group functions and enabling shared mental models are fundamental.

Another consequence of the utilized crisis leadership is that the interteam collaboration between off- and onshore teams is minimized. In order to try to be efficient, the offshore teams try to avoid talking with their peers onshore and handle the situation alone. This, however, is the opposite idea behind the rationale of the IO structure, as many of the experts have moved to onshore locations. As noted, this structure strictly relies on procedures and routines. Deviating

from the formal routines are perceived as highly negative, even during crises when thinking outside of the box in order to create innovative solutions is needed. Indeed, punishing attempts to innovate and work outside of boundaries efficiently stop teams from displaying the dynamics needed to adapt to uncertainty and novelty (e. Edmondson, 2012; Edmondson, Bohmer, & Pisano, 2001; Garvin, Edmondson, & Gino, 2008; Sjøvold, 2006b, 2014b). A vital part of the military SOF training is to understand when it is accepted, or not, to break formal routines and orders (Danielsen, 2015). Building such situational understanding into the O&G industy's training should be fruitful in order to help the teams to innovate and handle pressure.

In a setting where an interplay between teams is needed, the executed crisis leadership practices cause some concerns. While these leadership behaviors obviously hinder the facilitation of interteam collaborations, they also hinder the teams in breaking out of drilled patterns and procedures that often are obviously inadequate for the situation at hand. This can become especially dangerous if the teams face high levels of uncertainty that require the strength and knowledge from all teammates in order to operate at a high LoP, and individual "heroes" fail to save the day. Changing the existing institutionalized command and control crisis procedure to a new setting with dynamic interactions between several teams will be demanding, and must involve all personnel. In fact, trying to establish such teamwork without a collective organizational effort can lead to rejections (Krabberød, 2014). This is exemplified in the Mann Gulch disaster, where 13 men died due to not following the unexpected orders from their new leader (see Weick, 1993). Shamir (2011) explains that collective and dynamic leadership approaches are not consistent with people's leadership theories, and therefore the idea of being proactive in situations missing preplanned responses seem counterintuitive. However, the benefits of team leaders that are able to enable high LoPs, and hereof enhance a dynamic interteam collaboration with shared leadership cannot be ignored. Indeed, such team leadership behaviors will be highly beneficial in both normal and crisis settings.

Limitations

We have conducted our research within one of part of the IO structure, in one company. Nevertheless, based on our meetings this setting should be representative of the whole organization. Furthermore, as far as the executives could tell, the studied context should also be representative for most of the IO structures found in the oil and gas sector. Arguing for the

unique context, and not generalize the findings to broadly are similar to what several researchers front (e.g. Johns, 2006; J. Martin, Feldman, Hatch, & Sitkin, 1983).

Another important limitation is that we did not observe – or quantitatively measure – the teams in a crisis setting. Still, the systematic data collection gave a clear description of how the participants expected to perceive their leaders in crisis modes. Future research might deepen and broaden the understanding of the crisis settings by using more innovative measurement solutions than we have been able to do (direct observation by trained observers or sociometric badges (see Kim, McFee, Olguin, Waber, & Pentland, 2012; Stålsett & Sjøvold, 2016). Such research strategies can help to display real time interaction patterns within the teams, and help to develop necessary behaviors. We also suggest that future research should expand our work into new contexts and industries. In addition, we specifically believe that the extreme settings found in the frontline of military work can supply valuable knowledge, as these teams always work with novelty and uncertainty, and their ability to innovate and solve problems should thus be of deep interest for innovative frontline teams in civilian settings.

Conclusion and Implications

The team leadership behaviors witnessed within the IO structure in our study facilitate unhealthy interaction patterns within the teams. Even if the teams seem to function relatively well during normal situations, they struggle with communication and collaboration problems. Furthermore, the leadership behaviors vary from team to team depending upon personal traits and expertise, which is somehow ironic as the organization tries to standardize all procedures, in order to make their structures and collaborations as efficient and transparent as possible. It is also obvious that the organization enforces authoritarian leadership practices that prevent interteam collaboration and innovative behaviors during novel circumstances. In fact, the strong emphasis of procedures and routines for the sake of efficiency seems to be more important than the ability to innovate and solve problems. By comparison, the Special Operation teams in the military do have a formal leader, but the leadership activity is not necessarily bound to the formal position. These teams illustrate that leadership activities can be facilitated and shared within the team, without the loss of formal power or depriving the leader of their responsibility. Such military teams interact with the flexible dynamics found in teams operating a high LoP. In such groups are individuals expected to challenge the status quo, and break orders if needed, in order to solve

the task at hand. These highly adaptable military teams have a clear understanding of their overall goal, and recognize how they should cooperate in order to push forward in attempts to innovate and find better solutions. Similar mentality, group dynamics, and leadership behaviors should be implemented in the O&G teams in order to excel and innovate during a crisis, as well as foster cooperative and innovation friendly environment during normal operations.

Our findings suggest that leaders have a distinct responsibility to balance their behaviors between setting directions and being emphatic, in order to align their teams with their tasks and operational circumstances. This is especially true in the technological-heavy, but relatively young, IO structure found in the Norwegian oil and gas industry. In our study, we document that the leaders generally struggle with this balance, and that the implemented authoritarian principles actually prevent dynamic, collaborative and innovative interteam behaviors. Obviously, such negative traits can be dangerous in a highly dynamic and ever-changing context.

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