COLLABORATING AND COMMUNICATING ACROSS DISCIPLINARY BOUNDARIES

A qualitative case study into the cross-disciplinary collaborative practice in Biomedical Engineering in the Netherlands

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About the cover

In this study team actualization was used as a conceptual aid to investigate a real-world collaboration. Team actualization is inspired by Maslow's famous (or infamous) pyramid of human needs, and like Maslow's pyramid, team actualization is depicted as a triangle in this report. The cover made by Charjan Steenhuis is an abstract illustration of the research process in this graduation project. Initially, team actualization was a major part of my efforts to grasp cross-disciplinary collaboration. As the study progressed empirical data started to play a more important role in understanding the collaboration process across disciplines.

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Ferdoos Esrail

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Thesis report for the Master track Science Communication at TU Delft

Preface

This report is a concise yet comprehensive end product of a long, exciting and at times a very arduous graduation project. At the same time it epitomizes the transitional process of becoming a qualitative researcher and thinker. Through my graduation I had to learn to think like a qualitative social researcher, which proved to be much harder than I thought it would be. However, I am very glad that I persisted because my personal learning goal was to become familiar with the qualitative tradition of social research. This thesis gave me the opportunity to enhance my intellectual capabilities and learn to think in a qualitatively (pun intended) new way. I could not have succeeded without the help of many people who supported me in my graduation project.

I want to thank the people of the DORA project for their cooperation in this study. Without their help I would not have been able to conduct an empirical study. I also want to tsshank Jenny Dankelman for her enthusiasm in the initial phases of this study, her guidance in the search of an appropriate project for my case study and her constructive feedback in the final phases of my graduation project.

I want to extend my gratitude to my second supervisor Caroline Wehrmann for her constructive critique of my work. I should have involved you much earlier in the process! I also want to thank my third supervisor Nick Verouden for his availability and continuous readiness to help me when I had difficulties with thinking like a qualitative researcher. I especially enjoyed our conversations on the sixth floor of the public library of Amsterdam. They were constructive and fun all in one! Of course, I want to thank my first supervisor Maarten van der Sanden for his dedication to my graduation project and the struggles that came with it. Without you, I probably would have given up the idea that I ever could finish this project. You were there when I needed you and you stayed away when I needed some space to think things over. I was very lucky to have a supervisor like you watching over me!

I want to thank my family and all my friends for helping me in some way to get to the finish line. I especially want to thank Leon, Marianne, Tiyam, Charjan for their support in the final phases of this project. Also, I want to thank the people in the SEC graduation room for their feedback and social support when things were difficult. I especially want to thank Benjamin, Aafke and Robin for their feedback on earlier drafts of this report.

Ferdoos Esrail
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پدر ومادر و عزیز و مهربانم!

زبان , ساده زبان به پس نکردم پیدا اما , بدهد نشان شما به مرا احساس اندازه که کنم پیدا خوب متن یک که گشتم خیلی هستید دنیا مادر و پدر بهترین شما که نویسم می و گویم می خودم!!!

وقت ها درس تراکم نسبت اما کنم تعریف اینجا مانرا های کودکی دوران جالب و زیبا خاطره چند خواست می دلم خیلی هر از فارغ میزدیم پرسه تان محبت و مهر های کوچه در که بخیر یادشان ها روز ان و ها خاطره ان ولی ,نمیکنم و بود معجزه نگاهش که مادری که داشتیم خود پشت مستحکم تکیه گاه دو چون مسولیت گونه هر و زندگی های دغدغه میکرد معجزه دستهایش که پدری.

حس چون ,نکنم تکرار را گذشته اشتباهات ,کنم زندگی خوب گرفتم یاد که شدم بزرگ آنقدر ,شدم بزرگ دیگه امانم برد لذت ان از باید است نظیر بی و ای تازه شروع اش لحظه هر زندگی این که کنم میکنم.

کنیم اش حس نگذاشتید شما که هایش کمبودی همه با مان زندگی جزیره همین داریم که کوچک خانه همین که ام فهمیده بود خواهد و بوده بهشتی چی.

در که فکریست مهم ...نیست مهم برایم شان فکر طرز و ها آدم ,نیست خانواده از مهمتر هیچی که دانستم و شدم بزرگ مهم ,داره بی بی جنس از های نگرانی که دانایست بزرگ مادر مهم ...است رفیقم دو و برادر دو مهم .... دارم سر پرستار دو مثل و کنم حس را مادر دوری نگذاشتند انهایکه دارم میلاد و ژاله و هما خاله با که است خوشی خاطراتی را سینا علی و فردین دوری تا خنداند که می مرا هایش شوخی با فقط که میلادی و .بودند کنارم در روز و شب مهربان کنم فراموش .

کریستال و کیان زیبا فرشته دو مهم. اند ام زندگی رفیق دو که است ولید ماما و ضیاء ماما ببخشید... اوه سیاه ماما مهم بداریم شان دوست ما تا آورد دنیا به را اینها که مادرشان از تشکر و .دارند خاصی جای خانواده فرد هر دل در که است دو هر و ساخت رنگین مارا روز و شب زحمات با و که مادریست مهم نکرد دریغ ما از را مهرش که پدریست مهم زندگی فرزندانش که بینند می اینک و . شدند ما گاه تکیه خوب های روز در بد های روز در داشتند توان در که آنچه ادانند می قدر و اند گرفته یاد را کردن!!!

آزاد اینکه برای ,.اید بوده ما کنار در که هایی وقت همه برای عزیز خانواده و جان مادر و جان پدر تشکر دیگر یکبار , مادر و عزیز پدر و ,.دادید گوش ,.کردید تحسین ,.کردید اعتماد اینکه برای , . کنیم تجربه را زندگی تا گذاشتید مان شما ,.کنید حساب برادرانم و من روی داشتید دل درد به احتیاج وقت هر که بدانید من خدای نه فرشته نه , فرشته نه مادر چون کرد اندازه نمیشه را شما محبت . باشید شاد و بخندید همیشه پس ,.خندید می وقتی مخصوصصن آوردید شادی همیشه بود خواهد و است نهایت بی .

شما به من ,بنویسم را دانشگاه نامه پایان اینجا تا نبودم من امروز نمیشدید گاهم تکیه و نبودید کنارم در ها شما اگر از موفقانه غربت و جنگ اخیر های بختی بد و مشکلات همه با توانستید که باشید بلند سر باید هم شما و میکنم افتخار ما به که عشقی با شما اما دشوار کاریست خودش بیگانه کشور یک در کردن زندگی و آمدن شوید بدر زمان ازمون شماست با سایه چون همیشه تلخ های گذشته ان میدانم چی گر ,, نکردید فکر ان به و گذاشتید سر پست را همه داشتید کند خم را تان کمر که نمیگذارید و دارید شهامت اما .

چی و بیاورم زبان به چی دارم دوستتان همیشه و کنارم در تان بودن برای تشکر و سپاس هزاران هم باز اخیر در نیاورم!!!

با محبت و عشق فرزند تان فردوس

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Contents

Summary

This graduation thesis forms an inquiry into the cross-disciplinary collaborative practice in Biomedical Engineering in the Netherlands. The rationale of this study was provided by Professor Jenny Dankelman (BioMechanical Engineering, TU Delft) who indicated that she would like to gain better understanding of the collaboration process of technical experts and health care experts. Professor Dankelman's experiences and a literature study showed that cross-disciplinary collaboration is challenging because of diverse group of disciplinary experts with differing perspectives need to develop a common working understanding in their collaborative project.

To explore how these challenges took form in cross-disciplinary collaboration in Biomedical Engineering in the Netherlands, we conducted a qualitative case study of a cross-disciplinary project between a technical university and a peripheral hospital (the DORA project). The main goal was to create more awareness within team DORA of the challenges and opportunities of the collaboration process. We used Deanna D. Pennington's framework of *team actualization* as a conceptual springboard to empirical investigation. She maintains that effective cross-disciplinary collaboration depends partly on a group's capacity to value different disciplinary perspectives appropriately and to accommodate those perspectives in a shared research vision that makes full use of the diverse expertise available in the group. Team actualization represents an ideal type of situation in which cross-disciplinary experts can work autonomously but the team is effective because every expert knows how his/her fits in the shared vision that drives the team effort. The main research question of this research project was as follows:

To what extent does team actualization enable participants of the DORA project in the collaboration process?

To answer this research question we employed a qualitative research strategy and an inductive-deductive approach to data analysis. The concepts constituting team actualization were used as sensitizing concepts in setting up an interview guide for semi-structured interviewing. Sensitizing concepts are often used in qualitative research as springboards to investigate empirical instances. The main research method comprised 9 semi-structured interviews with key participants of the DORA project. These data were complemented by observations of interactions between participants in the DORA project at 11 meetings. We used a thematic analysis to analyze the data. This process was initially inductive of nature, which means that the first interviews were coded using 'open' codes that stayed close to the data. These codes were used to set up a 'closed' coding framework with which the remaining interviews were coded. The observational notes were used as aid in the interpretation of themes that emerged from the interview data.

The findings of this study suggest that team actualization within the context of the DORA project is characterized by the following:

- The research vision of the technical university researchers incorporated the interests of the hospital and acted as an important driver of this collaboration. The vision was broadly supported by the team members and seemed to mediate the different perspectives that were present in this collaboration.

- The team of researchers and health care professionals had a contact group as the main decision-making organ. The long-standing relationships and familiarity between key members of the contact group had resulted in a firm basis of trust, which manifested itself in informal decision-making based on verbal agreements.

- One team member played a crucial role in safeguarding the substantive progress of the collaboration by monitoring research activities in the hospital. In this way she was pivotal to the effectiveness of team DORA's collaboration process and therefore helped team DORA to become actualized.

Based on our findings we want to raise team DORA's awareness for the following points:

- Team DORA is effective in reaching their goals due to the presence of a content manager in the collaboration process. This is potentially a good strategy for effective collaboration because the team does not need to set up a very dense substantive shared vision in which all individual perspectives of team members are incorporated. Then the team should enable one member to be the manager of the collaboration process and explicitly discuss what he or she needs to make the collaboration move forward.
- When a content manager is elusive, team members will probably have to build a substantive shared vision for the collaboration to progress. The firm basis of trust can then be used a springboard to a substantive shared vision that integrates different disciplinary perspectives present in the collaboration.
- According to the points above, there are two ways for team DORA to expand their network. First, a new actor may be familiar with the common history of interaction and the long-standing relationships of team DORA. The basis of trust of team DORA will probably ensure an easy entry of the new actor into the team. Second, a new actor may be interested to join the collaboration, but not have the proper social connections with team DORA. According to our understanding of the collaborative process of team DORA, this means that the content manager will be the main entry point for the new actor.

According to our knowledge, this is the first social scientific study into cross-disciplinary collaboration in Biomedical Engineering in the Netherlands. We hope that this inspires further study of the collaborative practice in this field and we recommend the following topics for future research:

- What organizational structured and management styles are required for effective cross-disciplinary collaboration (in terms of reaching intended goals) in Biomedical Engineering?
- How do the social relationships between different disciplinary experts in a collaboration affect communication in cross-disciplinary problem solving in Biomedical Engineering?
- How do individual differences in framing of the content of a collaboration (research problem, goals etc.) affect communication in cross-disciplinary problem solving in Biomedical Engineering?

1. Introduction

The subject of this Science Communication thesis is cross-disciplinary collaboration in Biomedical Engineering in the Netherlands. In this introductory chapter we will first provide the reader with some background to this project (section 1.1). Then this chapter will move on to discuss the rationale of this research project (section 1.2). Sections 1.3 and 1.4 elaborate on the theoretical notions about cross-disciplinary collaboration. Section 1.5 discusses the purpose of this study. Sections 1.6 and 1.7 present the research goals and research questions. In section 1.8 we will shortly discuss the relevance of this research project. Section 1.9 contains the concise outline of this document.

1.1 Background

The increasing complexity of problems facing society challenges the conventional, unidisciplinary production of knowledge in science and engineering (Miller & Mansilla, 2004; Pennington, 2008; Stokols, Hall, Taylor, & Moser, 2008). Facing challenges like climate change and aging populations many governments, funding agencies and other key players in science and engineering in Western countries have recognized that research teams comprising multiple disciplines are required to solve these problems (Spaapen, Dijstelbloem, & Wamelink, 2007; Paletz & Schunn, 2010; Mansilla, Lamont, & Sato, 2013). For instance, Medical Delta is a consortium of life sciences, medicine and technology partners that promotes collaboration between experts from those fields in order to tackle pressing challenges in the health care sector in the Netherlands. One of its aims is to enable "focused cooperation between ... technical expertise and the medical field" in developing innovative solutions to health care problems (Medical Delta, n.d.). While this type of *cross-disciplinary* research is increasingly encouraged by funding agencies, one of the greatest obstacles to effective collaboration between researchers from multiple disciplines remains setting up and sustaining cross-disciplinary communication over the life-span of a collaborative project (Jeffrey, 2003; Mansilla et al., 2013; Pennington, 2011a). Many commentators argue that effective communication is crucial for the process of knowledge integration and development of innovative solutions to complex problems that face science and engineering (see e.g. Klein, 2005; Pennington, 2008; Stokols et al., 2008a,b; Wagner et al., 2011).

1.2 Rationale of the study

The topic of this graduation research project is cross-disciplinary collaboration in the field of Biomedical Engineering in the Netherlands. The focus on Biomedical Engineering follows from my background in Mechanical Engineering at the TU Delft. In this project we worked together with Professor Jenny Dankelman of the department of BioMechanical Engineering at the TU Delft. Professor Dankelman is a leading expert in minimally invasive surgical techniques and she is also closely involved in the Medical Delta consortium described above. As such she has collaborated with many clinicians and health care professionals throughout her career. In our talks it became clear that she acquired numerous insights about the collaborative process from experience in cross-disciplinary projects with health care researchers and professionals. Professor Dankelman acknowledged that disciplinary differences in the way of thinking and working styles caused difficulties in the communication and collaboration between engineers and health care experts. She

indicated that better understanding of the collaborative process in Biomedical Engineering projects could yield beneficial insights on how to overcome these difficulties in current and future endeavors. To address this knowledge gap this Master's thesis focused on extending the understanding of cross-disciplinary collaboration in Biomedical Engineering by exploring the perceptions and experiences of other collaborators in that field.

1.3 Cross-disciplinary as a generic label

There are well-known approaches to cross-disciplinary research described in literature, typically ranging from *multidisciplinary* through *interdisciplinary* to *transdisciplinary* (Stokols et al., 2008a). The distinctions between these approaches are often related to the degree of knowledge integration respectively going from mere juxtaposition of disciplinary knowledge to the merging of disciplinary knowledge into hybrid perspectives (Wagner et al., 2011). In this thesis, we will partly follow Stokols et al. (2008a) in the sense that we are concerned with "initiatives that promote cross-disciplinary collaboration rather than unidisicplinary" (p.S78). They move on to use the labels interdisciplinary and transdisciplinary because, they argue, those collaborations have the explicit goals of intergration of knowledge, method and tools. However, many authors use interdisciplinary and multidisciplinary as synonyms. To avoid confusion we will use cross-disciplinary collaboration as a generic label for all types of collaborative scientific efforts that tend to *cross* disciplinary boundaries (Jeffrey, 2003; Dewulf et al., 2007).

1.4 Challenges of cross-disciplinary collaboration

Unlike unidisciplinary collaboration, cross disciplinary collaboration involves complex problem solving or the creation of new and integrated knowledge by experts with different disciplinary backgrounds (Maglaughlin & Sonnenwald, 2005; Wagner et al., 2011; Pedersen, 2012). The diversity of explicit and tacit knowledge, methods, tools and skills in a cross-disciplinary setting provides researchers with opportunities for setting up a comprehensive and potentially innovative framework for a problem that requires multiple disciplines to be solved (Maglaughin & Sonnenwald, 2005; Sonnenwald, 2007; Pennington, 2011a). However, the diversity of disciplinary perspectives involved in cross-disciplinary collaboration presents a major challenge when researchers try to make sense of issues in a specific research context (Dewulf et al., 2007). Research that cuts across disciplines can be problematic because integration of knowledge is cumbersome due to the fundamental differences between disciplinary perspectives of collaborators (Pennington, 2008). For example, the way an engineer makes sense of a certain problem differs substantially from the way a surgeon does. While the engineer is trained to look for the optimal solution and takes his or her time to find it, the surgeon may have limited time and will arguably accept a solution that is 'good enough'. The term *disciplinary perspective* refers to the way of seeing and thinking that is based on commitments to a discipline, and which is used to frame problems in a particular way (Miller & Mansilla, 2004; Pennington, 2008).

Communication in cross-disciplinary collaboration pertains mainly to effective coordination among those "minds that frame the world in distinct ways" (Miller & Mansilla, 2004, p.5). Differences in interpretations and expectations may lead to intellectual or interpersonal conflicts throughout the lifetime of a cross-disciplinary endeavor (Levine & Moreland, 2004; Klein, 2005). For example, impasse in the construction of a common vision on the most important aspects of a cross-disciplinary project (e.g. the research problem and methodology), may cause researchers to withdraw from the collaboration and skew research efforts toward a certain discipline (Jeffrey, 2003). Challenges like

these can emerge in every stage of a collaboration (Sonnenwald, 2007). Interactions between disciplinary experts must therefore be conducive to a cross-disciplinary dialogue if the group wants to reach its intended goals (Mansilla et al. 2013; Pennington, 2011b). Dialogue as a paradigm for communication entails willingness to listen, respect for other opinions, openness to alternative interpretations and suspending judgments among other factors (Boreham & Morgan, 2004; Nagda, Gurin, Rodriguez, & Maxwell, 2008). The cross-disciplinary dialogue is an ongoing process in which collaborators explore disciplinary assumptions and biases, learn from other perspectives and work towards a common understanding that amalgamates various disciplinary perspectives (Nagda et al., 2008; Sonnenwald, 2007; Pennington, 2008). This means that participants in a cross-disciplinary collaboration must invest time in establishing social ties and building rapport (Guimera, Uzzi, Spiro, & Amaral, 2005; Shrum, Genuth, & Chompalov, 2007; Stokols et al., 2008b). Interpersonal factors such as familiarity, communication, mutual trust and respect and a sense of belonging to the group play an important role in creating and maintaining a hospitable conversation space for cross-disciplinary dialogue (D'amour et al. 2005; Klein, 2008; Stokols et al., 2008b; Mansilla et al., 2013).

Inter-organizational character of cross-disciplinary collaboration

Collaborations are not only marked by the presence of individual researchers from diverse disciplines. Cross-disciplinary research projects may also feature multiple organizations (academic, industrial and governmental) that come together to form innovation partnerships, public-private consortia and large-scale research networks (Klein, 2005). In inter-organizational settings the individual interests of disciplinary experts (Dewulff et al. 2007; Pennington, 2011a) is accompanied by the interests and constraints of their parent organizations (Shrum et al., 2007). In their recent book *Creating Conditions for Promising Collaborations*, Kaats and Opheij (2014) present a concise description of collaboration between organizations and, although they do not focus on scientific collaborations, their definition certainly illuminates the inter-organizational character of cross-disciplinary research collaboration: "Collaboration between organizations is a form of organizing in which people from autonomous organizations go into durable agreements and, by doing so, mutually harmonize elements of the work between themselves. This results in a wide range of collaborative partnerships with a durable intention, but still with a finite duration" (p.15).

1.5 Purpose of the study

The purpose of this study is to gain better understanding of cross-disciplinary collaboration within the context of Biomedical Engineering in the Netherlands. We have seen in the previous section that cross-disciplinary collaboration more than unidisciplinary collaboration features complex interpersonal interactions between team members. To assure that we get a good impression of these, we have chosen for a qualitative case study as a general approach in addressing the purpose of this study. This methodology enables the researcher to look at the subject of study from multiple angles (e.g. several data collection methods) and to acquire depth of understanding of a certain phenomenon (Baxter & Jack, 2008). With the risk of describing this research project in terms of what it is not, we want to convey to the reader at the outset that this study falls in the qualitative tradition of social research and is not about measuring variables, proving hypotheses or generalizing results. The research methodology will be discussed in more detail in chapter 3.

Because cross-disciplinary collaboration can vary in various dimensions such as goals, size, duration, organizational structure and the scope of the collaborative project (Stokols et al., 2008a), it is important to be clear at the outset about the kind of collaboration studied here. The subject of this case study is an inter-organizational collaboration

between a department in a technical university in the Netherlands and a local hospital. The group of involved researchers and professionals has a cross-disciplinary character including disciplinary backgrounds in engineering, nursing and medicine. Their collaborative effort concerns a health care innovation project (the "Digital Operating Room Assistant"; acronym "DORA") instigated by the technical university in 2011 and their objective is to explore the possibilities of automatic monitoring of operation room processes in order to optimize these processes in terms of safety and efficiency. This innovation idea was still the driving force of the collaboration during the period of empirical study (December 2014 - April 2015) and the need for better understanding the cross-disciplinary collaboration was pertinent to the group. We will refer to the group of involved researchers and health care professionals as "team DORA" and their collaborative project as "the DORA project". The subject of study is described in more detail in section 3.2.1.

There are several reasons for choosing this case as focus of this study. First and foremost, this collaboration is a suitable context for addressing the knowledge gap that we described in section 1.2 because it provides rich information on cross-disciplinary collaboration in Biomedical Engineering. Indeed, the case features researchers and professionals with engineering and health care backgrounds who are trying to find solutions to pressing problems in the health care practice. Second, it is an exemplifying case because it is member of a broader category of cross-disciplinary projects. Similar types of collaboration with other medical centers were in fact instigated by the same department of the technical university and their intention is to extend these activities in the future. Third, gaining access to the group members of this collaboration was relatively easy. This minimized the practical constraints of selecting an appropriate sample of participants for the study.

1.6 Research goal

The specific goal of this research is to gain insights in the collaboration of team DORA with the intention to better enable team members in the collaboration process by extending their awareness of the positive aspects, the challenges and the opportunities of the collaboration process.

1.7 Research questions

Research shows that cross-disciplinary collaboration is a multifaceted phenomenon which requires a theoretical lens to facilitate analysis. This thesis uses *team actualization* (Pennington, 2008) as a conceptual springboard to empirical study. Pennington (2008) argues that effective cross-disciplinary problem solving depends partly on a team's capacity to value different disciplinary perspectives appropriately and to accommodate those perspectives in a shared research vision that makes full use of the diverse expertise available in the group. She indicates that team actualization represents an ideal type of situation in which individual researchers work autonomously but the team is effective because individuals know how their focus fits in the shared vision that drives the team effort. Moreover, the shared vision functions as a compass for collective decision making in the group (Pennington, 2008). There are several important factors that influence the ability of a team to become 'actualized'. For instance, it requires that the perspectives are made explicit and that fundamental disciplinary assumptions must surface (Pennington, 2008). Individual researchers must be willing to submit their disciplinary perspective to scrutiny and challenge their assumptions, which requires open communication and a safe environment in which interactions take place. This can be

facilitated by social relationships and mutual trust between individuals involved in a cross-disciplinary collaboration (Pennington, 2008). An appropriate physical environment for interpersonal interactions (e.g. good meeting rooms) is a necessary condition for collaboration to actually happen (Pennington, 2008).

Pennington (2008) views effective cross-disciplinary collaboration as an advanced learning problem. According to her, team actualization as a framework constitutes important motivational factors that contribute to a better understanding of cross-disciplinary collaboration as a learning process. She moves on to consider constructivism and organized learning as important processes for cross-disciplinary collaboration but this falls outside the scope of this research project. In this study team actualization functions as an appropriate springboard to intensive analysis of a single case. With reference to this, the most important consideration for choosing team actualization as a framework was that it is sensitive to the challenges of cross-disciplinary collaboration as described in literature reviewed here (see section 1.3). We will discuss this in more detail in chapter 2.

Pennington's work focuses on collaboration of domain scientists by IT-experts and computer scientists (who build tools/environments for those researchers). This resonates with the situation in the field of Biomedical Engineering where engineers are needed for their technical expertise in solving pressing problems in health care and medicine (Medical Delta, n.d.). However, the transferability of findings or conceptualizations based on one field may be limited because each cross-disciplinary collaboration is unique in some way (Pennington, 2008; Wagner et al., 2011). It is therefore important to be critical and to put the perceptions and experiences of the participants on center stage. Indeed, the impetus of this study was to gain deeper understanding of the collaboration process of the DORA project team. Team actualization was used as a starting point and an interpretive aid through the research process (see section 3.1.2). The overall research question and subquestions are as follows:

To what extent does team actualization enable participants of the DORA project in the collaboration process?

To what extent does team actualization enable the participants of the DORA project to cope with the diversity of perspectives present in the collaboration?
To what extent does team actualization enable the participants of the DORA project to make decisions with respect to the goals of the collaboration?
To what extent does team actualization enable the participants of the DORA project to monitor progress toward the goals of the collaboration?

The main method used to answer the research questions was semi-structured interviewing. Observations of meetings within the context of the DORA project were used as an auxiliary method to semi-structured interviewing to get an impression of the social dynamics of this collaboration.

1.8 Relevance of the study

This research project has been done as a thesis assignment for the Master of Science track *Science Communication* of the department of Science Education and Communication (SEC) at the TU Delft. The relevance of this study for SEC mainly pertains to the detailed account of the interactions and communications of a cross-disciplinary team comprising

technical researchers and health care professionals. Although this project considers a relatively small network, it has added value for the research SEC conducts on the role of strategic communication within multidisciplinary collaboration in networks. Furthermore, according to our knowledge this study is the first social scientific analysis of the cross-disciplinary collaboration practice in Biomedical Engineering in the Netherlands and hence it may be a useful springboard for further study of cross-disciplinary collaboration in that field.

1.9 Report outline

This report features 6 chapters including this chapter. The next chapter discusses the conceptual framework in more detail. Chapter 3 elaborates on the research methodology that was applied to answer the research questions. It includes details about research strategy, research design and data analysis techniques. Chapter 4 presents the main findings of data analysis and chapter 5 answers the overall research question described in section 1.7. Chapter 6 concludes this thesis report by reflecting on the research process and on the findings and conclusion. It also contains recommendations for future research and recommendations for team DORA.

2. Conceptual framework

In this chapter we will discuss the conceptual framework that underlies our empirical study. Section 2.1 introduces the conceptual model of *team actualization*. Section 2.2 elaborates on the elements of this model: shared vision, recognition of perspectives, social relationships, group security and physical mechanisms.

2.1 The team actualization model

In her 2008 article *Cross-disciplinary Collaboration and Learning* Pennington explores the idea of cross-disciplinary collaboration as a learning problem. She advances that "a set of individuals representing diverse perspectives and interests must learn each other's mental models, learn how to fuse those differences into a collective conceptual framework, and learn how to use that conceptual framework as a springboard to creative problem solving" (p.1). She argues that if learning is an integral part of collaborating across disciplines, then enabling effective collaboration relies on developing a better understanding of learning in cross-disciplinary group settings. In accordance with Abraham Maslow, Pennington maintains that learners must be motivated and that understanding motivational factors for participation in cross-disciplinary settings is key to enabling effective collaboration. Within this context, she proposes the notion of team actualization in mapping out these motivational factors.

We used team actualization as a conceptual framework that concisely yet comprehensively links together a number of important factors related to cross-disciplinary collaboration. Based on Pennington's ideas, we have conceptualized these factors as *shared vision, recognition of perspectives*, *social relationships*, *group security* and *physical mechanisms* (see in figure 2.1). Team actualization is the equivalent of self-actualization, the highest motivational level, where advanced learning happens (Maslow as cited by Pennington, 2008). Pennington (2008) states: "Team actualization occurs when different perspectives are recognized and valued, and the team has evolved to accommodate the different perspectives into a shared vision that makes full use of the expertise available on the team" (p.13). Parallel to Maslow's reasoning, Pennington (2008) maintains that team actualization can only occur when concerns about lower 'needs' are satisfied. For this reason we organized the factors mentioned above in the hierarchal model shown in figure 2.1. In the next section we will discuss these factors one by one.
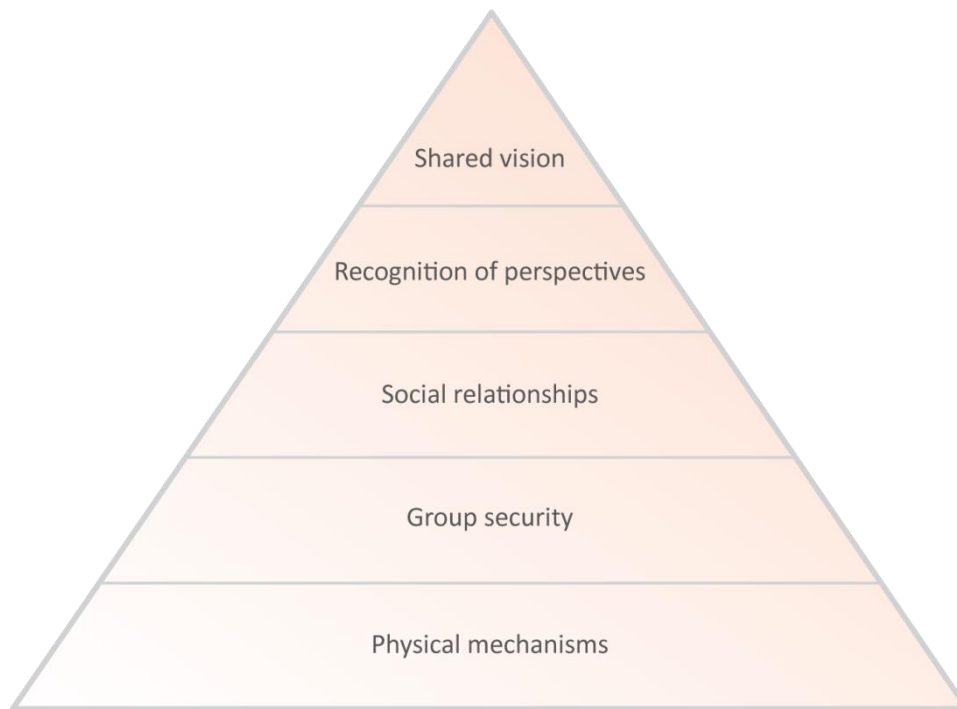
Figure 2.1 Conceptualization of Pennington's ideas

2.2 Elements of team actualization

2.2.1 Shared vision

A shared vision ensures that individuals in a cross-disciplinary setting have a collective understanding of what they want to accomplish as a team and how individual contributions fit the team effort (Paletz & Schunn, 2010). It functions as a guiding principle when the team makes decisions on the course of action in the collaborative project (Pennington, 2008). As the collaboration progresses the team must ensure that the shared vision remains clear and relevant, and adjust the vision if necessary (ibid.). Pennington (2008) argues that the degree to which team goals are congruent with the participants' personal goals influences their commitment to a shared vision. She states that goal congruence is salient to cross-disciplinary collaboration as individual researchers are often trained to narrow down their research focus, which makes the process of finding common ground difficult and consequently impedes the construction of a shared vision. However, the collective nature of the general problem requiring cross-disciplinary collaboration can also be the facilitator of finding common ground, as individuals are able connect their research focus and goals to a greater objective (Sonnenwald, 2007).

2.2.2 Recognition of perspectives

Setting up and maintaining a shared vision depends on a cross-disciplinary group's ability to apply divergent thinking in exploring the problem space and convergent thinking in determining how individual contributions may contribute to solving the problem (Pennington, 2008). Recognition of the value and strengths of each disciplinary perspective is key here (Pennington, 2008; D'amour et al., 2005). This has several implications. For instance, how does the group cope with the diversity of knowledge and is it able to find complementarity in perspectives? Pennington (2008) maintains that links between the different disciplinary perspectives can only be established through dialogue. Dialogue is an ongoing communicative process, which requires that participants show willingness to listen, remain open to alternative interpretations and respect each other's opinions (Boreham & Morgan, 2004). Cross-disciplinary teams feature multiple disciplines, each with its own concepts, methods, language and standards (Miller & Mansilla, 2004). If ambiguity arises from differing interpretations, the group must not do away with differences but rather explore them in a constructive way in order to come to a common working understanding of their project (Sonnenwald, 2007; Dewulf et al., 2007). This allows the group to map different disciplinary perspectives and how these may contribute to the team outcome.

2.2.3 Social relationships

Building linkages between perspectives through dialogue is difficult because it requires repeated and constructive social interactions between team members (Mansilla et al., 2013). Pennington (2008) states that social relationships between team members are critical in their effort to collaboratively solve a problem or create new knowledge. She indicates that any group consists of individuals with different characteristics. Experts in a cross-disciplinary team are likely to have weak social ties because they have had training in different departments or universities, attend different conferences and publish in different journals (Cummings & Kiesler, 2005). In essence, social relationships between group members weave together a socially and professionally diverse group of disciplinary experts and provide the foundation for constructive cross-disciplinary dialogue (Pennington, 2008; Mansilla et al., 2013).

2.2.4 Group security

Group security relates to conditions that make up a suitable environment for social and intellectual engagement between team members (Pennington, 2008). Pennington (2008) advances that cross-disciplinary collaborations thrive in an egalitarian and trusting atmosphere in which members feel safe to express their views and opinions and feel secure about the composition and intactness of the group through the life-time of a collaborative project. She states that dominant individuals - who tend to set out research directions - must therefore be contained to allow meaningful engagement between team members. Klein (2005) maintains that individuals with academic status may dominate discourse and inhibit other participants in the collaboration from speaking. Power relationships must be symmetrical to allow participation of all group members in the team effort (D'amour et al., 2005; Pennington, 2008). Without sufficient participation of all disciplinary experts, the team may not take full advantage of the diversity of disciplinary background information (Paletz & Schunn). External factors such as stable funding sources and institutional support also have an influence on group security because they provide team members time to develop relationships and trust (Pennington, 2008; Stokols et al., 2008b).

2.2.5 Physical mechanisms

Pennington (2008) argues that physical presence is a basic requirement for collaboration to actually occur. Coordination mechanisms that promote communication and interaction between participants a cross-disciplinary setting are necessary for building relationships, exchanging information and effective application of participants' expertise (Pennington, 2008; Stokols et al., 2008b). Rich communication media such as face-to-face meetings, workshops and regular contact via telephone or email are more desirable in dealing with the inherent social and intellectual diversity within a cross-disciplinary group than poorer media such as formal information exchange systems and special reports (Dewulf et al., 2007; Cummings & Kiesler, 2005). Physical environmental factors such as spatial proximity of offices and laboratories and comfortable meeting rooms encourage social contact and may facilitate group discussions (Pennington, 2008; Maglaughin & Sonnenwald, 2005; Sonnenwald, 2007; Stokols et al., 2008b).

3. Research methodology

This chapter elaborates on some important considerations underlying qualitative social research as used in this study. In section 3.1 we will discuss the philosophical underpinnings of the research strategy and the use of sensitizing concepts. Section 3.2 contains a detailed description of the subject of the case study. Furthermore, this section discusses the data collection methods that were applied to answer the research questions. Section 3.3 explains the approach to data analysis and contains a step-by-step account of the process of analysis.

3.1 Research strategy

3.1.1 The interpretative-constructivist paradigm

As mentioned in the introduction to this report, the aim of this research project is to gain deeper understanding of the cross-disciplinary collaboration process in the DORA project. According to Bryman (2012), such depth can be reached by employing a qualitative research strategy because qualitative research often entails intensive study of a small group or individuals sharing certain traits. He indicates that a qualitative research strategy favors the epistemological position of interpretivism over positivism and the ontological position of constructivism over objectivism. He maintains that from interpretivist perspective "the stress is on the understanding of the social world through an examination of the interpretation of that world by its participants" (p.380). This is contrasted by the positivistic approach to social research, which employs methods of the natural sciences to seek universal laws by means of "allegedly value-free, detached observations" of social reality (Owen, 2014). Ontological considerations entail questions regarding the nature of social entities: "The central point of orientation here is the question of whether social entities can and should be considered objective entities that have a reality external to social actors, or whether they can and should be considered social constructions built up from the perceptions and actions of social actors" (Bryman, 2012, p.32). The ontological position constituting most qualitative research strategies is the latter. This constructivist approach to the nature of knowledge views social objects and categories as socially constructed: there is no objective knowledge; rather, knowledge is constructed in the mind of the social actor (Bryman, 2012; Owen, 2014).

In practice the interpretative-constructivist paradigm entails looking through the eyes of the participants in the study (Bryman, 2012). This is especially important in investigating cross-disciplinary collaboration because every collaboration is a distinct combination of individuals in a specific research context with possibly unique social dynamics (Kaats & Opheij, 2014; Pennington, 2008). During data collection, we tried to capture this uniqueness as much as possible by placing the experiences and perceptions of and the interactions between the DORA project participants on center stage (see section 3.2.2). The interpretative-constructivist approach also means that research design should be flexible (Bryman, 2012). We used the conceptual framework described in the previous chapter as a starting point, but as the investigation proceeded and we learned more about the collaboration and the team we deviated from this 'protocol' to record instances that appeared to be important to the participants (see section 3.1.2).

3.1.2 Sensitizing concepts

According to Bryman (2012), the use of concepts in qualitative research differentiates from the way quantitative research utilizes concepts. He states that for "most qualitative researchers, developing measures of concepts will not be a significant consideration, but concepts are very much part of the landscape in qualitative research" (p.388). The key difference between quantitative and qualitative research is that the former uses concepts to elaborate definitive prescriptions of what to see and the latter employs concepts as "very general sense of what to look for" (Bryman, 2012, p.388). Blumer (1954) originally formulated this notion of *sensitizing* concepts as a critique of definitive concepts in quantitive social research. Currently, researchers tend to see sensitizing concepts as "interpretative devices and as starting point for a qualitative study" (Bowen, 2006, p.5). The concepts within team actualization (see chapter 2) were used as sensitizing concepts in this study. In line with an interpretative-constructivist approach mentioned above, these concepts formed a springboard in the sense that they drew attention to important aspects of the collaboration process and provided guidelines for data collection within the context of the DORA project. For instance, the concepts of physical mechanisms and group security drew attention to how interpersonal interactions took place between DORA project collaborators. This made us inquire through interview questions about the atmosphere and physical environments in which meetings of collaborators actually proceeded (see section 3.2.3 and Appendix A). This was complemented by observations of interactions at meetings in the DORA project (see section 3.2.3).

3.2 Research design and methods

3.2.1 Case study: the DORA project

Assuming a qualitative research strategy, we selected a case study design because it seemed to fit the purpose of this study: "[The] qualitative case study is an approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources. This ensures that the issue is not explored through one lens, but rather a variety of lenses which allows for multiple facets of the phenomenon to be revealed and understood" (Baxter & Jack, 2008, p.1). We thought this would make it possible to capture the complexity of the interactions in a cross-disciplinary collaboration, which could produce meaningful knowledge about the collaboration process. Another research design that was deemed feasible within the time-span of this project was a cross-sectional study using qualitative surveys. In contrast to the case study, that design would arguably not deliver deep and rich enough information that we thought was required for understanding the cross-disciplinary collaboration process.

The subject of this case study is the collaboration between a technical university and a medical center within the context of a healthcare innovation project in the Netherlands. The "Digital Operating Room Assistant", often referred to by its acronym "DORA", was conceived after several years of research on the use of technology in operation rooms of medical centers. The knowledge gained in those years accumulated in the innovation idea of developing a digital "colleague" that can support hospital staff by monitoring processes in the operation room and providing feedback. Within this context, the technical university has set up collaborations with three medical centers (see figure 3.1). The subject of this case study is the collaboration between the technical university and medical center 1 (MC1, a peripheral hospital) and this collaboration is designated as the "DORA project". At the time of the study, there were three subprojects in which technical university researchers and health care professionals from medical center 1 worked together. The following is a brief description of these projects:

-
- Project 1 concerns the automatic monitoring of operating equipment and apparatus by means of a sensor attached to the equipment.
- Project 2 is about IT-support of processes concerning the sterilisation of operating instruments.
- Project 3 concerns the monitoring and analysis of the energy use of a surgical instrument.
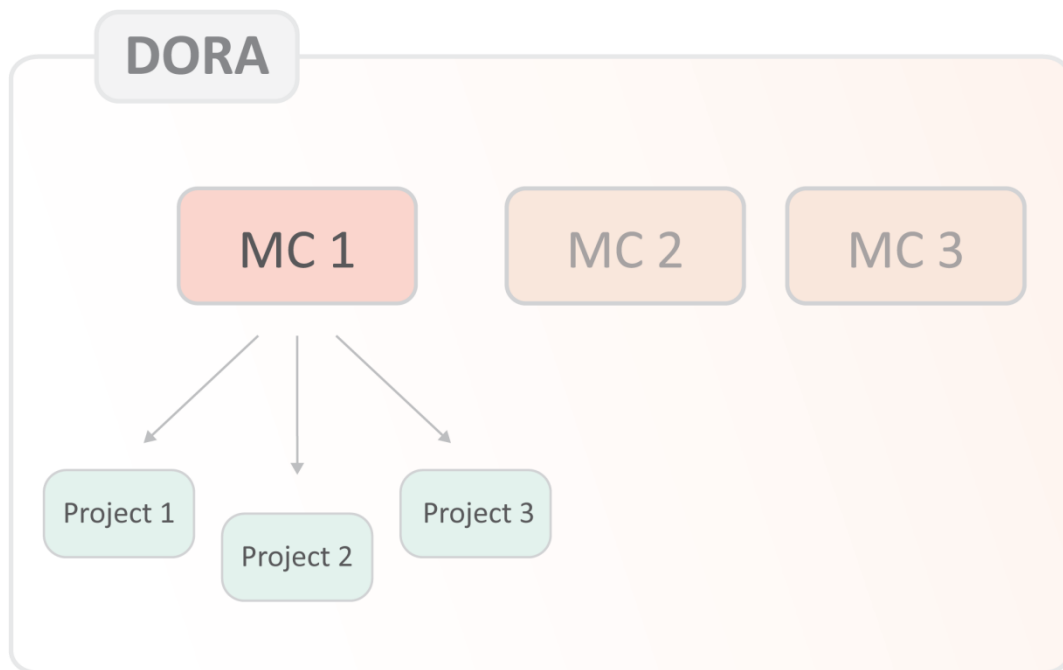
Figure 3.1 Simplified overview of case study.

3.2.2 Selection criteria case

The DORA project was purposively selected as the focus of this study. In light of the purpose of this study, it represents an exemplifying case (Bryman, 2012) because it is a member of a broader category of cross-disciplinary collaboration in Biomedical Engineering in the Netherlands. Participants involved in this collaboration come from different disciplines and different organizations (see table 3.1). Therefore, it forms a suitable context for addressing the purpose of this research project. Furthermore, this case also provided some practical advantages in terms of time and data collection possibilities. The participating organizations were in close proximity of our department and access to contact information of key participants was gained relatively easy.

Table 3.1 Profile of participants in this study

Code no.	Disciplinary background	Occupation	Organization
1	Medicine	PhD-researcher	technical university/medical center 1
2	Project management	Project manager ICT	medical center 1
3	Psychology	Associate professor	technical university
4	Engineering	PhD-researcher	technical university
5	Mathematics	Full professor	technical university
6	Medicine	Surgeon	medical center 1
7	Nursing	Team leader operation room assistants	medical center 1
8	Engineering	Graduate student	technical university
9	Engineering	Graduate student	technical university

3.2.3 Data collection

3.2.3.1 Semi-structured interviews

We employed semi-structured interviewing as the main method in answering subquestions 1, 2 and 3. According to Bryman (2012), this is an appropriate approach for researchers who have a reasonably clear focus on the research topic. The list of specific issues that needed to be targeted during the interviews were included in an interview guide (see Appendix A for the final version of the interview guide). This interview guide was based on the conceptual framework and it was developed and sharpened with the aid of the first and third supervisor. According to the third supervisor (an experienced qualitative researcher) the questions in the first version of the interview guide were too abstract and suggestive. On the basis of his comments, the author developed a second version containing more concrete questions. Again, after discussion with the third supervisor, the author changed the order of the major topics that had to be addressed to make the interview run more smoothly in the sense that the interview guide invoked a natural flow of a conversation. The final version of the interview guide consisted of a list of questions of which we were confident that could explore the most important aspects of the collaboration process of team DORA.

Respondents had the opportunity to choose a venue for the interview. At the start of the interview the purpose and goals of the research were explained and prior to the recording the interview with a voice recorder interviewees were verbally asked for permission. Although the interview guide was useful, the respondents were encouraged to share as much as possible their perceptions and experiences of the collaboration process. This was done by asking follow-up and probing questions when interviewees said something interesting or unexpected in light of the research questions. Afterwards, the interview recordings were transcribed word for word using audio-transcription software.

The author of this report, who performed data collection and analysis, did not have prior experience with qualitative research. The third supervisor was experienced in qualitative research and gave advise about the amount of interviews, selection of participants and the number of meetings to join for observations. Using this as a starting point, the author

held 9 interviews with team members of the DORA using snowball sampling as a main approach to selection of respondents. Selection of participants for the interviews was purposive because it was aimed at selecting those members of the collaboration who could provide rich information regarding the research questions. E-mail contact was set up with two technical university researchers who where involved in the DORA project and agreed to participate in this study. They had a clear view of the key individuals involved in the collaboration and they suggested participants from the medical center who were involved in the DORA project and with whom they had regular contact. With their help e-mails with with a request for an interview were sent to 5 potential participants who all agreed to have an interview, bringing the total number of respondents to 7. After the first two interviews, some respondents recommended to sent additional requests for interviews to 2 potential participants, who also agreed to have an interview. This brought the total number of participants to 9.

After these 9 interviews were conducted and transcribed, the author started the analytical process. During this process, it was decided whether more interviews would have added value; whether they would yield useful information that was not available in the interviews that were conducted. By joining meetings of team DORA before and after the interviews were conducted, the author also had the opportunity to get a feeling for how many persons were involved in DORA project and what their roles were. Through informal conversations, assessments were made about the kind of information they could convey about the collaboration process. This knowledge was used for the final decision to stay with the 9 interviews because having more interviews were likely not to have added value for the analysis.

3.2.3.2 Observations

The author of this report joined 11 meetings within the context of the DORA project to make observations of the interactions between the people involved in this collaboration (see table 3.2). With reference to the number of meetings that were joined to make observations, the author tried to join as much meetings as possible, provided that these meetings were about the DORA project and/or that they would provide useful information about the collaborative process of team DORA. The final amount of 11 meetings were a large part of the meetings that were held within the context of the DORA project in the time frame of this research project. Initially, participant 4 provided information about meetings that would be interesting in terms of observing interactions between researchers and hospital staff. Later on, participant 2 also provided information about meetings that were held within the hospital and where the DORA project (or one of its subprojects) would be the main topic. Observational work was relatively unstructured in the sense that the author joined the meetings to get an impression of how and in what kind of atmosphere these meetings proceeded: who are the people that attended? what was the topic of discussion? how did they communicate with each other about important topics? etc. The author made as many notes as possible during the meetings and after the meeting these were processed into detailed notes (an example can be found in Appendix B). Distinctions were made between actual happenings and interpretations of these happenings in these notes if it was necessary.

We employed observations of interpersonal interactions at the DORA project meetings as an auxiliary method to semi-structured interviewing for the purpose of triangulation. Guba and Lincoln (as cited by Bryman, 2012) maintain that triangulation is a good way to improve the credibility of a qualitative study. Triangulation entails using more than one method and/or sources of data to study social phenomena and is used by qualitative researchers (Bryman, 2012). For

example, ethnographers employ triangulation to check their observations with interview questions to determine whether there misconceptions in what they have seen (ibid.). By making observations of the interactions between participants in the DORA project at meetings, we tried to get a sense of the social dynamics involved in this collaboration. These observational data complemented the more 'static' interview data because they gave overview of how participants actually engaged with each other in real situations over a short period of time. Indeed, the observational notes were an important aid in interpretation of interview data and reflection on emerging themes from the iterative process of data analysis. Moreover, joining these meetings made it possible to achieve of detailed view of the interactions and communications within the the organization of the DORA project. As depicted in table 3.2, the attendance and purpose of the meetings varied, making it possible to see the whole spectrum of activities and people involved in the DORA project both at the technical university as at the hospital.

Table 3.2 Overview of joined meetings DORA project

Date and location	Project	Activity	Attendees
4-12-2014 hospital	2	working session risk analysis project 2 of the DORA project	• participant 4 • participant 8 • participant 7 • participant 2 • 2 employees hospital (operation room (OR) assistants) • 2 employees sterilization company
8-1-2015 technical university	All	progress meeting PhD-researchers DORA project	• participant 3 • participant 4 • participant 1
13-1-2015 technical university	All	general progress meeting researchers DORA project	• participant 5 • participant 4 • participant 1 • participant 3 • participant 9
16-1-2015 hospital	2	evaluation meeting risk analysis project 2 of the DORA project	• participant 2 • participant 8 • participant 4
19-1-2015 hospital	2	evaluation meeting risk analysis project 2 of the DORA project	• employee hospital (surgeon) • participant 8 • participant 4
30-1-2015 hospital	All	contact group meeting with representatives of the university and hospital	• participant 6 • participant 4 • participant 5 • participant 3 • participant 2 • employee hospital (OR manager) • employee hospital (clinical physicist)

Date and location	Project	Activity	Attendees
4-2-2015 hospital	2	evaluation meeting risk analysis project 2 of the DORA project	• employee hospital (surgeon) • employee hospital (OR assistant) • participant 2 • participant 4 • participant 8
10-2-2015 hospital	1	progress meeting project 1 with hospital staff	• participant 2 • 2 employees hospital (OR assistants) • 2 employees hospital (technical support) • representative of involved IT-company
16-2-2015 hospital	1	Kick-off in the hospital of follow-up project 1	• participant 2 • participant 4 • employee hospital (OR manager • 2 employees hospital (clinical physics) • representative involved IT company • employee hospital (surgery resident) • 2 employees hospital (OR assistants) • 2 employees hospital (technical support) • 3 employees hospital (IT)
24-2-2015 technical university	All	general progress meeting researchers DORA project	• participant 1 • participant 3 • participant 4 • participant 5 • 2 technical university researchers • anesthetist from an academic medical center
1-5-2015	All	contact group meeting with representatives of the university and hospital	• participant 1 • participant 3 • participant 4 • participant 5 • participant 6 • employee hospital (surgery intern)

3.3 Data analysis

3.3.1 Strategy

To analyze the data generated by the interviews we applied thematic analysis. Bryman (2012) states that thematic analysis is a common approach to qualitative data analysis. A theme is "a category identified by the analyst through his/her data that relates to his/her research focus (and quite possibly the research questions) and that builds on codes identified in transcripts and/or field notes" (Bryman, 2012, p.580). We applied an inductive-deductive strategy in the thematic analysis to make sure that the perceptions and experiences of the respondents would be reflected appropriately by the final themes. This meant that the coding process was initiated inductively with open coding of 3 interviews. Open codes summarize in a word or short phrase the topic of a passage or sentence in the transcripts. These codes were based on wording in the transcripts (i.e. the wording of the respondents). The open codes were then

used to set up 'closed' codes that were deductively applied to code the remaining interviews. This meant that the codes were 'imposed' on the data. The coding process was terminated with 5 closed codes that were descriptive in nature. These closed codes were then further analyzed to set up the final themes that accurately described patterns and ideas in the data. The thematic analysis was performed by the author of this report.

3.3.2 Process stages

The data analysis process was non-linear and iterative of nature, but for the sake of clarity we will describe it in discrete stages. The reader should note that each stage was an iterative process on itself. We have summarized in bullet points the most important aspects of some stages.

Stage 1: Familiarization with the data

Stage 1 consisted of reading and re-reading interview transcripts to get familiarized with the data. Ideas about seemingly important themes in the transcripts were jotted in preliminary analytic memos.

Stage 2: Coding first 3 interview transcripts

After a phase of reading and re-reading the transcripts to get familiarized with the raw data, the initial coding phase was started by coding the first 3 interview transcripts sentence for sentence. The author used descriptive code names with similar phrasing ('open' coding) as in the transcripts. This was quite a mechanistic process but interesting ideas and patterns that appeared in the data were recorded through analytic memo writing. The open coding process produced a long list of codes that would make thorough analysis unmanageable. A categorization step was applied by examining these open codes for overlaps, redundancies and similarities. Stage 2 was finalized by setting up a set of 12 categories or 'closed' codes.

- Chunks of data: sentences
- Open codes
- Analytic memos
- List of open codes
- List of 12 closed codes (captions are descriptive and in Dutch):
  - "Financiering"
  - "Overleggen"
  - "Relaties"
  - "Perceptie DORA"
  - "Persoonlijke traits"
  - "Innovatie zorg"
  - "Leiding/sturing geven"
  - "Klinische relevantie van technisch onderzoek"
  - "Persoonlijke motivatie"
  - "Soorten samenwerking"
  - "Meerwaarde DORA voor [ziekenhuis]"
  - "Interactie met OK"

Stage 3: Coding remaining interview transcripts

These closed codes were applied to code the remaining 6 interview transcripts and after an iterative cycle of coding and re-coding, the coding process was finalized by bringing down the number of closed codes from 12 to 5 closed codes. The third supervisor advised to bring down the number of closed codes because further analysis would otherwise become too descriptive in nature, not reaching the analytical depth that we were looking for in this research project. The remaining 5 closed codes were selected as 'candidate themes' for further analysis. It is important to remark that although a thorough analysis of the data was not taking place yet, estimations were made of the relevance of the closed codes to the research purpose and to the research questions in selecting appropriate closed codes for further analysis. The captions of the candidate themes were translated to English but remained descriptive of nature.

- Chunks of data: sentences and paragraphs
- Closed codes
- Analytic memos
- List of candidate themes:
    - "Interdependency"
    - "Perception of DORA"
    - "Contact group interactions"
    - "Personality"
    - "Relationships"

Stage 4: In-depth analysis of 'candidate themes'

The search for themes must go beyond coding; it requires researchers to go beyond the surface meanings and find meaning of the coded data, reflect upon these findings and identify "continuities and linkages" between coded data and emerging themes (Bryman, 2012, p. 580). The author collected the interview quotes under the 5 candidate themes described above and examined the ideas and concepts to see what they mean and how they relate to the research questions. Interpretations were made about how these concepts and ideas interacted with each other. This entailed a long iterative process in which emerging themes were continuously scrutinized by their relevance to the research questions, by constantly comparing them with the data in the transcripts and by examining interrelationships between themes and subthemes. Through this stage, the author used some suggestions by Bryman (2012) in the search for the major themes in the data: What topics recur again and again? Are there great differences in how respondents describe e.g. their social relationships? Do respondents use striking metaphors or analogies to describe the collaboration? The author also checked for the coherence of his interpretations of themes with the interview transcripts, analytic memos: Do the interpretations reflect patterns and ideas in the interview data? The observational notes were used as an aid in interpreting interview data and to reflect on emerging patterns and ideas in the data: do the observational notes support, refute or contradict the emerging themes from the interview data? In this stage the 5 candidate themes that were descriptive became 3 major themes (comprising several subthemes) that captured the essence of large parts of the interview data set. This was an arduous exercise but it was necessary to ensure that the final themes were both relevant to the purpose of this research project as well as firmly anchored in the data. Figure 3.2 is an example of how a major theme is built up from the data.

Stage 5: Construction of narrative from major themes and subthemes

The aforementioned stages yielded a list of themes of which the author was confident that they portrayed 'the big picture' of the collaboration process in the DORA project and started to write up the findings in a narrative. However, the analysis continued during this phase as well. Preliminary writings were shared with supervisors and peers who gave feedback that sharpened the narrative. The final result is presented in a narrative in the following chapter.

- List of final themes:

  - Framing DORA: research vision and organizational interests

  - Contact group interactions: the importance of familiarity in decision-making

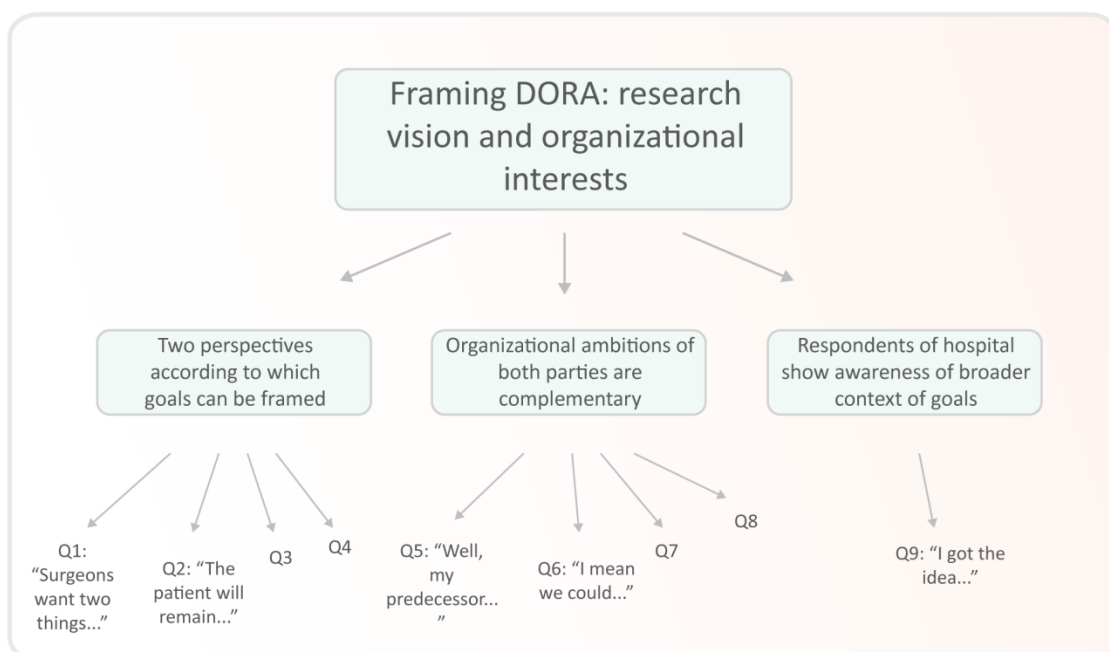 - Respondent 4's pivotal role in the collaboration

Figure 3.2 Classification tree for the theme Framing DORA: research vision and organizational interests

4. Findings

This chapter chapter presents the three themes that emerged from the data after analysis. These themes are *Framing DORA: research vision and organizational interests* (section 4.1), *Contact group interactions: the importance of familiarity in decision-making* (section 4.2) and *Respondent 4's pivotal role in the collaboration* (section 4.3). Section 4.4 summarizes the essence of these themes.

Note: the quotes that support the themes are left out in this public version due to anonymity issues. For the report version with quotes, please contact the author (see colophon for contact details).

4.1 Framing DORA: research vision and organizational interests

Respondents gave accounts of goals of the DORA project that appeared to be intricately connected to the meaning they assigned to the term "DORA". When asked about the problem addressed by and the objectives of the collaborative project, respondents associated with the *hospital* referred to DORA as a 'system' and framed the project goals according to that perception. Their accounts were suggestive of a pragmatic viewpoint. Indeed, in their perception DORA was a monitoring system for operation room apparatus that served as an aid in the core task of the hospital, namely the care and safety of patients. Although respondents associated with the *technical university* also mentioned 'patient safety' with reference to the project goals, they appeared to place these goals in a broader context and saw DORA as a template for research on processes in the operation room. These accounts appeared to convey a research perspective. In their discussions of the future possibilities of the DORA project, hospital respondents showed awareness of the broader context referred to by the technical university researchers

It is important, however, to consider the organizational framework in which these perceived goals of the DORA project seemed to be situated. Respondents often gave accounts of the benefits of the collaborative project in terms of their organization's interests. Practical relevance of scientific research was an important feature of these accounts and appeared to be an important indicator of the incentives for both parties to engage in collaboration. Technical university respondents emphasized their ambition of knowledge valorization and the accompanied need for a 'lab' for experimentation and measurements. Their accounts reflected a genuine readiness to make technical research practically usable, which appeared to suit the incentives for involvement of hospital in the DORA project. Respondents associated with the hospital gave valorized accounts of its engagement in scientific research and particularly emphasized the applicability of new knowledge in improving the healthcare practice.

4.2 Contact group interactions: the role of familiarity in decision-making

Respondents gave accounts of social interactions between technical university and hospital representatives that pointed out the presence of a contact group as the main decision making organ. The primary moments for interpersonal interaction were meetings at the hospital. Although some respondents spoke of 'monthly' gatherings, there were three months between consecutive meetings during the period of this study. Respondents' detailed descriptions of these sessions and observational notes indicated that although the composition could vary from meeting to meeting, key members of the contact group were respondents 1, 3, 4, 5, 6 and the operation room manager

of the hospital. Respondents referred to the purpose of these meetings as maintaining social contact, exchanging research ideas and deciding on the project's course of action, and discussing important financial matters.

During the study, it gradually became clear that the partnership between the technical university and the hospital in the DORA project was formalized minimally and decisions were made according to relatively informal verbal agreements. Participants showed an acute awareness of this informality when the author inquired about the documentation of project goals at one contact group meeting (May 1st 2015). The reactions were such as 'there you have a good point' and 'you're right about that'. It appeared that everything was actually organized quite informally, based on oral agreements and trust. Part of the financing came from healthcare insurance company and was a matter of 'signing a small contract' by respondent 5 and CEO of the healthcare insurance company, but beyond that there were no formal contracts. Interestingly, respondent 6 indicated that perhaps this should be taken care of in the future, because apparently things did not go well with an involved IT company, but he did not go into detail about that. Respondent 3 indicated that in other collaborative partnerships there was much more formal regulation and every detail was (legally) recorded in a contract.

These observations implied participants' realization that such informal verbal agreements may not be appropriate outside the close-knit network of the contact group, and were suggestive of the importance of personal trust between representatives of the technical university and the hospital. Furthermore, the absence of a formal interdependency appeared to magnify the need for shared understanding in sustaining the mutual beneficial character of the collaboration in terms of interests of both parties - the need for a common objective. This informal way of decision making based trust and understanding could not be separated from the well-established social ties reported by the interviewees. In this regard, respondents appeared to place considerable emphasis on the long-standing relationships between key players in the contact group, often alluding to key members' collaborative history prior to the DORA project.

These accounts emphatically reflected the role of familiarity in social interactions during contact group meetings. Considering this, respondents gave valorized accounts of good rapport between contact group members that seemed to be related to the maturity of their social network. At times the meetings appeared to resemble informal rendezvous where the communal atmosphere was set at the start and sustained in the course of the session, leaving room for jokes and off topic chitchat: The relatively unstructured course of these sessions could also be observed during one contact group meeting (January 30th 2015) when several conversations between different participants in the meeting went across each other after one of the participants joked about some topic of the day. These crosswise conversations happened a few times during that meeting but nobody made an explicit comment about it. Indeed, respondents referred to the meetings as progressing in a 'little chaotic' manner, lacking strict agendas and divisions of labour. They did not, however, appear to be distressed by the absence of a formal and structured routine; on the contrary, several respondents appeared to emphasize the positive aspects of the communal atmosphere in which the contact group sessions took place. This appeared to provide contact group members with a sense of safety in engaging in the discussion of issues related to the project. Respondents gave accounts that were suggestive of open communication between participants during these meetings, referring to discourse on project related topics as an 'open discussion', 'conversation' and 'brainstorm session'. However, two respondents gave accounts that seemed contradictory to good

rapport between contact group members. An important feature of these accounts was the avoidance of uncomfortable matters. This suggests that, in the context of generally positive attitudes to the informal course of contact group meetings, there was a small undercurrent of avoiding sensitive issues that may be linked to maintaining the communal nature of personal contact.

4.3 Respondent 4's pivotal role in the collaboration

Several respondents gave accounts that highlighted importance of the role of participant 4 in the collaboration process. Respondents of the technical university pointed out the importance of participant 4's social 'skills' in laying the groundwork for the collaboration in the DORA project and maintaining contact with operation room personnel. Respondents associated with the hospital were quite positive about their personal contact with respondent 4 and attributed personal traits such as good communicator, 'openness' of character to her personality. Respondent 4 showed remarkable awareness of her pivotal role in the continuation of the collaborative effort. In her accounts, she showed empathy for the operation room personnel and stated that technical university's research activities were not part of their core task, the care of patients, and emphasized the importance of flexibility in making appointments with hospital staff. She considered the effort and time needed to build rapport with hospital personnel as an integral 'part of the job' as PhD-researcher and without it, she was convinced, 'DORA would not have made it to the operation room'.

Analogues to the contact group, familiarity and personal trust appeared to characterize the relationships between participant respondent 4 and members of the hospital staff. Outside the contact group meetings, the author joined respondent 4 in several meetings with hospital staff over a period of two months (see table 3.2). These meetings varied in structure, purpose and attendance but gradually it became clear that her PhD-thesis was aimed at integration of projects 1, 2 and 3 as described in the previous chapter (see figure 3.1), which indicated that her research activities were the substantive heart of the collaboration in the DORA project. Overall the impression was that she played a pivotal role in monitoring progress of technical university's research activities in the hospital and indeed safeguarding the progress of the collaboration in terms of tangible outcomes.

4.4 Summary of main findings

Respondents gave accounts of the goals of the DORA project that appeared to be connected to their perception of the term "DORA". One perspective was associated with respondents of the medical center. They perceived "DORA" as a system and emphasized its added value to monitoring and safeguarding the status of operation room devices. The perspective advanced by the technical university researchers placed the goals of the DORA project in a larger context. They saw "DORA" as a research vision on monitoring and optimizing operation room processes in general. However, respondents of the medical center regularly alluded to this vision in their discussions of future possibilities of the DORA project. Respondents gave accounts that were suggestive of the mutual beneficial character of the collaboration in terms of their organizations' interests and ambitions. An important feature of these accounts was the practical utility of technical research, which appeared to be an indicator of the compatibility of both parties' interests in the collaboration.

Respondents gave accounts that highlighted the role of social ties in sustaining the collaborative effort. These accounts and the observational notes indicated the presence of a contact group as the main decision making organ in the DORA

project. In their discussions of social interactions at contact group meetings respondents appeared to place considerable emphasis on familiarity between key members. Important features of these accounts were good rapport between the technical university researchers and representatives of the hospital and informal decision-making based on mutual trust and understanding between key members of the contact group. Several respondents' accounts and observations of interactions at meetings outside the contact group meetings implied the importance of the role of respondent 4 in safeguarding progress of research activities in the DORA project.

5. Conclusion

In the first chapter of this report we stated that we sought better understanding of the collaboration process in the DORA project. We applied the concepts within team actualization as sensitizing concepts to conduct empirical research. Through an inductive-deductive approach to data analysis, we described in the previous chapter the most important themes with reference to the collaboration process of team DORA. In this chapter we will answer the overall research question by answering the subquestions that were described in the first chapter.

Subquestion I: To what extent does team actualization enable the participants of the DORA project to cope with the diversity of perspectives present in the collaboration?

The findings of this study suggest that the vision of the technical university seemed to accommodate the interests of the hospital enough to provide it with incentives for collaboration. The research vision had broad support under the respondents and mediated the difference in perspectives present in this collaboration. Concretely this meant that the vision of the technical university researchers had added value for the staff of the peripheral hospital in the form of a tangible monitoring system for operation room apparatus. Equivalently, one could argue that the hospital's interests were rightfully addressed by the broad research vision of monitoring and optimizing operation room processes.

Subquestion II: To what extent does team actualization enable the participants of the DORA project to make decisions with respect to the goals of the collaboration?

The findings of this study suggest that familiarity and mutual trust between contact group members were the main drivers of decision making with respect to the goals of the collaboration. The longstanding relationships between contact group members and their regular social interactions appeared to have established a firm basis of trust. This manifested itself most clearly in the informal way that decisions were made. With minimal formalization of objectives and obligations of the collaborative project, contact group members relied upon verbal agreements, assuming a shared understanding of the goals of the collaboration. The primary moments for decision-making were face-to-face meetings at the hospital. Familiarity between contact group members appeared to affect these meetings by setting a safe and trusting atmosphere for discourse on project related matters.

Subquestion III: To what extent does team actualization enable the participants of the DORA project to monitor progress toward the goals of the collaboration?

The findings of this study suggest that respondent 4 played a crucial role in the collaboration process of team DORA (i.e. contact group members and non-contact group members). Respondent 4's efforts were crucial in monitoring the actual progression the collaborative project toward the direction decided on by the contact group members. Through continuos communication with team members outside the contact group she appeared to have incorporated their perspectives into her research activities. Because her research project lied at the heart of the collaboration, she is likely to have enabled team DORA to become actualized.

Overall research question: To what extent does team actualization enable participants of the DORA project in the collaboration process?

The findings of this study suggest that team actualization in this collaboration is characterized by a research vision that was sufficiently tangible to adequately address the goals of the peripheral hospital. In this way, this vision connected the pragmatic and research perspectives of respectively the hospital participants in this collaboration and technical university participants. The vision and the accompanying goals of the collaborative project were minimally formalized in contracts. Instead, decision making in relation to project goals and future directions was based on interpersonal trust, which appeared to be a product of the long-standing social relationships between key members of the contact group. The importance of social relationships was also emphasized by the role of respondent 4, who invested time and energy to build rapport with hospital staff who are not members of the contact group. By monitoring the progress of research activities in the hospital, she is likely to have contributed to team actualization of team DORA by connecting the practical needs of the hospital staff with the broad vision of the university researchers.

6. Discussion

This chapter reflects on the content and process of this research project. Section 6.1 reflects on the quality of this research by evaluating its validity and reliability. In section 6.2 we will discuss our findings in relation to the ideas of Pennington (2008) and other literature. This section will function as a basis for section 6.3 where we will provide some recommendations for team DORA. Section 6.4 contains recommendations for future research. We will conclude this report by reflecting on the contribution of this research project to the research of the Science Communication group at TU Delft (section 6.5).

6.1 Assessment of the quality of research

6.1.1 Validity

To our knowledge there were no comparable (social scientific) studies done about cross-disciplinary collaboration in Biomedical Engineering in the Netherlands. This makes it difficult to make statements about the transferability of our findings. A follow-up to this study could improve transferability of our findings by examining several cross-disciplinary projects (i.e. a multiple case study) in Biomedical Engineering using a similar methodology. This research project could then be used as input for setting up interview questions and observation protocols and subsequently the transferability of our findings could be assessed much more rigorously.

Another limitation of this study is that the semi-structured interviewing (our main method of investigation) were 'snap-shots' in time of the collaboration process of team DORA. By adding an ethnographic element (observations of interactions at meetings) to our methodology, we have attempted to capture the social dynamics of the collaboration process in the DORA project over several months. Therefore, we are fairly confident that the detailed account given in chapter 4 is a valid description of the collaboration process of team DORA. A follow-up to this study could improve validity of our account of the collaboration process by applying a longitudinal design to the study of team DORA. By extending observational work over a longer period of time, a full ethnographic methodology could improve validity of our findings and conclusions about the collaboration process of team DORA.

6.1.2 Reliability

Reliability as related to the extent that a study can be replicated is a difficult criterion to meet in qualitative research because social settings and the conditions of the initial study cannot be 'frozen' to make it replicable to the degree that quantitative research enables (Bryman, 2012). We believe, however, that the systematic approach to data collection and analysis (as described in section 3.2) provides future researchers with sufficient opportunities to replicate this study. The author of this report has endeavored to make this process as transparent as possible and has kept an 'auditing trail' with records of transcripts, coding frameworks, analytic memos with data analysis decisions and observational notes. These can be made available when peers want to replicate this study or evaluate its validity.

Furthermore, the author of this report is available for a consultation about his use of the interview guide and the social role he adopted during observations of interactions at meetings. This can potentially increase the reliability of this study because researchers that replicate it are prone to adopt a similar interviewing style and social role during their investigations, which may make their interpretations more comparable with the interpretations of the author of this report.

6.2 Reflections on findings and conclusions

6.2.1 A firm basis for collaboration

Trust and a non-hierarchal power structure are two important mechanisms that cultivate participation of members of a cross-disciplinary group (Pennington, 2008; Stokols et al., 2008b). Pennington (2008) states that trust between group members is an important facilitator of group security. Moreover, she argues that power relationships must be mediated to a degree that all group members feel enabled to express their views. Non-hierarchic structures acknowledge group members' autonomy and foster participatory formulation of objectives and decision-making (Stokols et al., 2008b). The contact group showed some features of non-hierarchal arrangements in decision making during its meetings. Respondents gave accounts that conveyed an image of members engaging on equal footing in discussions about topics related to the collaborative project. These discussions were characterized by open communication between contact group members. In line with the communal atmosphere at the meetings, they were relatively unstructured lacking strict agendas and divisions of labour. Respondents were generally positive about the way the contact group meetings progressed. Mansilla et al. (2013) describe this as a cross-disciplinary group's "way of doing things":

> Blow by blow, these researchers' interactions create a symbolic network that holds the group together and contributes to the creation of a repertoire of customary rules ... that constitute "the way we [the group] do things" (p.12).

Furthermore, Mansilla et al. (2013) argue that in successful collaborations these rules may promote a "climate of collegiality" that is characterized by a trusting atmosphere, open debate and polite argumentation. In addition, teams that incorporate communication norms - expectations and implicit rules regarding communication - that promote a collaborative spirit rather than contention between members are found to be more innovative (Paletz & Schunn, 2010). According to Stokols et al. (2008b), good communication between team members fosters feelings of trust and psychological safety. In this sense, the contact group members appeared to have established reasonably clear (albeit implicit) rules of engagement through their common history of interaction. The most striking feature of this set of rules was the effort of keeping things communal, which seemed to make communication inclusive and collaborative.

Pennington (2008) maintains that social relationships are critical and that a group must invest time in learning how to interact well despite differences between its members' personal traits. However, she differentiates between building trust for group security and establishing social ties in accordance to Maslow's hierarchal distinction between safety needs and social needs. The findings of this study suggest that longstanding social ties and the presence of trust are mutually constituent and that both aspects are fueled by regular interactions between team members. In team DORA this manifested itself in regular face-to-face meetings between contact group members and ongoing communication of respondent 4 with hospital staff outside the contact group. D'amour et al. (2005) state that such "trusting

relationships" between team members are important in cross-disciplinary collaborations because they are positively related to an individual's sense of belonging to the team. Shrum et al. (2007) indicate that in the formative stages of a cross-disciplinary project researchers must be dislodged from other ongoing activities to be committed to the activities of the cross-disciplinary group. They argue that such commitments are promoted by relationships with individuals who are known and trusted; old collaborative partnerships may be reactivated. The set up of the collaborative project in this study was facilitated by the pre-existing relationships between some key members of the contact group, giving extra weight to the social character of forging cross-disciplinary alliances.

In short, our findings suggest that the factors physical mechanisms, group security and social relationships are intertwined and mutually reinforce each other: through an extensive amount of face-to-face meetings team members get to know each other and interpersonal relationships may develop. Through the build up of a joint history, collaborators keep filling the mutual 'trust reservoir' (Kaats & Opheij, 2014) with each face-to-face meeting. We argue that physical mechanisms, group security and social relationships are probably not separate "steps" or "levels" like in Maslow's hierarchy of needs. They rather form the 'basis' of a cross-disciplinary collaboration and their interrelationships may be much more non-linear than the hierarchal relationships suggested by Pennington (2008). This is shown below in figure 6.1.
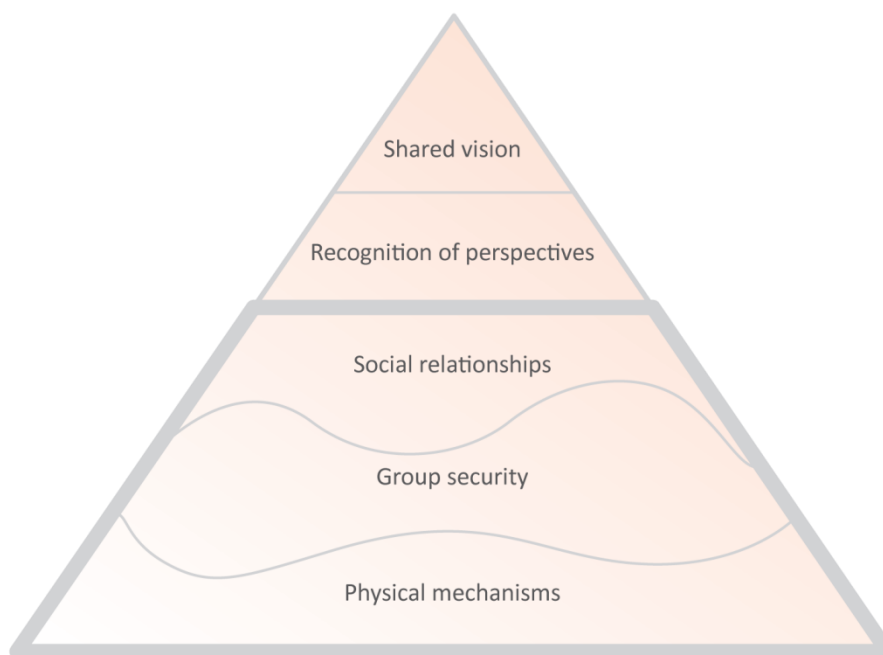

Figure 6.1 A visual representation of the interrelationships between the lower 'levels' of the team actualization framework according to our findings

6.2.2 Facilitating team actualization

Pennington (2008) argues that a cross-disciplinary team needs to integrate intellectually the different perspectives that are present in a shared vision in order to be effective in reaching its intended goals (i.e. to become actualized). This shared vision dictates commitment to the group effort because individuals feel that their goals and interests are represented in a larger objective (Senge, 1990; Sonnenwald, 2007). Jeffrey (2003) argues that lack of a vision that is

supported by all disciplinary experts may lead to withdrawal of several researchers. A shared vision may also empower participants in a cross-disciplinary setting to surpass obstacles in reaching the goals of their project (Klein, 2005; Stokols et al., 2008b). In this regard, we see that the DORA project team functioned well at the social level, or at least participants had a common understanding on how the group should function on the social level, but the team did not have a shared vision that integrated the goals and disciplinary perspectives of the individual team members. It appeared, however, that team DORA did not need to collectively set up such a shared vision because there was one team member that acted as a 'content manager' and translated the technical university's broad research vision into research activities that were also relevant for the hospital staff. By repeatedly communicating with operation room staff she incorporated their perspectives into her research activities and made sure that the DORA project remained relevant for all members of the collaboration. In this sense, she seemed to actually develop a shared vision that integrates disciplinary perspectives (i.e. according to Pennington, 2008) for her own project but in doing this she propelled the team forward because her project was at the heart of this collaboration.

Although team members appeared to utilize two different perspectives (the pragmatic perspective and the research perspective) on the goals of the collaboration, there seemed to be a broad concern that was shared by all the individuals present in the collaboration: the importance of the practical utility of scientific research. This appeared to be an important driver of the collaboration. If we adopt an organizational view on this, we could argue that the broad research vision of the technical university provides the hospital with strategic incentives to fulfill their ambition of staying scientifically relevant. Kaats and Opheij (2014) state that collaboration between organizations is likely to be initiated with a reason: it has to have benefits for both organizations. They argue that organizations generally engage in collaboration because they can jointly achieve objectives that would be unattainable on their own. They maintain that doing justice to organizational interests will result in mutual gains. The findings of this study suggest the technical university researchers and the health care professionals from hospital had found each other on an organizational level in the sense that they wanted to explore together the future possibilities of monitoring and optimizing operation room processes. Both partners appeared to be in collaboration for the mutually beneficial exchange of knowledge and other resources, which appeared to be independent of the vision or idea behind "DORA", and the collaboration appeared to be driven by the 'mutuality of interests' between both organizations (Kaats & Opheij, 2014) rather than a shared vision that incorporated the different disciplinary perspectives and acted as a "springboard to creative problem solving" (Pennington. 2008, p.1). Indeed, the respondents appeared to convey a shared vision on the collaborative process in terms of what type of relationship existed between their parental organizations. An important feature of the shared vision on this interrelationship was the compatibility of organizational interests. Kaats & Opheij (p.15) maintain that the "mutual relations and interactions" of collaborating partners form the basis for bringing together different interests and aims in a broadly supported view on their common concern. In this regard, the DORA group seemed to thrive as a team because the relationships and interactions of the contact group were conducive to maintaining the support from both organizations for the common concern of making operation room processes more efficient and safe. From an organizational perspective, the DORA team's familiarity served as a platform for a meaningful collaboration between both parties and therefore aided the team to become actualized. However, the team still needed respondent 4 to propel the collaboration forward because she was the one who monitored whether the practical needs of the hospital staff kept matching the research activities of the technical university researchers (see figure 6.2).
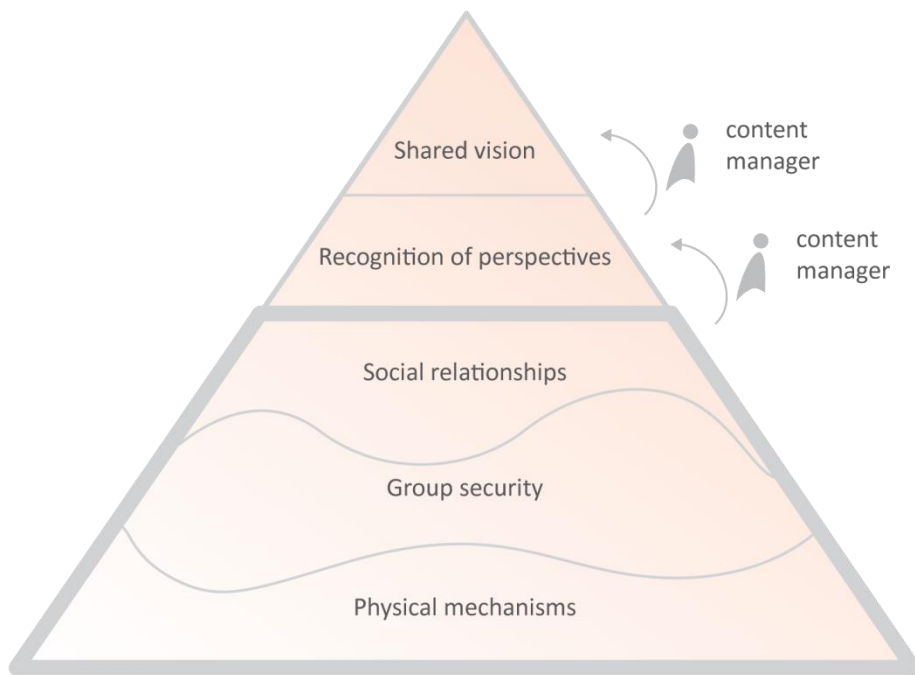
Figure 6.2 Visual representation of the role of the content manager in the team actualization framework

6.2.3 Revision of the team actualization framework for team DORA

From a communication perspective, one could argue that the collaboration process in the DORA project is characterized by a relationship aspect and a content aspect. This statement is based on one of the fundamental ideas that underlies the 'interactional' view on human communication as advanced by Paul Watzlawick and colleagues, namely that "communication not only conveys information [i.e. content, FE] but that at the same time it imposes behavior" (Watzlawick, Beavin, & Jackson, 1967, p.51). Two people who communicate do not only exchange information but they also create expectations for each other's behavior and they therefore (re-)define their relationship by their interactions (Littlejohn & Foss, 2010). If we apply these ideas to our findings, one could put forward the notion that team actualization within the context of the DORA project seemed to be characterized by a relationship aspect and content aspect (see figure 6.x). The relationship aspect relates to the team's common history of interaction and the accompanying shared vision on how to engage (i.e. define their relationships) in the collaborative process as individuals from parental organizations with different interests. The content aspect relates to the role respondent 4 as the content manager of this collaboration: making sure that the collaboration moves forward in terms of tangible results by repeatedly exchanging information with hospital staff and monitoring the progress of research activities in the hospital. Indeed, as we have argued in the previous section, her efforts appeared to be directed at setting up a shared vision on the content of the collaboration.

According to Pennington (2008), both the relationship and the content aspect are needed for team actualization to occur: the 'need' for good social relationships are a requirement for the higher 'needs' of recognizing perspectives and setting up a shared vision. However, she appears to put emphasis on the content (exchange of information and knowledge) rather than interactions and relationships between collaborators through in the collaborative process. A

shared vision that is characterized by intellectual integration is at the top of the pyramid (see figure 2.1). In other words, the team actualization framework implies that the content aspect of the collaboration is of a higher 'level' than the relationship aspect. Our findings suggest that there may be a different 'path' for teams to become effective in cross-disciplinary collaboration and therefore to become actualized. This could be best understood if we make an explicit distinction between the relationship aspect and the content aspect at the higher 'levels' of the team actualization pyramid. We believe that adding these two aspects to the team actualization framework makes it sharper because it notifies the reader that, according to our findings at least, that team members may not need to invest time and energy in setting up a *substantive* shared vision that incorporates *all* the disciplinary perspectives in order to thrive as a cross-disciplinary team. If a part of the team members maintain a proper platform (in this case a contact group) by frequently interacting in face-to-face meetings and enables one team member to construct a *substantive* shared vision for the different subprojects within the boundaries of a broadly supported common concern, the collaboration may thrive as well. These ideas are summarized visually in figure 6.1.
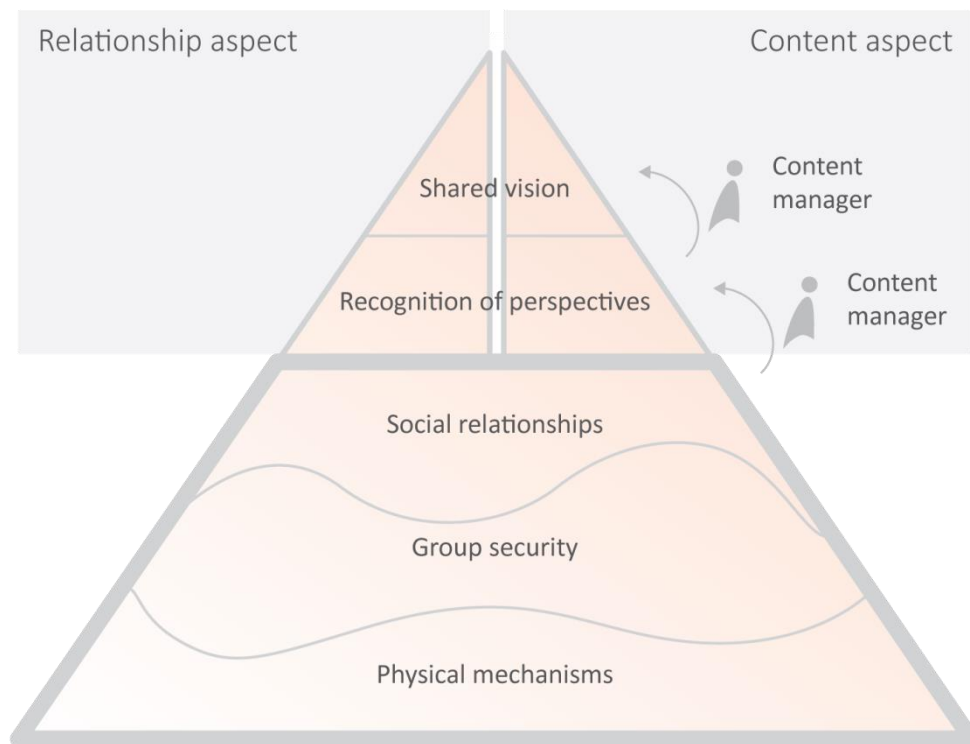

Figure 6.3 Revision of the team actualization framework for the collaboration in the DORA project

6.3 Recommendations for team DORA

We have discussed the collaboration process of team DORA extensively in this report and overall our perception was that the team functioned well. The collaboration was characterized by a strong platform of trust and familiarity. Although a substantive shared vision - by which we mean a shared vision according to the ideas of Pennington (2008) - seemed not be present there was a team member that acted as a content manager and facilitator of the collaborative endeavor. Furthermore, there appeared to be a common concern that was of interest for both organizations involved and that had support of all team members. These points appeared to give team DORA its momentum and made the collaboration move forward. However, we see some challenges and opportunities for team DORA and we want to

discuss these toward the end of this report. We think that awareness of these challenges and opportunities can potentially enable team DORA in the collaboration process in its current and future endeavors.

We have seen in the previous chapters that respondent 4 played a pivotal role in the collaboration process and that she essentially acted facilitator of the DORA project in terms of content of the collaboration. This is potentially a good strategy for effective collaboration because the team does not need to set up a very dense substantive shared vision in which all individual perspectives of team members are incorporated. As Pennington (2011b) has shown this process can take a long time and requires presence of all team members. For team DORA this means contact group members and non contact group members should meet repeatedly which may be arduous for some team members, especially for operation room staff. Therefore, enabling respondent 4 as a manager of the collaboration process and explicitly discussing what she needs to make the collaboration move forward could prove to be a promising tactic for team DORA to be effective in achieving its goals. If the contact group is considered as the main decision making organ this means that in meetings team members could partly focus on the assistance of the content manager, and partly focus on aligning interests of both parties in the collaboration.

However, this approach to collaboration could also be problematic if or when respondent 4 leaves team DORA. Inspired by our findings, we think that the team should be aware of two points if or when this happens. First, the team could collectively decide to install a replacement with the same function (i.e. content manager) as respondent 4. If the successor initiates a new project or a follow-up project within the boundaries of the broadly supported view on operation room processes, the team could follow the strategy as described above to enable him or her in the process of setting up a substantive shared vision. Second, the team should be aware that when a successor is elusive, team members may have to build a substantive shared vision for the collaboration to progress. In this case, the adjusted team actualization framework for the DORA team (see figure 6.3) may be used to make team members aware of they have achieved already and how they can use the firm basis of trust as a springboard to a substantive shared vision that integrates different disciplinary perspectives present in the collaboration. The importance of a content manager and thus the importance of a substantive shared vision will become more clear when we discuss the expansion of team DORA (i.e. extension of the 'network' of the DORA project).

A second set of opportunities and challenges is related to the organization (or structure) of the collaboration in the DORA project and the expansion thereof. In section 6.2 we have discussed the explorative nature of this collaboration in the sense that the DORA project appeared to be aimed at exploring together the possibilities of automatic monitoring and optimization of operation room processes, which was connected to the common concern of making these processes safer and more efficient. One could imagine that such an idea may attract other actors (persons, companies or other types of organizations) that are interested to join the collaborative effort. Team DORA could benefit from this when they are aware of the opportunities and pitfalls of the possible situations that may arise according to our understanding of its collaboration process. First, a new actor may be familiar with the common history of interaction and the long-standing relationships of team DORA and enter the collaboration from the relationship 'side' (see figure 6.3). The basis of trust of team DORA will probably ensure a smooth transience into the team. However, Kaats and Opheij (2014) note that an explorative collaboration (characterized by a broad concern as its 'assignment') may attract parties that are unable of adding value to the collaboration and potentially pose a threat to the quality of

the partnership. For the team DORA this means that the content manager must monitor whether relatively new actors make constructive contributions to the substantive shared vision of the collaboration. Again, when the team recognizes this and enables the content manager to monitor the progress of the collaboration, this could be a good strategy.

Second, and related to the first point, a new actor may be interested to join the collaboration, but not have the proper social connections with team DORA. According to our understanding of the collaborative process of team DORA, they will probably enter from the content 'side' (see figure 6.3). This means that the content manager will be the main contact point for the new actor. Kaats and Opheij (2014) advise that in this situation the "top priority" of the "moderator" of the collaboration should be "to minimize the barriers to access the collaboration for the desired partners and to make sure to create effective opportunities for interaction [with other team members, FE]" (p.25). For team DORA this means that the content manager should be enabled to bring the new actor into the collaboration by, for example, organizing face-to-face meetings with DORA team members. However, as we have seen in our findings it may take some time before new parties have built rapport with all team members. This means that initially a new actor may be connected to team through the content manager. When team is aware that the new actor is 'loosely' coupled (Kaats and Opheij, 2014) to their network, they could enable the content manager to expand their network in this way. When a content manager is absent, the team could try to set up a substantive shared vision using the adjusted team actualization framework (see figure 6.3) as a starting point. In this way, they have a reference frame for the content of the collaboration when new parties want to join or when the team decides it needs 'fresh blood'.

6.4 Recommendations for future research

6.4.1 Managing cross-disciplinary collaboration in Biomedical Engineering

Pennington (2008) states that team actualization forms a motivational framework for understanding the environment that leads to effective collaboration across disciplines but in relation to this she appears to put emphasis on the density of a substantive shared vision: "team actualization in a distributed, multi-institutional and multi-disciplinary context is rare - in most cases the team either does not function effectively at the social level, individuals fail to develop the skill of acquiring other perspectives, or participants never construct a shared vision that fully integrates *all* [my emphasis] of the different individual goals" (p.8). In line with this reasoning she argues that for cross-disciplinary teams to be effective, they must be managed by a 'boundary spanner' who is recognized by all team members as 'facilitator' of the collaboration. Our findings suggest that cross-disciplinary collaboration should indeed be managed but that management may also happen informally. Although respondent 4 was effectively the content manager of this collaboration, the communal atmosphere suggested that this role was much more implied than it was explicit. Future researchers of the cross-disciplinary collaboration process in Biomedical Engineering are advised to take into account that small-scale collaborations like the DORA project may be have informal instead of formal management. Further study could reveal what type of management styles are desired for cross-disciplinary collaboration in Biomedical Engineering.

6.4.2 The relationship aspect of cross-disciplinary collaboration in Biomedical Engineering

Pennington (2008) recognizes that social interactions and relationships are important and should be managed, but she appears to convey the message that effective cross-disciplinary collaboration is mainly about intellectual integration of different types of knowledge and disciplinary perspectives.

According to her the latter implies a learning process: team members should be aware of the different disciplinary perspectives that are present in a collaboration and learn how to integrate those perspectives into a substantive shared vision on their collaborative effort. Stokols et al. (2008b) see interactions between team members and their social ties as key *contextual* factors that influence intellectual integration of disciplinary perspectives in cross-disciplinary collaboration. More recent studies appear to focus intensively on the interrelationships between the social and cognitive dimensions of cross-disciplinary collaboration (Mansilla et al., 2013; Paletz & Schunn, 2010). We concur with this direction and in the following we want to give some recommendations for future research of cross-disciplinary collaboration in Biomedical Engineering from a communication perspective.

In the previous section we used the ideas of Watzlawick et al. (1967) to advance the explicit distinction between the relationship aspect and the content aspect of team actualization. This pertained only to one part of the axiom put forward by Watzlawaick et al. (1967): they also argue that the relationship aspect 'classifies' the content aspect in the sense that the latter forms the 'data' of the communication and the former conveys how the communication should be understood. If we extend this idea to cross-disciplinary collaboration in Biomedical Engineering, this suggests that the relationship aspect of cross-disciplinary communication is more important than the content aspect of cross-disciplinary collaboration - assuming that the intellectual aspect is characterized by the exchange of information about knowledge, data and methods - because the former conveys how the information (often new information) should be understood regardless of whether the communicators are fully aware of the definition of their relationship (Watzlawick et al., 1967). Although many authors touch on the subject of communication within cross-disciplinary teams, few provide deeper insights than the fact that communication is important - most literature review here emphasize the importance of coordination mechanisms like regular e-mail or face-to-face contact. This could be because most authors see communication as exchange of messages or that they implicitly weave together aspects of interpersonal interaction and communication. Either way, we believe that research on the relationship aspect of cross-disciplinary communication in Biomedical Engineering may provide opportunities for gaining better understanding of effective cross-disciplinary collaboration in that field. This can, however, be challenging because the relationship aspect is often implicit: researchers are prone to discuss content rather than relationships during interviews (Mansilla et al., 2013). In this regard, focused future research on the relationship aspect (e.g. ethnographic study) of cross-disciplinary communication within the context Biomedical Engineering may reveal how the relationships between researchers in a cross-disciplinary team affect the exchange between and the integration of different disciplinary perspectives. Subsequently it may produce insights into the intricate relation between the cognitive and the social dimensions of cross-disciplinary collaboration in Biomedical Engineering.

6.4.3 The content aspect of cross-disciplinary collaboration in Biomedical Engineering
In the introduction to this report we showed with an example that an engineer frames a problem differently than a surgeon. This difference in approaching or 'seeing' a problem stems from their education in and their commitment to a discipline (Miller & Mansilla, 2004; Dewulf et al., 2007; Pennington, 2008). Our study only touched the surface of this problem: we found that there was indeed a difference in how respondents from the hospital looked at "DORA" and how the technical university researchers perceived it. If we relate this to figure 6.3, we could say that there were two distinct perspectives with which respondents looked at the content of the collaboration. With the data we collected, however, it is quite hard to determine whether these were disciplinary perspectives or that they were more connected

to the occupation or organization of the respondents. One could argue that the present occupation of the respondents was connected to their disciplinary background, and by that logic the frames were actually related to the disciplines present in this collaboration. As mentioned already, the differences in disciplinary perspectives were present but they appeared to be mediated by the attractiveness of the research vision behind the DORA project.

To validate this statement, much more research is needed about the different levels of cross-disciplinary collaboration in Biomedical Engineering. The example from the introduction is focused on the individual differences in disciplinary perspectives: an engineer and a surgeon decide to collaborate, which triggers a process of cross-disciplinary communication and interaction to determine a common stance about the problem at hand. This process relates to the content aspect of cross-disciplinary collaboration in Biomedical Engineering. In our study, we have caught glimpse of this process by observing some interactions of respondent 4 with the health care professionals from the hospital. On the individual level, future research could focus on the differences in framing of a problem in the cross-disciplinary communication between for example an engineer and surgeon. The work of Dewulf, Gray, Putnam, Lewicki, Aarts, Bouwen, & Van Woerkom (2009) on cognitive and interactional framing could be a promising framework for further study. They make a distinction between frames that are cognitive representations of "the way people experience, interpret, process or represent issues" and frames that are "communicative devices that individuals use to negotiate their interactions" (Dewulf et al., 2009, p.160). Using these insights in a focused ethnographic study of the collaboration process of an engineer and surgeon could yield insights about how differences in disciplinary perspectives influence the effectiveness of cross-disciplinary problem solving, and how these differences may be overcome to allow effective collaboration.

The contact group meetings appeared to be a decision-making organ and functioned much more on an organizational level. Our findings with respect to the collaboration process of team DORA is probably a mix of statements on the individual level described above and on an organizational level. On the organizational level, we recommend further study on how a cross-disciplinary collaboration can be managed in such a way that a team can effectively reach its goals. Our findings show that an organizational structure with a contact group and a content manager may be promising basis for a cross-disciplinary collaboration in Biomedical Engineering. We hope that this study inspires more research about how other collaborative projects in Biomedical Engineering are organized and how this organization influences the content aspect of cross-disciplinary collaboration.

6.5 Significance of this study for Science Communication TU Delft

The significance of this study for the Science Education and Communication (SEC) department at TU Delft can be regarded as a contribution to the research efforts of the Science Communication group (SC). The practical contribution of this study lies mainly in extending awareness of the team and enabling it to anticipate on the challenges and opportunities that are present in the collaboration process. Although this study was not concerned with designing a tool or communication process, the methodology that was used has potential for developing for example a decision support tools that are highly customized for a certain team or project. For instance, the details of the collaboration process in the DORA project could make it possible to develop a tool or process that is highly sensitive to the needs of team DORA, which would have an impact on the utility of such a tool.

The Science Communication group has a qualitative research project about understanding strategic communication in multidisciplinary collaboration in innovation networks. The scientific contribution of this study can be seen as an addendum to that effort because it shows that a qualitative methodology elicitates a detailed account of the collaborative practice of cross-disciplinary teams. It shows the potential of such an approach in complementing the quantitative and design-based research that is being done on support systems for communication professionals. The detailed account of the daily practice of a cross-disciplinary team provides valuable insights in the complexity of interactions and communications between (academic) engineers and health care professionals. This was made possible by the qualitative research strategy that was described in chapter 3 and the inductive-deductive approach for data analysis, both of which were aimed at looking from the perspective of the collaborators to gain better understanding of the actual workings of a cross-disciplinary team.

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Appendix A: Interview guide (Dutch)

BRIEFING

Dit interview wordt gebruikt om een goed beeld te krijgen van samenwerkingsverbanden binnen de biomedische techniek. Met de inzichten die worden verkregen kunnen toekomstige samenwerkings-verbanden beter worden ingericht.

Laat ik mezelf eerst even voorstellen: mijn naam is Ferdoos Esrail en ik ben student aan de TU Delft. Dit interview vindt plaats in het kader van mijn afstudeerproject, waarin ik onderzoek doe naar samenwerking tussen personen met verschillende achtergronden binnen de biomedische techniek. Mijn doel is om de belangrijkste aspecten van het samenwerkingsproces in kaart brengen.

Het interview zal ongeveer tussen een uur duren. De vragen die ik u ga stellen hebben betrekking op uw ervaringen en beleving van het samenwerken met betrokkenen binnen het DORA kader. Er zijn dus geen goede of foute antwoorden. Probeer de vragen zo ruim mogelijk te beantwoorden. Alles wat u denkt of voelt en wat volgens u relevant is voor de vraag mag u aanhalen.

Alle informatie uit dit interview wordt vertrouwelijk behandeld en uw anonimiteit wordt natuurlijk gewaarborgd. Alle interviews worden tegelijk verwerkt en alleen het eindrapport van mijn afstudeerproject zal publiek worden. Om het verwerken van de interview naderhand te vergemakkelijken, zal ik de interview opnemen op een recorder.

Heeft u hierover nog nog vragen of opmerkingen?

Ok, dan ga ik nu de opname starten. **[recorder starten]**

INLEIDING

Voordat we het gaan hebben over samenwerken, ben ik benieuwd naar uw werkterrein en via welke weg u in deze functie bent terechtgekomen. Kunt u mij daar iets over vertellen?

Nu bent u betrokken bij een TU Delft project dat valt binnen het kader van DORA, Digital Operating Room Assistant.

- Bij welk project bent u betrokken?
- Hoe bent u erbij betrokken geraakt? Wat is uw rol?
- Welke specifieke kennis/expertise voegt u toe?
- Heeft u een vaste taak? Wat is die taak?
- Hoeveel tijd van uw werkdag/week spendeert u hieraan? Maakt u daar expliciet tijd voor vrij of gaat het tussendoor?

VISIE EN DOELEN

De volgende vragen gaan over de **visie** achter DORA. Hoe zou u deze visie omschrijven?

- Welk probleem probeert DORA volgens u aan te kaak te stellen? Wat is uw visie op dit probleem?
- Wat is volgens u het **doel** van DORA?

- Heeft u het gevoel dat de personen waar u mee samenwerkt naar dit doel toewerken? Dat de 'neuzen dezelfde kant op staan'?
- Wat wilt u persoonlijk bereiken met uw betrokkenheid bij dit project binnen DORA?

SOCIAAL COMPONENT

Hoe zou u de sociale omgang in dit geval karakteriseren? Wat zijn de belangrijkste kenmerken?

- Is jullie contact/omgang heel formeel of juist niet? En waarom denkt u dat het zo is?
- Met wie gaat u veel om of heeft u veel contact? Waarom juist met die? Heeft u veel nieuwe contacten gemaakt met dit project?
- Hoe was de omgang bij aanvang van het project? Is dit veranderd naarmate jullie langer met elkaar samenwerken?
- Zijn er veel verschillen (en overeenkomsten) in persoonlijk karakter? Worden die expliciet besproken? Hoe beïnvloedt dit jullie omgang met elkaar?

KENNIS/EXPERTISE COMPONENT

Naast uw **kennis/expertise** zijn er andere expertises aanwezig die allemaal hun eigen inbreng hebben in het project. Ik ben benieuwd hoe jullie daar mee omgaan. Zou u voor mij een vergadering in het kader van DORA willen beschrijven?

- Hoe bereidt u zich voor op een vergadering?
- Waar vergaderen jullie meestal? Is dit een prettige plek om te vergaderen [wordt u niet gestoord bijvoorbeeld]?
- Worden er notulen gemaakt? Wie doet dat?
- Wat is uw inbreng in de vergadering?
- Hoe bepalen jullie welke onderwerpen er besproken moeten worden? Gaat dit altijd zo?
- Hoe worden taken verdeeld? Gebeurt dit altijd op dezelfde manier?
- Wat zijn die taken? Wie doet wat?
- Hoe beoordelen jullie of taken goed zijn uitgevoerd?
- Is er een duidelijke projectleider?
- Kunt u zijn stijl van leidinggeven omschrijven?
- Hoe beïnvloedt de stijl van leidinggeven de beslissingen die genomen worden in het project? Heeft iedereen evenveel in te brengen?

AFSLUITING

Waar denkt u dat DORA over een 10 jaar zal staan? Bent u dan er nog bij betrokken, zo ja in welke rol? Zo nee, waarom niet?

Voordat we het gesprek gaan beëindigen, zou ik u willen vragen of er bepaalde zaken zijn die volgens u niet aan bod zijn geweest?

- Is er nog iets wat u wilt vertellen over uw ervaring en beleving van het samenwerkingsproces?
- Zijn er nog vragen die u mist maar die wel belangrijk zijn voor dit onderzoek?

- Zijn er nog mensen die ik zou moeten spreken voor dit onderzoek?

DANKWOORD

Dan wil ik u bedanken voor het meewerken aan dit onderzoek. Mocht u op de hoogte willen blijven van de resultaten van dit onderzoek, kan ik u uiteraard mijn uiteindelijke rapport toesturen.

Appendix B: Example of observational notes from a meeting (Dutch)

Aantekeningen vergadering DORA

Datum: 30-1-2015

Tijd: 13.00 uur

Locatie: Ziekenhuis, raadkamer 5

Aanwezigen: participant 5 , participant 3 , participant 2 , participant 6, OK-manager ziekenhuis, participant 4, klinisch fysicus ziekenhuis

Afwezig: participant 1

- Iedereen ontmoet elkaar voor raadkamer 5, sommige mensen kennen elkaar niet en stellen zichzelf voor
- We zitten in raadkamer 5, een overdrachtsruimte met stoelen in een presentatie opstelling
- We gaan om een kleine tafel zitten, iedereen schuift z'n stoel een beetje naar achteren
- Omdat een aantal mensen elkaar niet kent, doen we een voorstel rondje
- Participant 6 komt wat later binnen, in witte doktersjas, hij brengt thee en koekjes
- Voorstelrondje gaat door, hier en daar worden wat grapjes gemaakt, vooral door participant 6
- Klinisch fysicus geeft aan dat hij zich meer bezig moet gaan houden met de samenwerking met de technische universiteit, participant 6 haakt hierop aan en attendeert hem erop dat het belangrijk is dat klinische fysica een goed beeld heeft van het project DORA en haar geschiedenis, zodat er geen misverstanden ontstaan
- Participant 6 geeft aan dat klinische fysica een "essentieel" onderdeel is van de samenwerking
- Er wordt expliciet gesproken over persoonlijke connecties/relaties en over fondsen werven, de klinisch fysicus wordt aangeraden om de persoonlijke connecties met de technische universiteit zichtbaar en duidelijk te maken
- Er wordt een issue besproken waarbij het geld dat het beschikbaar beschikbaar had voor project 1 onder spanning kwam te staan maar het is inmiddels opgelost: er wordt expliciet gemaakt dat project 1 en project 2 bewust als twee aparte projecten zijn opgezet binnen het ziekenhuis, het budget van project 1 is daarbij dus veiliggesteld
- Vervolgens vertelt participant 4 iets over de plan van aanpak van participant 1, de klinisch fysicus probeert duidelijk te krijgen wat e-learning daarmee te maken heeft, participant 4 en participant 6 geven daar uitleg bij
- De klinisch fysicus wekt sowieso de indruk zich goed te hebben 'ingelezen' en voorbereid te hebben op dit gesprek: hij is erg oplettend en neemt actief deel aan de discussies
- Participant 2 houdt zich een beetje meer op de achtergrond, meeste discussies lijken buiten haar expertise te vallen
- Participant 6 vraagt hoe het gaat met participant 1 (heeft een epileptische aanval gehad), participant 4 en participant 5 geven aan dat het wel goed komt maar dat ze goed moet rusten en geen nachtshifts meer moet doen
- Dan vraagt participant 6 hoe het gaat met haar en haar onderzoek en of Jenny daar tevreden mee is. Hoe participant 5 en collega's met haar omgaan tijdens het onderzoek wordt expliciet besproken
- Kort wordt er gesproken over data, de klinisch fysicus zegt dat er een hoogleraar big data op de technische universiteit wordt benoemd, participant 5 plaatst dat in context en geeft aan dat het heel moeilijk is om

"goeie" data te vinden, waar je iets mee kan.. participant 2 en de OK-manager lijken zich afzijdig te houden bij dit soort dingen..

- De OK-manager begint over project 2, terwijl participant 6 al grappend koekjes uitdeelt..

- Participant 6 legt uit wat het perspectief van de artsen is op de problemen met project 2, geeft aan dat zij ook geduldig moeten zijn, en dat het "start problemen" betreft

- Een discussie komt op gang, de klinisch fysicus probeert er tussen te komen maar lukt niet helemaal. Er ontstaan even twee aparte gesprekken, tussen participant 5, participant 6 en participant 3 en tussen de anderen

- Dit switcht even naar centraal en vervolgens weer naar decentraal, de klinisch fysicus en participant 6 gaan met elkaar praten en de rest ook een beetje met elkaar

- Dan gaat het gesprek wat centraler, participant 6 vraagt iets aan participant 4 over "tags", participant 4 maakt een inschatting en participant 2 valt haar bij

- Er wordt weer door elkaar heen gepraat, de OK-manager is zich daar bewust van en betrekt mij erbij door aan te geven dat ze "niet zo goed communiceren nu"... ik maak een grapje, daarna worden anderen bewust ervan en gaat de vergadering centraal

- Het valt mij op dat niemand er last van lijkt te hebben, althans het wordt niet expliciet gemaakt, dat mensen door elkaar heen praten... het gaat eventjes zo en na een tijdje pakken ze de draad soort van op, niemand intervenieert.. de OK-manager een soort van door mij erbij te betrekken

- Participant 3 neemt nu duidelijk het woord.. noemt daarbij het woord "hacken", participant 6 maakt een grapje over de actualiteit, is verbaasd dat de jongen die iemand gijzelde bij NOS van de technische universiteit is en uit [stad in Nederland] komt, weer ontstaan er twee gesprekken die kruislings gaat, tussen participant 3 en de klinisch fysicus; en tussen participant 4, participant 5 en participant 6... De OK-manager en participant houden zich afzijdig..

- Die kruislingse gesprekken gebeuren wel vaker.. er wordt gewoon door elkaar heen gepraat, maar niemand die daar expliciet een opmerking over maakt..

- Er wordt gepraat over de "onderzoeks OK" waar mensen van de technische universiteit metingen enzo kunnen doen, participant 6 stelt voor dat er een karretje met sticker van de technische universiteit, want dat is beter voor de "acceptatie" volgens hem..

- Participant 6 laat de POWI-bundel vallen als idee, en vraagt of de technische universiteit mensen daar iets mee kunnen doen en of het gekoppeld kan worden aan DORA.. participant 4 geeft aan dat er misschien een afstudeerder aan kan zitten..

- Participant 6 wekt sowieso de indruk een facilitator/promotor te zijn van het samenwerkingsverband

- Participant 4 wil een topic aanhalen maar participant 6 vraagt participant 3 over een conferentie waarvoor hij hem had uitgenodigd waar patientveiligheid werd besproken, participant 3 reageert hierop en daarna mag participant 4 weer verder...

- Participant 4 legt uit wat het "idee" achter het stroommeter project is, ze praat over een "ver weg idee" en waar het project nu is ("wat kunnen we, wat kunnen we meten en ermee doen")

- Participant 5 vraagt even door over het stroommeter project om dingen voor haarzelf helder te krijgen, participant geeft hier antwoord op.. na een korte discussie is dat dat helder..

- De meeting gaat nu richting zijn 'officiele' eind.. participant 6 lijkt zaken te willen doen en vraagt of er dan een afstudeerder erop gezet kan worden

- Participant 3 vraagt aan participant 6 hoe hij dan de opdracht zou formuleren... participant 6 legt wat uit... participant 5 en participant 3 geven aan dat dat misschien beter een stage kan worden.. met andere woorden, er lijkt min of meer onderhandeld te worden over een klein project van participant 6 dat ondersteund kan worden door de technische universiteit.. Participant 6 praat over een volgorde: "eerst een stage dan een afstudeerder..", vindt dat een goed idee, maar participant 5 en participant 3 reageren daar niet heel duidelijk op, lijken de boot een beetje af te houden

- Opmerkelijk: participant 3 geeft aan dat hij die POWI bundel eerder bewust uit DORA heeft gehouden (zegt sorry tegen participant 6, beetje half grappend lijkt het wel)

- Er worden soort van afspraken gemaakt over inrichten van de onderzoeks OK, de klinisch fysicus gaat daar achter aan, op verzoek van participant 6...

- Er wordt gesproken over ene DORA symposium.. participant 3 geeft aan dat "als er iets tastbaars zou zijn, zouden we toch een klein feestje houden?"

- Officieel vergadering afgelopen, OK-manager gaat als eerste ervan door, de rest blijft voor een napraatje: participant 3 en de klinisch fysicus lijken hun banden aan te halen, participant 3 zegt meerdere "lijntjes" te hebben binnen de technische universiteit en dat die wel belangrijk zijn voor de klinisch fysicus

- Participant 6 praat met participant 5 en participant 4 nog wat na over participant 1 en een nieuwe studente van hem ("een tante met pit", dat miste hij een beetje in participant 1)...

- Ik praat nog een tijdje met participant 6 over mijn onderzoek, daarna met de klinisch fysicus en participant 4, daarna praten participant 5 en participant 6 wat bij, terwijl de klinisch fysicus en participant 4 ook wat praten met elkaar..

- Terwijl de technische universiteit mensen weggaan blijven participant 1, participant 6 en de klinisch fysicus achter en gaan weer om de tafel zitten..